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GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

BULLETIN 101

SURFICIAL GEOLOGY OF VICTORIA AND STEFANSSON ISLANDS, DISTRICT OF FRANKLIN

J. G. Fyles

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PLATE I. Drumlinized lowland of southern Victoria Island, view eastward from a point about 30 miles east of Read Island. Drumlins average $1\frac{1}{2}$ miles in length and record glacial flow towards the observer. Note miniature esker in the lower left quadrant. Rough-textured pale areas are felsenmeer and rubbly outcrop of Palaeozoic dolomite. (R.C.A.F. T321 L-180)

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PREFACE

During 1959, the Geological Survey of Canada conducted an aircraft-supported geological reconnaissance of Victoria, Stefansson, and Banks Islands in the western part of the Canadian Arctic Archipelago. Although the project was primarily concerned with the bedrock geology, the author was attached to the field party to study the surficial geology of this little-known region, which is believed to straddle the northwestern boundary of the last continental North American ice-sheet. This report deals with the two eastern islands; a parallel report is planned for Banks Island.

J. M. HARRISON,
Director, Geological Survey of Canada

OTTAWA, May, 1962

Bulletin 101 — Oberflächengeologie der Victoria-Insel und der Stefansson-Insel (Bezirk Franklin). Von J. G. Fyles.

Dieser Bericht beschreibt glaziale Landformen und Ablagerungen auf zwei Inseln im zentralen Teil der kanadischen Arktis und deren Beziehung zu dem Zurückweichen und Verschwinden der letzten Eisdecke des Pleistozäns. Auch postglaziale marine und nichtmarine Formen werden beschrieben.

Бюллетень 101 — Дж. Г. Файлс
Ледниковая геоморфология о. Виктория и Стефанссон, район Франклина.

Отчет представляет описание ледниковых форм поверхности и отложений на двух островах в центральной части Арктики Канады и отношение этих форм к отступлению и исчезновению последнего ледникового покрова плейстоценовой эпохи. Описываются также морские и неморские отложения послеледникового времени.

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Abstract

Victoria and Stefansson Islands lie within the northwestern part of the region overridden by the Laurentide ice-sheet during the last (classical Wisconsin) glaciation. In general, the ice-sheet flowed northwestward across the islands, although the pattern of movement was highly complex in detail. The regional relationships of moraines, drumlinoid features, eskers, meltwater channels, and glacial lakes point to progressive glacial retreat from north to south and from west to east.

Large morainal complexes in western Victoria Island border broad depressions now occupied by arms of the sea. These moraines accumulated along the margins of residual active ice-tongues that occupied the depressions during and after deglaciation of adjoining higher ground. Beneath the morainal deposits are widespread gravels, sands, and silts; in one place, such strata yielded tundra vegetation 28,000 radiocarbon years old. Drumlinoid features dominate the landscape of Stefansson Island and of the central and eastern lowland of Victoria Island. The complex, curving, divergent, and convergent drumlin trends probably record successive changes of ice-flow direction during thinning of the ice-sheet.

Prominent marine features record post-glacial submergence of large parts of the present lowlands. The highest earliest marine level now increases in altitude from 250 or 300 feet in the north and northwest to 600 feet or more in the southeast. Radiocarbon dates suggest that the initial maximum submergence decreased in age from northwest to southeast, and that most of the subsequent uplift took place early in post-glacial time.

Résumé

Les îles Victoria et Stefansson gisent dans la partie nord-ouest de la région qui a été occupée par la calotte glaciaire Laurentide au cours de la dernière glaciation (celle du Wisconsin). D'une façon générale, la calotte glaciaire s'est déplacée vers le nord-ouest à travers les îles, mais le détail du mouvement est très complexe. A en juger par la disposition régionale des moraines, des drumlins, des eskers, des chenaux d'écoulement de l'eau de fusion et des lacs glaciaires, il semble que le recul progressif des glaces s'est fait du nord au sud et de l'ouest à l'est.

De grands complexes morainiques, dans la partie occidentale de l'île Victoria, longent de larges dépressions qu'occupent maintenant des bras de mer. Ces moraines se sont formées en bordure de langues actives de glace résiduelle qui occupaient les dépressions pendant et après la déglaciation du terrain attenant plus élevé. Sous les dépôts morainiques, il y a de larges étendues de graviers, de sables et de limons et, à un endroit, ces strates contenaient des éléments végétaux typiques de la toundra dont le procédé de datation au carbone radioactif nous a permis de fixer l'âge à 28,000 ans. Les formes drumlinoïdes dominent le paysage de l'île Stefansson ainsi que des basses terres du Centre et de l'Est de l'île Victoria. Les directions complexes, arquées,

convergentes et divergentes des drumlins indiquent probablement des changements successifs de la direction d'écoulement des glaces au cours de la période d'amenuisement de la calotte glaciaire.

Des traits saillants d'origine marine témoignent de la submersion postglaciaire de vastes étendues des basses terres actuelles. Le niveau le plus élevé de la mer ainsi que le plus ancien passe maintenant de 250 ou 300 pieds d'altitude, au nord et au nord-ouest, à 600 pieds d'altitude ou plus, au sud-est. Le calcul fait par le procédé au carbone radioactif porte à croire que la submersion maximum initiale a diminué en âge du nord-ouest au sud-est, et que la majeure partie du soulèvement subséquent s'est produit au début de la période postglaciaire.

INTRODUCTION

Victoria and Stefansson Islands together constitute a landmass of some 86,000 square miles lying immediately north of the Arctic coast of continental North America and separated from the mainland by a strait averaging only about 30 miles wide. The landscape of the islands, like that of the mainland to the south, is characterized by an abundance of fresh glacial landforms. On the basis of the regional distribution of this freshly glaciated landscape, the islands are inferred to lie within, but close to the northwestern boundary of the area overridden by the Laurentide ice-sheet during the last regional glaciation. Western Victoria Island lies within a belt of large moraines that apparently forms the northwestern counterpart of the broad belt of moraines along the southern and southwestern periphery of the Wisconsin glaciated area in the Great Lakes and Great Plains regions. In contrast, southeastern Victoria Island, like the Canadian Shield, lacks large moraines and is characterized by abundance of drumlinoid features and eskers.

This report summarizes the results of a preliminary reconnaissance of the surficial geology of the islands; it is based upon ground and air observations scattered throughout the area and upon data derived from vertical and trimetrogon airphotos. The field data were collected during the summer of 1959 in the course of overall reconnaissance geological mapping of the islands, and during part of July 1960, when the writer was privileged to travel in northwestern Victoria Island with a party of the Army Survey Establishment. In 1959, field observations were made by R. L. Christie, R. Thorsteinsson, and E. T. Tozer, as well as by the writer. Transportation in the field was provided by Piper Super Cub aircraft equipped with oversized tires for landing on unprepared terrain. The aircraft were supplied by Bradley Air Services of Carp, Ontario.

Information regarding settlements, transportation, history of exploration, and previous geological work in the area is contained in the main report on the 1959 expedition (Thorsteinsson and Tozer, 1962). Washburn's excellent account of the geology of Victoria Island (1947) contains a wealth of information about the glacial geology and geomorphology of the southern and western parts of Victoria Island, based upon his own field work (1939 to 1941) and upon an exhaustive study of the literature. In his account of the glaciation of the western Arctic Islands, Jenness (1952) reported various observations (largely from airphotos) regarding the glacial landforms of Victoria Island. Fortier (1948) noted the raised beaches, eskers, and fields of drumlinoid features of eastern Victoria Island, as well as striae at Greely Haven.

Permission to join the field party of the Army Survey Establishment in 1960 was granted through the Directorate of Military Survey, Department of National Defence. The writer is indebted to Captain D. M. Matheson, officer in

charge of the Army Survey party, and to the various members of the party for their friendly interest and support. Grateful acknowledgment is also made of the many courtesies extended by J. W. Stanners, Manager of the Hudson's Bay Post at Holman Island, and by Mrs. Stanners. Some of the radiocarbon dates quoted in this report (designated GSC-) have been determined by the Geological Survey radiocarbon dating laboratory operated by W. Dyck within the Isotope and Nuclear Research Section; the remaining dates (designated I (GSC)-) have been provided by Isotopes, Inc. of Westwood, New Jersey.

Bedrock

As shown by Thorsteinsson and Tozer (1961, 1962), Stefansson Island and much of Victoria Island are underlain by gently dipping to flat-lying dolomite, and minor limestone, sandstone, and shale of early Palaeozoic age (Cambrian? to Middle Devonian). Precambrian strata (probably of late Precambrian age) form a broad syncline trending northeast across Victoria Island from Amundsen Gulf to Hadley Bay. These rocks comprise some 9,000 feet of sandstone, siltstone, shale, limestone, dolomite, and gypsum overlain by 1,000 feet of basaltic lava and agglomerate; both the sedimentary and volcanic rocks enclose numerous gabbro sills. Sandstone and gabbro apparently belonging in the lower part of the same succession are exposed along the south coast of Victoria Island near Richardson Islands and Wellington Bay and occur as small inliers surrounded by Palaeozoic dolomite as far north as Washburn Lake. Quartzite, greywacke, and granodiorite lying beneath the succession described above occupy a small area near the south end of Hadley Bay. The areas of Precambrian and Palaeozoic rocks are outlined on the small-scale inset map accompanying the surficial geology map.

Physiography

The main northeast-trending belt of Precambrian rocks on Victoria Island is a region of bedrock ridges and plateaux that comprises the Shaler Mountains (north-central Victoria Island). The remainder of the area consists of monotonous lowlands traversed by irregular belts of hilly moraine.

The Shaler Mountain belt consists of plateaux and ridges, steep escarpments, linear valleys, buttes, and cuestas. Summits are typically 1,000 to 1,500 feet above sea-level and locally attain an altitude of 2,500 feet. Ridges and plateaux are characteristically capped by basalt flows or gabbro sills, whereas intervening valleys have been cut into the less-resistant sedimentary rocks. Ridges, escarpments, and valleys generally trend northeast parallel to the strike of the gently folded rocks. Fresh glacial landforms are present throughout the mountains, but are dwarfed by the larger rock-controlled elements of the landscape.

The lowlands, making up the greater part of the area, are largely within 500 feet of sea-level, but locally reach an altitude of about 1,000 feet. Local relief ranges from a few tens of feet to about 200 feet. The landscape is dominated by glacial landforms, particularly drumlinoid features, and by exceedingly fresh raised marine beaches. These landforms are strikingly apparent when the country is viewed from the air. Lakes are numerous, and rivers generally follow irregular courses along topographic depressions left by the retreating ice-sheet. Despite the ubiquitous glacial landforms and beaches, the surficial cover of unconsolidated deposits is generally thin, and parts of the region are essentially ice-scoured bedrock plains surfaced by flat rubbly outcrop, felsenmeer (rock rubble), and patches of thin drift. Prominent rock outcrops are largely confined, however, to present or former seashore bluffs, to walls of stream gullies, and to the small areas underlain by Precambrian rocks.

Prominent belts of rough morainal topography make up large parts of western Victoria Island, and patches of similar topography occur within the lowlands farther east. The morainal belts consist of thick varied unconsolidated materials that commonly are heaped into more or less steep-sided hills and ridges. Some morainal areas, however, are characterized by broad smooth hills and ridges. The morainal areas commonly stand higher than the surrounding country and have a local relief of 100 to several hundred feet. Bedrock outcrops are largely confined to modern and former shoreline escarpments and to modern and abandoned river channels.

UNCONSOLIDATED DEPOSITS BENEATH GLACIAL DRIFT

Within some of the morainal belts and in other locations, various silts, sands, gravels, and other unconsolidated materials lie beneath glacial drift. A few of these deposits are known to have originated prior to, and separate from, the last glaciation, but most of them have not yielded the information required to indicate whether they belong in this 'old' category or whether they merely record an early phase of the glacial invasion that produced the overlying drift.

The best documented 'old' materials recognized so far are exposed on the walls of a river gully 3 miles north of Prince Albert Sound, and 28 miles east of Holman Post (lat. 70°38′N, long. 116°35′W). There, till 30 feet thick, and locally covered by knob-and-kettle gravel, is underlain by 150 feet of gravel, sand, and silt, which rests in turn upon 50 feet or more of dense till. The inter-till materials are fairly well sorted and, for most part, are horizontally stratified. Cobbly and bouldery gravels are present, but most of the succession consists of pebble gravel, sand, and silt. Near the base of the inter-till unit, below a covered interval and resting upon bouldery gravel, is 20 feet of thin-bedded, pale brownish silt containing closely packed mats of leaves and other remains of herbaceous plants. One of the plant layers contains sparse pollen of grasses, sedges, and other herbaceous plants (J. Terasmae, pers. com.), and has a radiocarbon age of 28,000±1,500 years (date number I(GSC)-30). These inter-till deposits appear to have been laid down by rivers and in lakes prior to the last glacial invasion under a climate not greatly different from the present one. They are inferred to record an interstadial interval equivalent to similar 'early' Wisconsin (pre-classical Wisconsin) events of central North America. Several small exposures of silt and sand apparently belonging to the same inter-till unit were seen up to 5 miles from the occurrence described above.

Stratified silt, sand, and gravel are widely distributed beneath the surface till on Prince Albert Peninsula in northwestern Victoria Island. These sub-till deposits are probably of various ages and origins, but it is not yet known whether any of them originated prior to, and separate from, the last glaciation. Within the area of smooth hilly moraine adjoining Prince of Wales Strait (*see* Fig. 1, Note B) extensive horizontally stratified silts, gravels, and sands, 100 feet or more thick lie beneath till. Generally there is no reason to doubt that the surface till is a direct glacial deposit, but in some places where the drift overlying stratified materials is less than 4 feet thick, the surface till may possibly be a secondary or redeposited material that has crept downslope over glacio-fluvial or glacio-lacustrine strata younger than the parent till. Sub-till silts, gravels, and sands rather like those near Prince of Wales Strait are exposed in many places along, and adjacent to, the large river that flows into the head of Richard Collinson

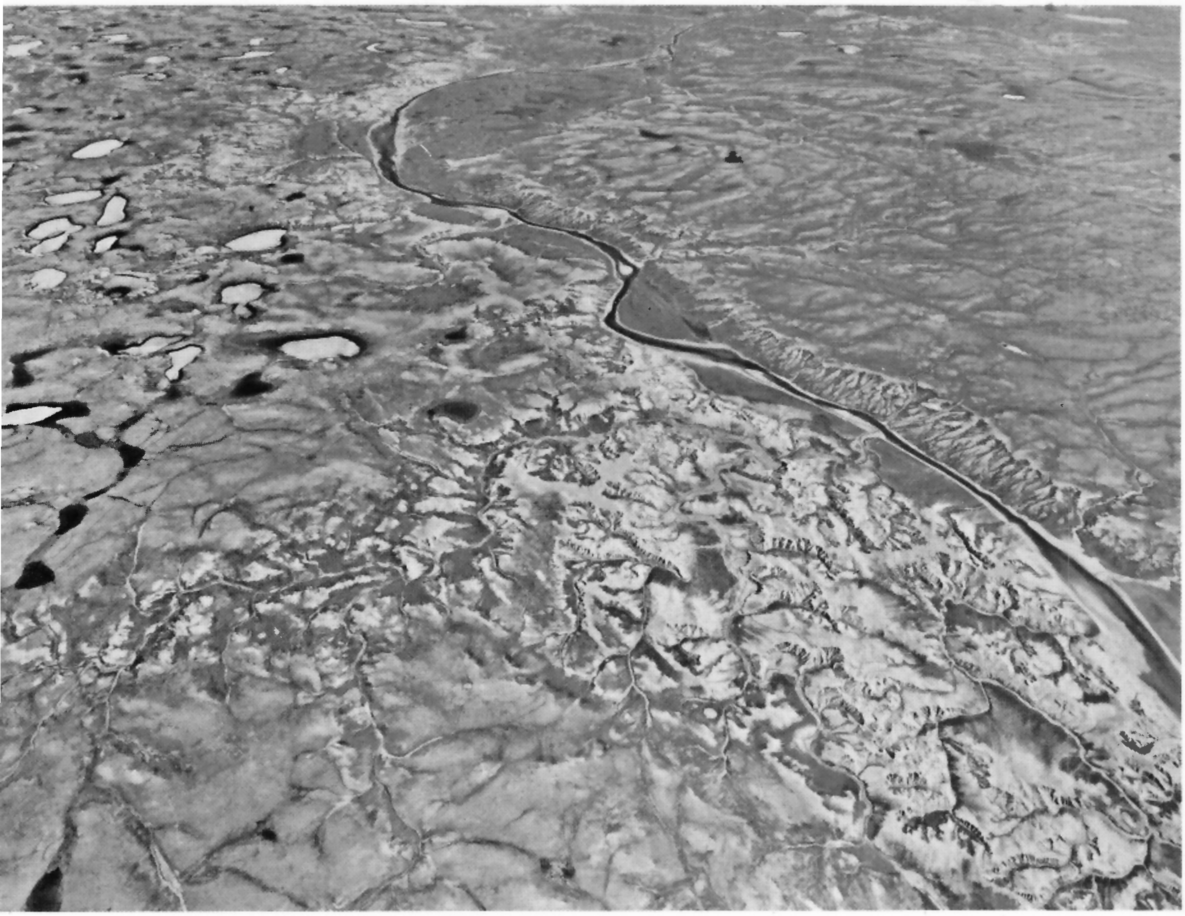

PLATE II. Thickly drift-covered area southwest of the head of Richard Collinson Inlet. As seen in river banks and gullies, the glacial drift surfacing the area is only a few feet thick and rests upon 100 feet or more of stratified sand and silt. Depth of photograph about 18 miles; north is to the left. (R.C.A.F. T347 R-127)

Inlet from the southwest (*see* Pl. II). These deposits are 200 feet or more thick and extend for 30 miles or more along the river. They are locally deformed, but characteristically display regular horizontal stratification. Pebbly sand containing shells of *Hiatella arctica* lies beneath thin till in the wall of a gully 2 miles west of Richard Collinson Inlet and 5 miles south of Loch Point (lat. 73°02′N, long. 114°03′W). Because of the topographic setting, it is unlikely that the till is a secondary material emplaced during post-glacial time. Hence, this exposure may record a glacial re-advance, although perhaps of exceedingly minor extent.

In the area 5 to 25 miles northeast, east, and southeast of Washburn Lake (east-central Victoria Island), glacial ice appears to have advanced over stratified unconsolidated deposits for 20 miles or more. Thick sands appear to be covered by glacial drift within the morainal belt northeast of the lake and are grooved by linear drumlins east of the lake (*see* Fig. 1, Note H). River-channels, apparently eroded in sand or gravel, and an esker have been modified by the same drumlin field southeast of the lake (*see* Fig. 1, Note G). The esker shows no sign of having been overridden near Ferguson Lake, beyond the south edge of the

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drumlin field. The above inferences have been drawn largely from airphotos. Ground observations, although confirming the presence of sands beneath thin stony materials, did not demonstrate a clearly defined cover of till.

GLACIAL FEATURES

Materials

The surface glacial drift of Victoria Island is characteristically pale, yellowish grey to yellowish brown, and consists of angular and water-worn pebble- to boulder-sized rock fragments set in a dense slightly sticky matrix of loamy to sandy loam texture. As would be expected, the size, nature, and percentage of rock fragments and the texture of the matrix vary considerably from place to place. Clayey till was noted in a few places, and exceedingly stony, loose gravelly till occurs in some morainal belts. Where the drift is thin, there are all gradations from the usual compact till to loose blocky felsenmeer. The common, pale yellowish grey colour of the drift resembles that of the Palaeozoic dolomite lying beneath most of the area. In a few places detritus from basal Palaeozoic and Precambrian red beds imparts a pink colour to the drift; in other places Precambrian, basaltic, gabbroic, and sedimentary rocks render it grey.

Pebble- to boulder-sized fragments of granitoid rocks derived from the mainland to the southeast occur in the drift throughout the island, although they generally constitute only a small proportion of the contained stones. More numerous, exceedingly large blocks of granite occur near Cambridge Bay and probably are distributed throughout the adjoining region to the east and as far north as Ferguson Lake. Fragments of rocks characteristic of the Precambrian sediments, sills, and flows exposed on Victoria Island and in the Coppermine and Bathurst Inlet regions to the south, are an abundant constituent of the drift in all but the easternmost parts of the area. The gross distribution of these upper Precambrian erratic stones records glacial transport in a general northwesterly direction. For instance, fragments of these rocks occur abundantly in the drift of northwestern Victoria Island northwest of their outcrop area in the Shaler Mountains. More specifically, basaltic erratics occur in great abundance south and east of Richard Collinson Inlet northwest of the high basalt plateau forming the core of the Shaler Mountains.

Moraines

The exceedingly varied features mapped as moraine belts, ridges, escarpments, and 'traces', are more or less linear constructional landforms or groups of such forms built of glacial debris or glacially deformed strata. These are believed to have accumulated along or adjacent to a glacial margin, or along discontinuities of flow within a glacial body. The moraine ridges range from major features several hundred feet high and traceable (more or less continuously) for tens of miles, to miniature forms only a few feet high and a mile or so long. Similar features with insignificant relief but nonetheless clearly apparent from the air are mapped as moraine 'traces'.

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PLATE III. Hilly topography within a morainal belt, north of Mount Bumpus on Wollaston Peninsula. The pond in the foreground is about 800 feet across and lies about 300 feet below the summits of adjoining hills.

The moraine belts are areas of thick drift and rough hilly topography and commonly stand above the adjoining country. They have been identified and delineated on the basis of their contrast with the surrounding region, in these respects, rather than by any standard relief, drift thickness, or height. Thus they are somewhat subjective units that include the sort of ground mapped elsewhere as end moraine, kame moraine, and hummocky moraine.

Moraines of Southwestern Victoria Island

The most prominent moraines within the map-area occur on Wollaston Peninsula in southwestern Victoria Island. These exceedingly rough areas comprise a bewildering array of ridges and conical to irregular-shaped hills that look like mountain ranges when viewed from a distance (*see* Pl. III). They constitute the highest part of the peninsula and culminate in Mount Bumpus, a boulder-strewn conical hill about 700 feet high with summit altitude of about 1,800 feet. The surficial materials forming these moraines are characteristically a few tens of feet to more than 100 feet thick, and locally exceed 500 feet. The most hilly areas consist partly of loose, stony, poorly sorted, unstratified glacial debris and partly of better sorted, stratified gravel and sand apparently of glacio-fluvial origin. More subdued morainal areas and most of the morainal ridges consist of dense stony till with loamy to sandy loam matrix. From the air, silty and sandy strata exposed beneath coarse glacial debris were noted on eroded banks in a few places.

On the northern side of the peninsula, a rough moraine belt, some 10 miles wide and 120 miles long, borders the southern edge of the depression occupied

PLATE IV. Moraine belt bordering the south side of Prince Albert Sound. Line AA is approximate boundary between moraine (left) and till plain (right). Note meltwater channels bordering the north edge of the moraine belt. Distance bottom of photograph to farthest 'A' is about 30 miles. (R.C.A.F. T347 R-45) by Prince Albert Sound (*see* Pl. IV). The drift escarpments, rows of hills, and short ridges forming the northern edge of this belt clearly relate to the southern margin of a glacier tongue that flowed westward along Prince Albert Sound. Low till and gravel ridges along the southern edge of this moraine parallel the northern edge of the moraine, but it is not known whether the ice that deposited them lay to the north, south, or both.

In the southern part of Wollaston Peninsula, a belt of till ridges and hills (*see* Pl. V), up to 200 feet high, constitutes a well-marked east-trending moraine 130 miles long. Less prominent moraine ridges forming the eastward continuation of this moraine have been traced intermittently for another 100 miles around a northward loop and south again almost to the coast between Byron Bay and Wilbank Bay (approximately long. 109°W). This moraine marks the northern edge of an extensive fan-shaped drumlin field (*see* Pl. VI) and appears to delineate a margin of the ice lobe that built the drumlins. Short channels of meltwater streams that flowed northward through the moraine indicate that ice lay along the south side of the moraine when the ground to the north was bare.

Moraine North of Prince Albert Sound

The belt of moraine north of Prince Albert Sound consists partly of rough hilly topography built of stony glacial debris and ice-contact gravel and sand, and partly of more subdued topography underlain largely by loamy to sandy loam till. Morainal ridges are short and inconspicuous but drift escarpments, several tens to 200 feet high, are traceable more or less continuously for tens of miles parallel to the axis of the belt. West of Tahiryuak Lake the boundaries of the moraine are rather indefinite, but north and northeast of the lake the hilly lake-dotted moraine contrasts sharply with the almost lake-free plain to the north with dendritic drainage. The Tahiryuak depression within the moraine was formerly occupied by a lake some 20 miles across. In general, this belt of moraine appears to have accumulated along the northern edge of a glacier tongue in Prince Albert Sound. The overall relationships, however, must have been more complicated at least in the eastern part of the moraine, where glacial ice still remained when the adjoining part of the Prince Albert Sound depression had become sufficiently free of ice to permit entry of the sea (see *Abandoned Channels*).

Moraines of Northwestern Victoria Island

Most of Prince Albert Peninsula in northwestern Victoria Island bears a thick, varied cover of surficial deposits forming a rough and hilly to rolling landscape ranging up to 1,500 feet above sea-level. The morainal belt shown on Figure 1 has been chosen rather arbitrarily and excludes some areas that might be classed as moraine. As discussed earlier (*see* p. 4), stratified, unconsolidated materials are widely distributed beneath the surface glacial deposits in this region.

The coastal moraine belt of northwestern Victoria Island differs in form and material from one end to the other. The southwestern part of the moraine, lying

PLATE V. Irregular moraine ridges comprising the south Wollaston
Peninsula moraine about 45 miles east of Read Island. (R.C.A.F. A16326-20)

PLATE VI. Moraine 'trace' (line AAA) outlining the northeast edge of a large field of drumlinoid forms (line AAA to background). View westward across southern Victoria Island from a point about 15 miles southwest of Byron Bay. This moraine 'trace' constitutes the eastern extremity of the south Wollaston Peninsula moraine, some 200 miles long. Note raised marine shorelines following belts of outcrop of flat-lying lower Palaeozoic dolomite. Distance from bottom of photograph to two large ice-covered lakes in the background is about 30 miles. (T337L-9)

west of line BBB (*see* Fig. 1, Note B) between Walker Bay and Armstrong Point, is characterized by rather smooth hills of loamy till and by lakes set in shallow but steep-walled depressions. This part of the moraine comprises the gently sloping east wall of the Prince of Wales depression and the adjoining parts of the hilly interior upland 800 to 1,000 feet above sea-level. A small moraine ridge, surfaced by stony till, winds along the top of the coastal slope. This ridge is only a few tens of feet high and 1,000 feet wide, but has been traced discontinuously for about 80 miles. Northeast of Armstrong Point the coastal moraine belt is more complex. A broad, smooth moraine ridge (locally more than one ridge) lies along the coast and is separated from the higher inland part of the moraine belt by a more-or-less continuous valley (*see* Pl. VII). The coastal ridge is generally 1 mile to 3 miles wide with summit 200 to 300 feet above sea-level and 100 to 200 feet above the floor of the adjoining valley. The coastal ridge and the valley are surfaced by marine and probably lacustrine clay and silt, and by clayey till that contrasts with the coarser textured drift farther inland. This coastal clayey ridge is most prominent near Peel Point and Loch Point west of Richard Collinson Inlet and between Willoughby Point and Clumber Point east of the inlet (*see* Fig. 1, Note A). The southern part of the moraine belt west of Richard Collinson Inlet consists of prominent hills and ridges of stony drift that die out southwestward and connect southeastward onto low broadly arcuate ridges of stony, loamy till that loop across the plain at the head of the inlet.

PLATE VII. Coastal moraine ridge and valley bordering the northeast side of Prince of Wales Strait between Armstrong Point and Peel Point. Depth of photograph about 15 miles; north is to the left. (T347 R-151)

The varied morainal features comprising the coastal belt described above appear to have originated along the margins of glacier tongues that filled the depressions now occupied by Prince of Wales Strait, Richard Collinson Inlet, and Viscount Melville Sound during and after withdrawal of the ice from the adjoining higher ground. The coastal clayey ridge on the northern ends of the peninsulas east and west of Richard Collinson Inlet probably accumulated along and beneath the edge of these remnant ice bodies when narrow lakes and narrow arms of the sea (connecting to the open sea to the northwest) were confined between the ice and the land.

Various small low moraine ridges in the interior of Prince Albert Peninsula (*see* Fig. 1, Note D) are not glacial drift features, but consist rather of tilted fluvial and/or lacustrine sand and silt. In the few places where these features have been visited, the upturned strata are strewn with isolated boulders but lack any continuous cover of glacial drift. Although most of these ridges are relatively straight and trend northeast, some trend in various other directions, are curved, or lie within areas of irregularly and complexly contorted strata. The deformed materials commonly are bordered by undeformed deposits of the same nature and presumably of the same age. Indistinct drumlins trending at right angles to the deformed ridges appear to be superimposed upon the same deposits about 30 miles east of Armstrong Point. The deformed ridges and associated features probably were formed by overriding glacial ice or by glacial thrusting of frozen strata a short distance beyond the ice margin. The easternmost part of the moraine belt south of Armstrong Point (i.e., east of line BBB) consists in part of highly deformed gravel, sand, and silt. This may record a more intense phase of the same deformation.

The high ground forming the interior of Prince Albert Peninsula (*see* Fig. 1, Note C) is an area of thick drift dissected by small river-cut valleys, which are commonly dendritic in pattern. This area contrasts with the dominantly constructional topography of the surrounding region. Part of this dissection undoubtedly was accomplished by meltwater streams during the retreat of the last ice-sheet, but some of the valleys may have originated prior to that glaciation and have been but little modified by the overriding ice, or perhaps in part, stood above the highest level attained by the last ice-sheet.

Moraines of Eastern Victoria Island

The morainal belts and ridges of eastern Victoria Island are small, low, and short, particularly when compared with the massive moraines farther west. Their irregular distribution and trend reflect the complex lobation of the glacial margin and the complex pattern of flow within the border zone of the glacier, as the ice-sheet retreated from this region.

Two small hilly moraine belts—one trending east along the northern side of the Washburn Lake depression and the other trending northeast, north of Ferguson Lake—lie on opposite sides of a fan-shaped drumlin field. They probably

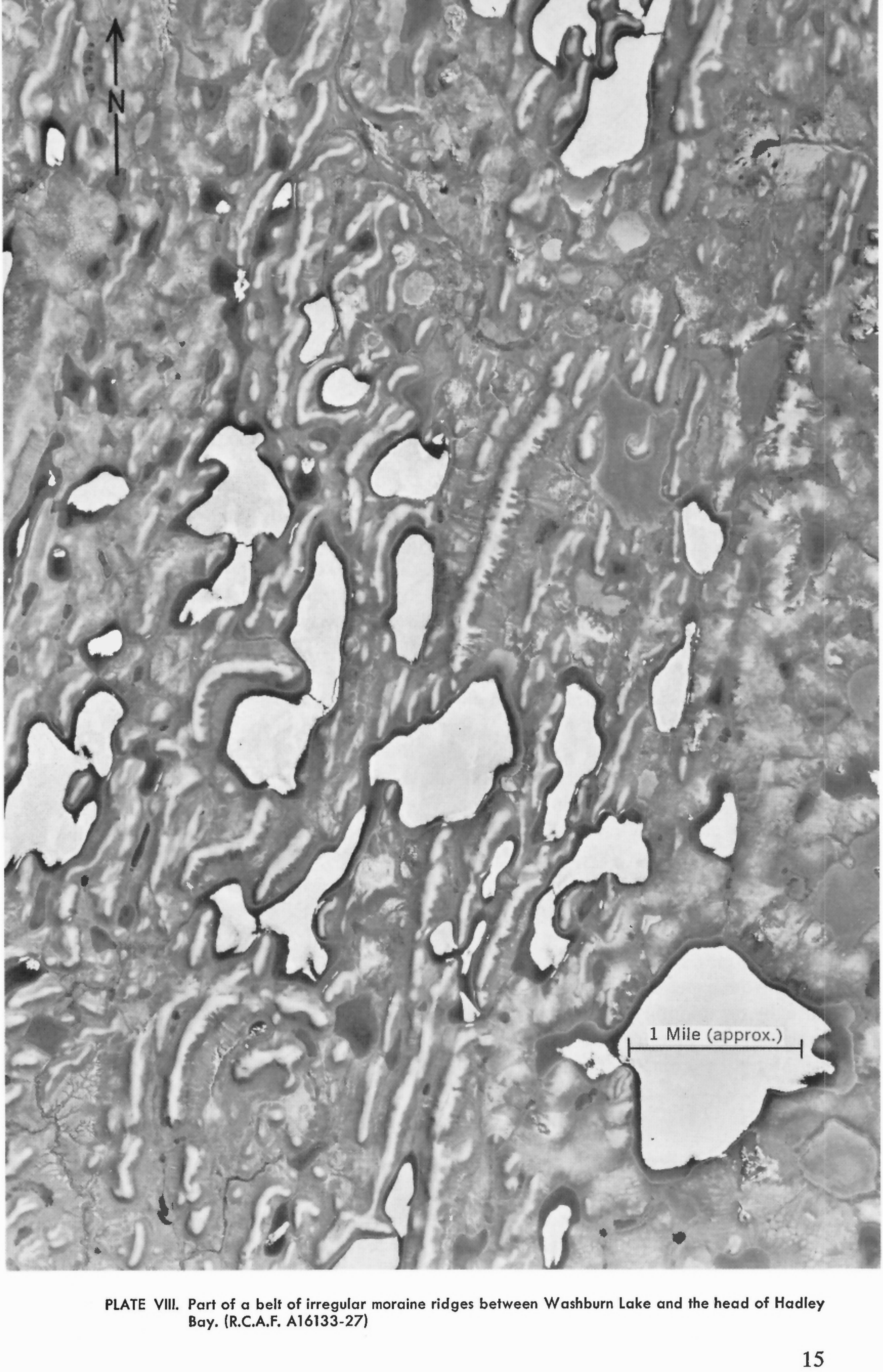

PLATE VIII. Part of a belt of irregular moraine ridges between Washburn Lake and the head of Hadley Bay. (R.C.A.F. A16133-27) mark the northeastern and southwestern margins of a late southwest-flowing lobe of ice that advanced a few miles over unconsolidated materials (see *Deposits Beneath Glacial Drift*).

Short moraine ridges trending north-northeast occupy an area some 70 miles long and 5 to 20 miles wide between Washburn Lake and Hadley Bay. These closely spaced anastomosing ridges are typically a few tens of feet high, a few hundred to 1,000 feet wide, and 1 mile to 3 miles long (*see* Pl. VIII), and consist of stony till of loamy to sandy texture. They are similar in material, size, and orientation to the drumlinoid forms to the west and north but differ from the drumlins in being curved or irregular in trend. Probably they accumulated along the eastern edge of an actively flowing glacial lobe (or lobes), perhaps along its contact with slowly moving or stagnant ice.

The moraine ridges that parallel the east coast of Victoria Island from Denmark Bay to Greely Haven are, for the most part, low and inconspicuous, although in a few places the component ridges and hills approach 100 feet in height and constitute the most prominent 'highs' in the rather monotonous landscape, particularly when viewed from the coast. Some of them lie at the top of low rubbly east-facing escarpments constituting the outcrop of resistant strata within the horizontal dolomite bedrock of the region. These moraine ridges trend more or less at right angles to the adjoining west-trending drumlins that occupy a narrow belt along the coast north of Denmark Bay and probably originated along or near the margin of the late ice-lobe that produced these drumlins.

Minor moraines of the type widely developed on the mainland to the southeast (Craig and Fyles, 1960; ribbed topography of Lee, 1959) occur in a few places on eastern Victoria Island, as for instance south of Tahoe Lake, and southwest of Hadley Bay These are short irregular ridges of stony till a few feet to a few tens of feet high, several hundred feet wide, and trending roughly at right angles to nearby drumlins. They characteristically occupy topographic lows.

The moraine 'traces' south and west of Hadley Bay are long and narrow, and range from exceedingly low ridges to drift-trends with insignificant relief. They are straight or smoothly curved and lie at right angles to the nearby drumlin trend and may be akin to the straight ridged minor moraines of Lee (1960) and washboard moraines of Mawdsley (1936).

Drumlinoid Features and Till Plain

The lowland parts of Victoria Island and nearly all of Stefansson Island comprise drumlinized and locally unoriented till plain or ground moraine. The loamy to sandy till covering the bedrock within these areas is generally no more than a few feet thick, but here and there is several tens of feet thick. Low rubbly bedrock outcrops, and patches of little-disturbed felsenmeer are commonly interspersed with the till. In some prominently drumlinized areas, bedrock outcrops and bedrock rubble make up a surprisingly large proportion of the ground surface.

Ice-scoured bedrock plains with little drift-cover occupy substantial areas west of Wellington Bay and north of Byron Bay. On aerial photographs, these essentially bedrock areas display tiny parallel glacial fluting that is difficult to distinguish from the equally prominent joint patterns in the horizontal rock.

The drumlinoid ridges range from elliptical to long narrow forms that vary considerably in size. Most commonly they are more or less cigar-shaped, ½ mile

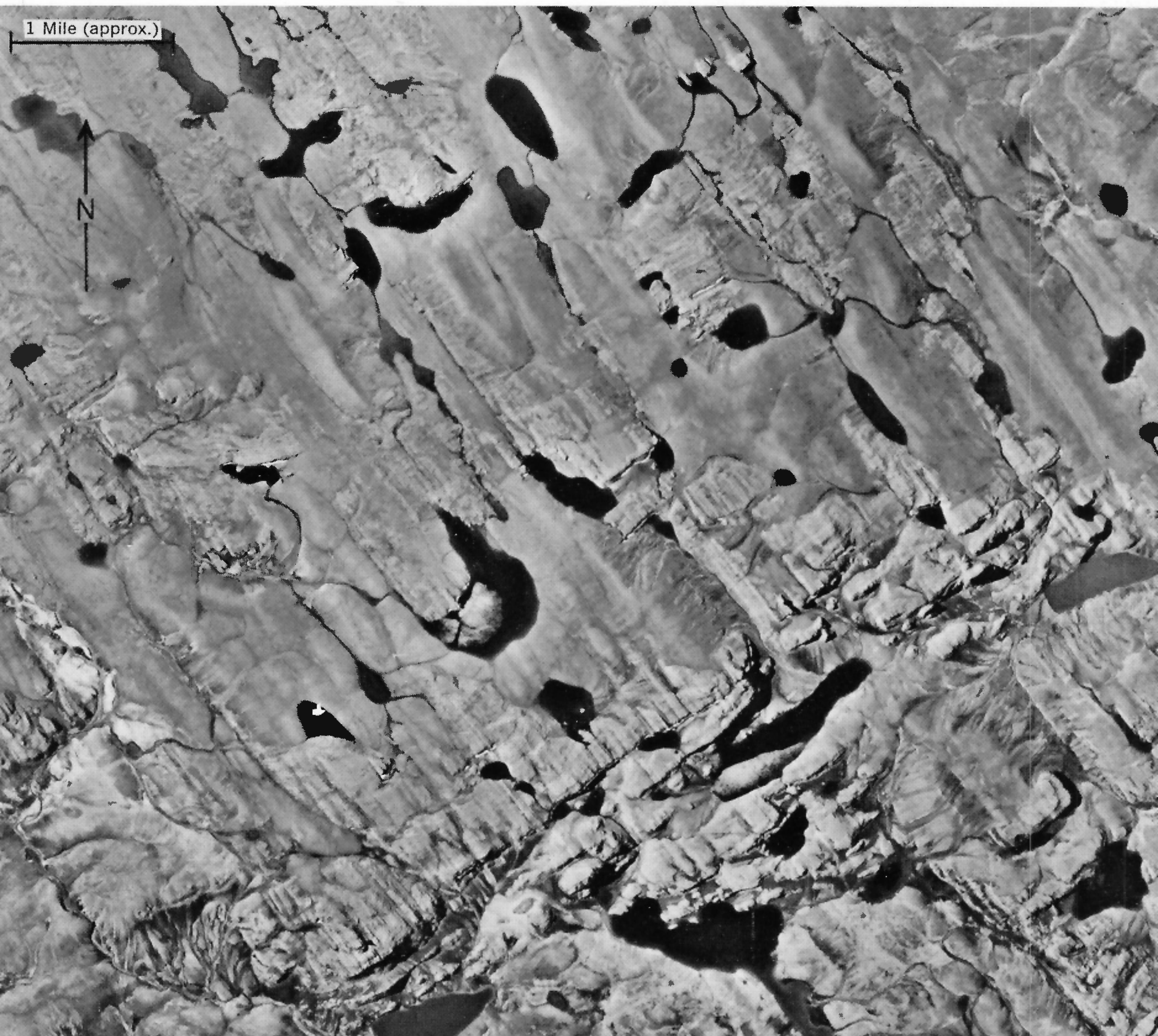

PLATE IX. Crag-and-tail hills on peninsula northeast of Wynniatt Bay, northern Victoria Island. Glacial flow was lower right to upper left. The bedrock is lower Palaeozoic dolomite. (R.C.A.F. A16330-57)

PLATE X. View eastward across curved field of long narrow drumlins on Stefansson Island. Glacial flow was from upper right to lower left. The larger of the two lakes in the foreground is about a mile long. (R.C.A.F. T327 R-171) to 2 miles long, and 500 to 2,000 feet wide (*see* Pl. I). In some places they occur as fields of individual drumlins, but more commonly they form a 'corrugated' topography of closely spaced ridges and furrows. Some, several tens of feet high, are clearly evident on the ground, but many are much lower and distinguishable only from the air through differences in vegetation, ground tone, or frost-polygon pattern. Crag-and-tail drumlinoid features range from till drumlins with small rock bosses at their stoss or upstream end, to glacially shaped outcrops with small tails of till or rubble at their lee or downstream end (*see* Pl. IX). Prominent crag-and-tail hills at Glenelg Bay (on the north coast) are made up entirely of bedrock with quartzite or diabase forming the crag and softer rock forming the tail.

The pattern of drumlinoid trends, as portrayed on Figure 1, is exceedingly complex, but in a most general sense records westward to northwestward glacial flow. Individual drumlin fields commonly display curved, convergent or divergent trends (*see* Pl. X). In many places, radically different drumlinoid trends occur side by side or are superimposed upon one another. Many changes of trend appear to be controlled by ridges and depressions of low relief (some with relief of not more than 100 to 200 feet) as if the ice whose movement is recorded by these features was thin and fed from distant rather than nearby accumulation areas.

The relative ages of the various glacial movements that gave rise to the drumlinoid trends are known only imperfectly. Where the age relations have been worked out, the ice-flow directions most strongly controlled by topography, or most closely related to nearby moraines, are younger than those of apparently more uniform regional trend. This relationship suggests successive change in ice-flow direction during downwasting (thinning) of the ice-sheet as local and 'upstream' topography had a progressively greater effect on the paths of easiest glacier flow. Age relations suggest, moreover, that the ice thinned, and presumably, that its margin retreated, from west to east and from north to south. Nonetheless, some drumlinoid fields may record local reactivation of the ice during general deglaciation or short readvances of the ice over bare ground. Such a readvance is suggested by drumlin trends superimposed upon a sand plain, an esker, and river channels east of Washburn Lake (*see* p. 5, and Fig. 1, Notes G and H).

GLACIO-FLUVIAL FEATURES

Eskers

Eskers are numerous and conspicuous within the low-lying eastern and southern parts of Victoria Island, but are few, short, and inconspicuous throughout the rest of the region. In some of the flatter parts of the eastern lowlands, esker ridges and associated kame hills constitute the most prominent elements of the landscape.

The eskers characteristically range from a few feet to 150 feet in height, but some 'knots' at the junction of two or more esker-tributaries are several hundred feet high. The most outstanding of these is Mount Pelly at Cambridge Bay, standing about 500 feet above its surroundings. Most eskers consist of sand or sandy gravel, but a few are surfaced by bouldery material, and some are remarkably similar in form and composition to moraine ridges. Although some of the eskers shown on Figure 1 are textbook forms consisting of a single more or less continuous ridge, others comprise a chain of short ridge segments or of kame hills, or include several ridges side by side or an anastomosing ridge complex. Commonly, series of esker-ridge segments, together with erosional river channels fit together end on end to form river-like esker systems. The longest esker system in the area has been traced for about 120 miles between Dease Strait and Prince Albert Sound and connects at its northwestern end onto a narrow belt of meltwater channels extending for about 70 miles along the hillside south of Prince Albert Sound. Most of the esker systems of the area, on the other hand, are traceable for only a few miles or a few tens of miles.

The general pattern of the eskers on Victoria Island records meltwater drainage towards the north, west, and southwest, and is in accord with southward and eastward glacial retreat. Most eskers are more or less parallel with adjoining drumlinoid features and were built by streams flowing in approximately the same direction as the ice that formed the drumlins. Some eskers, on the other hand, diverge markedly from the trend of the surrounding drumlinoid features, but most of these eskers are parallel with, and probably are related to, ice-flow directions recorded by nearby drumlin fields. Some divergent eskers are older than the surrounding drumlins (*see* Fig. 1, Note G), but others probably are younger.

Abandoned and Misfit Channels

Abandoned river valleys and valleys cut by streams larger than the present ones are prominent features of the landscape of the western and central parts of Victoria Island (*see* Pl. XI), and are particularly numerous in and adjoining the

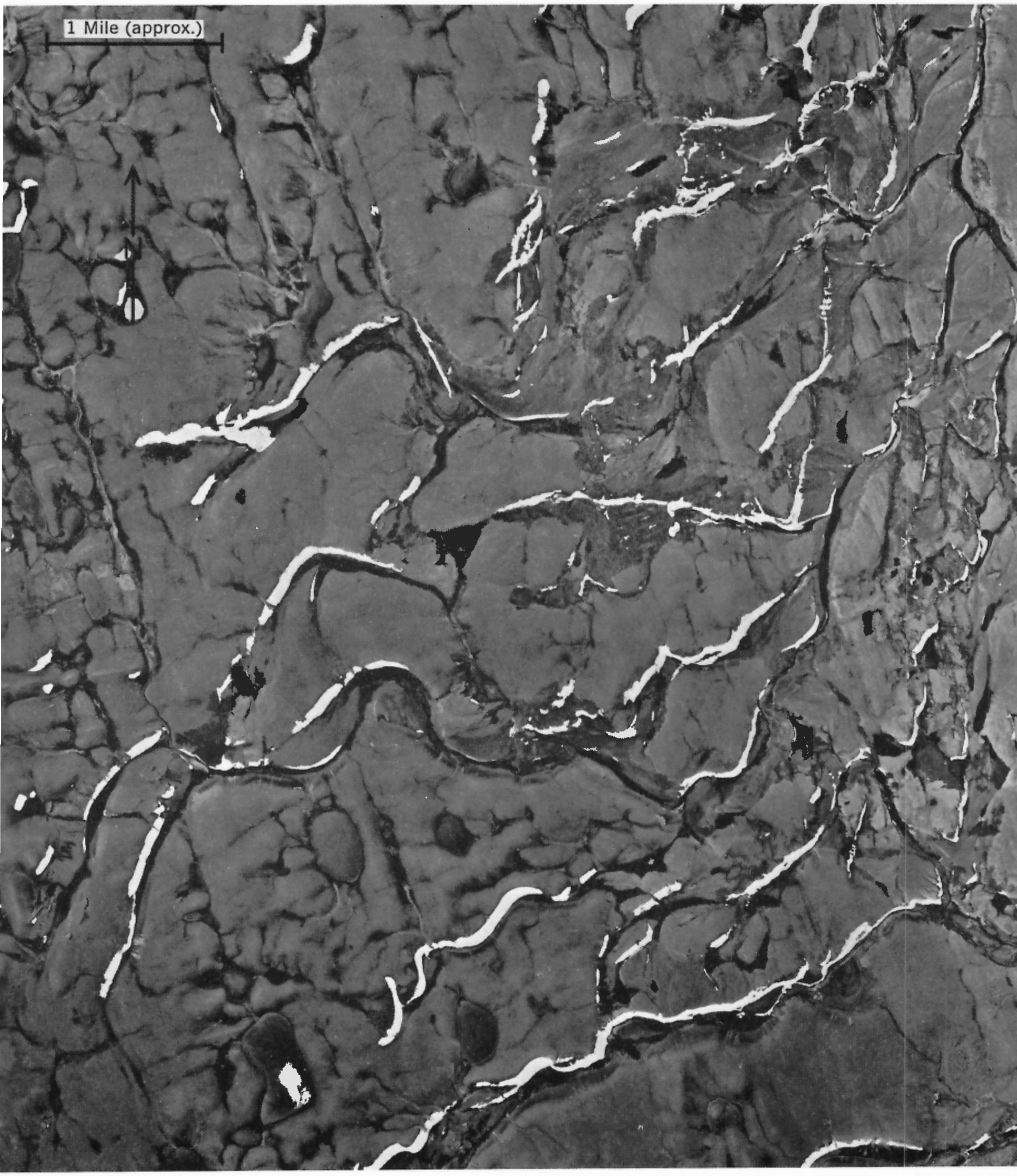

PLATE XI. Abandoned and misfit river channels (outlined by snow drifts) eroded by glacial meltwater streams. Locality is about 40 miles southwest of the south end of Hadley Bay. (R.C.A.F. A16154-93)

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Shaler Mountains and the large morainal belts. These channels appear to mark the courses of rivers that flowed along, within, or away from the glacial margin, or that drained ice-dammed lakes during the waning stages of the last glaciation. In the southern and eastern parts of the map-area, abandoned channels are few and inconspicuous and generally are integral parts of the esker systems.

In the Shaler Mountains, numerous abandoned channels cross cols or spurs, follow around hillsides, or follow valley floors. Many of these could only have contained streams if the adjoining lower ground were occupied by glacial ice. They are characteristically only a few tens of feet wide; most are a mile to several miles long and lack continuity. The channels may have gentle gradients or may run at high gradients diagonally or directly down a slope. Some head at passes or low points on a ridge, but others head indiscriminately on a smooth ridge or hillside. A few channels terminate at existing streams, but many end well above the valley floor. Successions of channels, many of which are more or less parallel, trend at gentle to steep grades along hillsides and valley walls. In such sequences each lower channel is younger than the one above it. Although most of these channels appear to have carried water along or away from the glacial margin, or within the marginal part of the ice, some probably drained or flowed into ephemeral ice-dammed lakes. They provide evidence that, at the close of the last glaciation, ridges became progressively free of ice while adjoining valleys were still filled with ice. In general, the channels drained to the west, northwest, or north, as if the ice surface sloped downward to the northwest and the ice-margin shrank from northwest to southeast. General southeastward retreat of the ice is also evident from the concentration of west-draining channels on north walls of west-draining valleys and north-draining channels on west walls of north-draining valleys. This channel pattern is strikingly evident in the Kuujjua River system.

Numerous meltwater channels occur in northwestern Victoria Island, particularly on and around the moraine belt on Prince Albert Peninsula. Many of these are exceedingly large, ranging up to 200 feet deep and several miles wide (*see* Pl. XII). Commonly the larger channels are floored with terraced alluvium or terminate downstream in outwash plains or in abandoned deltas originally built into ice-dammed lakes or the sea. The meltwater streams of northwestern Victoria Island characteristically drained northward. Some carried water (directly off the ice or out of ice-dammed lakes) from the Prince of Wales and Minto Inlet depressions into the interior of the peninsula. Others, at lower levels, flowed at low gradients along the sloping hillsides that now lie east of Prince of Wales Strait and west of Richard Collinson Inlet and occupied successive and different channels as changes in the ice level opened new paths by which water could flow off, onto, or around the ice and into or out of ice-dammed lakes. In general, at any one place, each successively lower channel is younger than the one above it. The general pattern of these glacial streams provides support for the sequence of late-glacial events suggested by other lines of evidence—that is, that the ice-sheet retreated from northwest to southeast off the high ground while ice-tongues still occupied the major

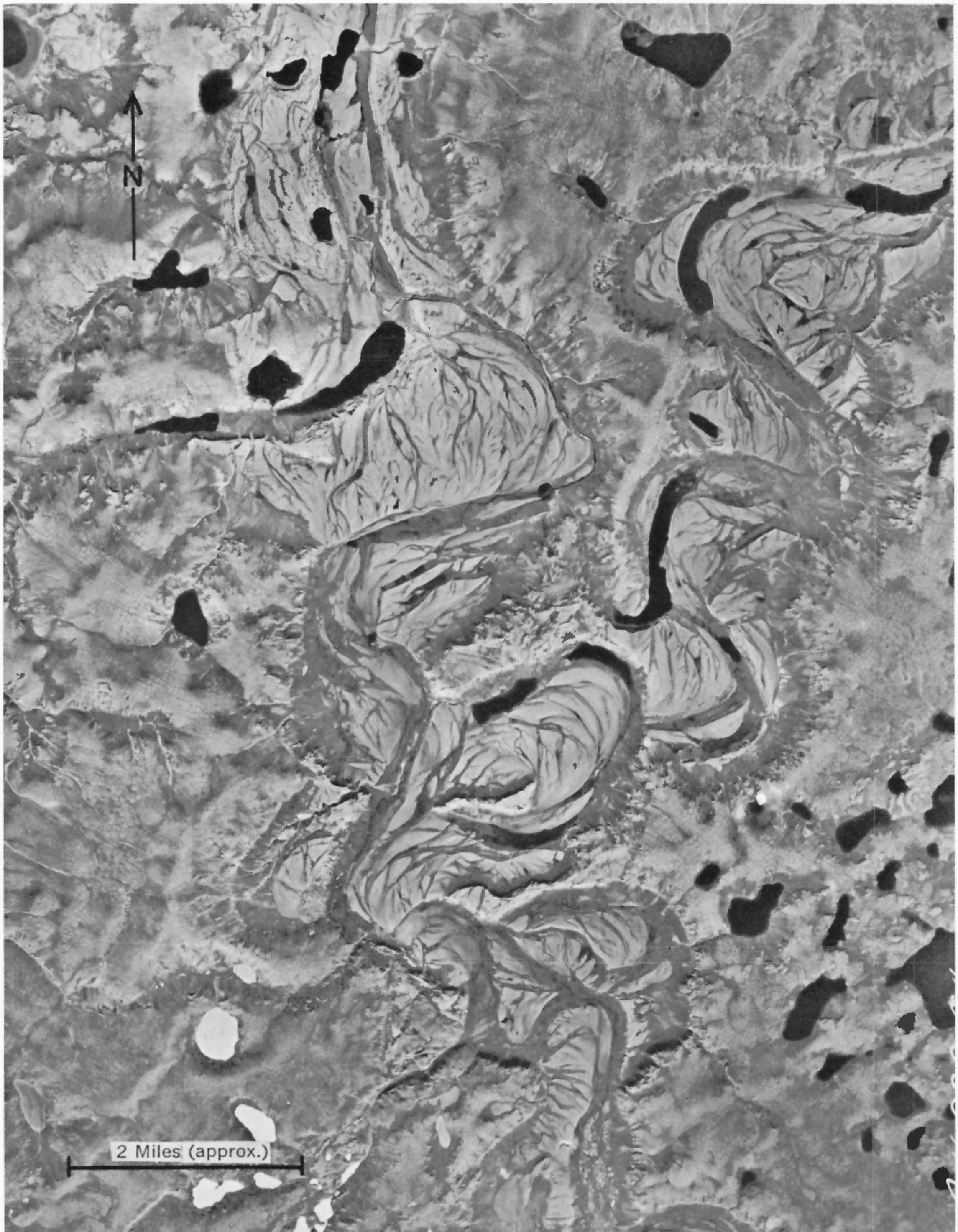

PLATE XII. Large channels cut into morainal deposits by north-flowing meltwater streams; northwestern Victoria Island between Deans Dundas Bay and Walker Bay. (R.C.A.F. A16829-54) depressions. The low-level channels record progressive thinning of the ice-tongues in the depressions and provide evidence that the ice retreated from north to south in the Prince of Wales depression and from west to east along Viscount Melville Sound.

Abandoned and misfit channels occur farther south in western Victoria Island, but are less numerous and less imposing than those on Prince Albert Peninsula. Most of these channels, like those in the northwestern part of the island, mark meltwater drainage along or across the various moraines. They commonly drained to the west or north and provide evidence of general southwestward shrinkage of the ice, complicated by persistence of ice-tongues in the major depressions.

A series of large misfit channels north of the east end of Prince Albert Sound record some divergence from the pattern of ice retreat outlined above. The rivers that cut these south-draining channels terminated in the sea and built deltas along the highest seashore level (altitude 400 to 450 feet). The westernmost channel (Kuuk River) may merely have drained the high ancestral Tahiryuak Lake, but the other channels apparently headed at a glacial margin (or successive margins) adjacent to the south edge of the main moraine. Although the trends and positions of the ice-margins from which the streams emanated remain to be unravelled, it is none the less apparent that the eastern part of the Prince Albert Sound depression must have been sufficiently free of glacial ice to permit entry of the sea while the upland to the north was still partly ice covered.

GLACIO-LACUSTRINE DEPOSITS

Clays and silts of apparently glacio-lacustrine origin occur here and there throughout the area but are most abundant along the margins of the morainal belts in the western part of Victoria Island. They probably accumulated in small lakes dammed between glacial ice and adjoining ice-free land. In some places these deposits have not been clearly differentiated from similar materials of marine origin. The most prominent glacio-lacustrine deposits lie between the present coast and the crest of the adjoining moraine belt near Richard Collinson Inlet, around the northwestern tip of Prince Albert Peninsula, around Deans Dundas Bay and Walker Bay, northwest of Holman Island, and in the southwestern part of Wollaston Peninsula. Extensive fine sands and silts, apparently of lacustrine origin, also occur in the northern interior of Prince Albert Peninsula.

In general, the ice-dammed lakes in which these deposits accumulated drained northward or westward. Their distribution conforms to the pattern of glacial retreat and of northward and westward meltwater drainage outlined above. Along the west coast, lake deposits are thicker and extend higher on the northern sides of coastal embayments than in the southern parts of these embayments. This relationship is most clearly apparent at Deans Dundas Bay and Walker Bay. Apparently, in each embayment, a lake was initially confined along the northern edge of the embayment and then fell to lower levels and occupied larger areas as the ice retreated out of the bay and uncovered lower outlets across the promontory to the north.

MARINE FEATURES

Marine shells, abandoned strand lines, raised deltas, and fine-textured marine sediments provide abundant evidence that the sea formerly covered areas that now stand as much as several hundred feet above sea-level. At the maximum stand of the sea relative to the land, almost half of the present area of Victoria Island was submerged.

The most prominent and widespread raised marine features are shingly to bouldery beach ridges (*see* Pls. XIII and XIV). Remarkable series of these ridges occur wherever the ground is made up of rubbly bedrock, glacio-fluvial gravel, or other materials readily susceptible to transport by waves. Clay, silt, and sand, locally aggregating several tens of feet thick, occupy depressions formerly occupied by the sea and are particularly abundant near former river mouths. Prominent deposits of this sort border the head of Wellington Bay, Prince Albert Sound, and Richard Collinson Inlet and extend a few miles inland from the southwest coast of Wollaston Peninsula near Lady Richardson Bay. Marine pelecypod shells are embedded in many of the marine deposits (particularly those of fine texture), and also are scattered about on the ground surface. Those on the surface are principally confined to eroded areas or to the ubiquitous frost boils (mud polygons, unsorted mud circles, etc.), which bring to the surface material from depths of 2 to 3 feet. Whale skeletons were found east of Hadley Bay and north of Ferguson Lake (*see* Fig. 1). In addition, whale bones have been encountered in an excavation at one of the Dew Line sites between Wellington Bay and Richardson Islands.

The inland limit of marine submergence marked on Figure 1 is tentative and in some places, where ground observations are widely spaced, is based mainly upon features visible on airphotos (*see* Pl. XV). Knowledge of the extent of submergence is particularly tenuous where large areas lie at or close to the uppermost level attained by the sea, as for instance on the peninsula between Hadley Bay and M'Clintock Channel and in the country extending south from this peninsula to Ferguson Lake.

An approximate indication of the highest level of the sea relative to the land is provided by the observed altitudes of 'high' marine features marked on Figure 1. Many of the recorded features appear to be close to the upper limit of submergence or at least to be the highest recognizable evidence of submergence in the vicinity. In general, the limit of marine submergence decreases in altitude from east to west and from south to north across the island. The highest marine features so far recorded are shells at an altitude of about 550 feet some 25 miles north of the Richardson Islands (lat. 68°50'N, long. 110°28'W) and a shell fragment reported by Washburn (1947, p. 67) at an altitude of 625 feet on Mount Pelly at Cambridge Bay; both these occurrences are close to the south coast of Victoria Island.

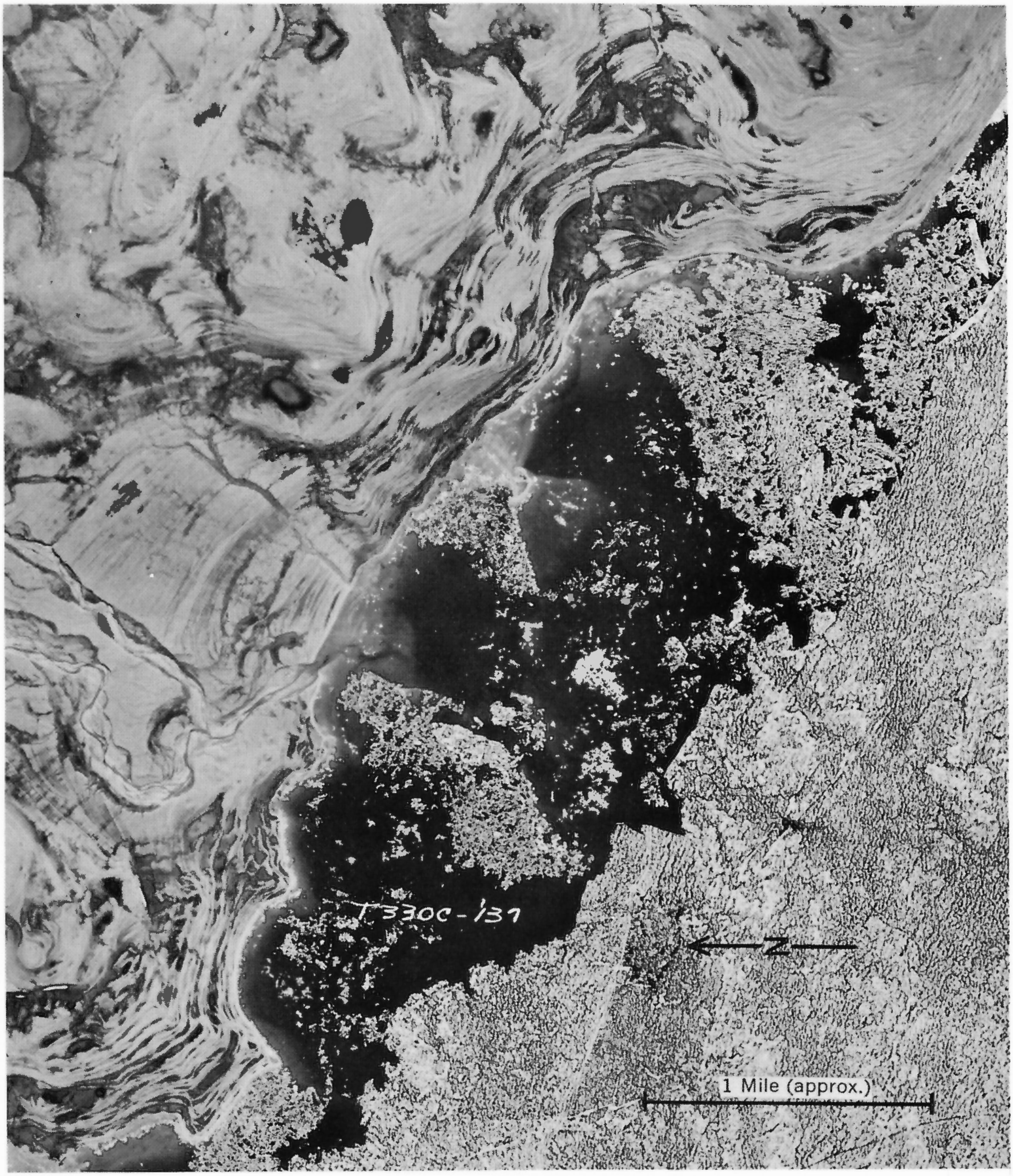

PLATE XIII. Raised marine shorelines north of Prince Albert Sound near Kuuk River. Beach ridges consist of rubble from flat-lying lower Palaeozoic dolomite. (R.C.A.F. T330C-137)

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PLATE XIV. Emerged beach ridges extending inland from the present shore about a mile west of Holman.

The associated maximum marine level may be 600 feet or more above the present shore. Some 40 miles north of both these localities, ground about 600 feet above present sea-level appears to have escaped submergence. West of Washburn Lake, the limit of marine submergence is marked in a number of places by 'highest' shoreline features at an approximate altitude of 520 feet. Westward from this locality for about 200 miles to Holman Island and northward about the same distance to the mouth of Hadley Bay, the highest marine level drops progressively to or slightly below an altitude of 300 feet. The marine limit appears to decrease in a similar manner from east to west along the north and south coast of Wollaston Peninsula. However, the highest marine level near the west end of the peninsula is rendered uncertain by the discrepancy between shells and shore features, found up to an altitude of about 250 feet, and deltas (marine or glacio-lacustrine?) standing 100 feet or more higher.

In northwestern Victoria Island, bordering Prince of Wales Strait and the west side of Richard Collinson Inlet, features attributable to the maximum marine level remain to be distinguished from features that appear to be glacio-lacustrine. Extrapolation of the limit of marine submergence from the adjoining country to the south and east suggests that the marine limit in this northwestern part of the island should be about 250 feet above present sea-level. The meagre data at hand do not contradict this figure. Thus shells of *Yoldia arctica* (identified by F. J. E. Wagner) and of *Hiatella arctica* have been found at an altitude of about 230 feet near Peel Point. Moreover, although fine-textured sediments extend to altitudes of several hundred feet, those with distribution compatible with a marine environment occur below 250 feet. Nonetheless, as glacial marginal channels occur at an altitude of

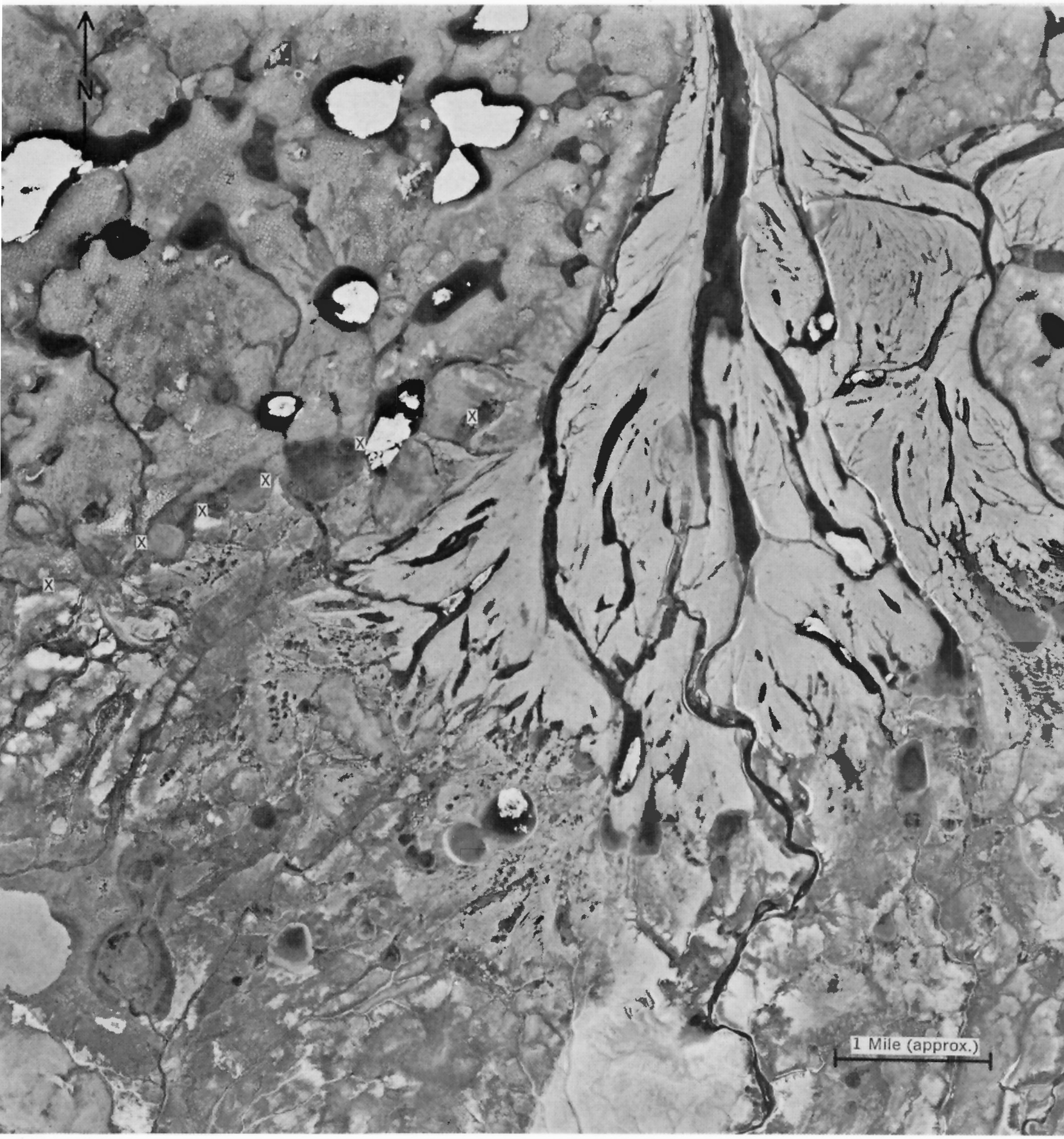

PLATE XV. Marine delta 450 feet above present sea-level 15 miles northeast of head of Prince Albert Sound. The delta marks the mouth of a glacial meltwater channel. Line XXX, which marks the boundary between sand-covered area (to the south) and unmodified moraine, appears to be the inland limit of marine submergence. (R.C.A.F. A16131-14)

200 feet and locally even lower, water bodies (whether marine or glacio-lacustrine) standing at higher levels probably were confined between glacial ice and the land, as suggested earlier in this report in connection with the moraines of this part of the map-area. An example of this relationship is provided by a delta (altitude 280 feet) 10 miles east of Richard Collinson Inlet, at latitude 72°57′N, longitude 112°30′W, which has been built into the clay-floored valley south of the coastal moraine ridge by a stream that appears to have emanated from glacial ice to the north.

NON-MARINE POST-GLACIAL FEATURES

Since retreat of glacial ice from the region and regression of the sea to its present level, small-scale modification of the landscape has been effected by rivers, wind, frost, and gravity-transfer of material. Although many rivers wander through virtually unmodified 'lows' in the glaciated ground surface, some have cut youthful valleys and gullies into overburden and, locally, into bedrock. In contrast to most of the region, parts of the interior of Prince Albert Peninsula (northwest Victoria Island) are dissected by numerous small flat-floored river valleys cut into drift. It is not known whether this dissection was accomplished entirely by post-glacial streams and late-glacial meltwater rivers or whether it is partly a relic of older stream dissection that survived the last glacial invasion. Floodplain deposits and alluvial fans have accumulated at various places along the rivers of the region, and deltas of considerable size have been built where some rivers enter the sea or lakes. Blankets of wind-blown sand and silt extend southeastward from some of these alluvial plains and from some of the sandy glacio-fluvial deposits. These aeolian deposits generally mantle the pre-existing landscape as a veneer a few inches to a few feet thick, but locally include patches of low dunes. From the air and in air-photos they appear as irregularly shaped, pale-coloured featureless areas. Particularly large aeolian blanket deposits (several miles wide) are situated at the head of Richard Collinson Inlet, 15 to 30 miles north of Washburn Lake, and about 40 miles west of the head of Hadley Bay.

Slopes and hillsides bear abundant evidence of downslope movement of the surface materials. Bedrock escarpments are fringed by aprons of talus and, in the higher parts of the Shaler Mountains, by 'lobate' rock glaciers. Slopes covered with drift or fine-textured bedrock debris bear the scars of landslides and mudflows as well as solifluction stripes and lobes and other manifestations of 'creep'. Accumulations of colluvial material at the foot of hillsides and valley walls attain thicknesses of up to 10 feet or more and commonly contain peaty layers composed of moss, grass, sedge, and other plants. Flatter areas bear numerous and varied circles, polygons, frost cracks, and other patterned-ground features. These forms appear to be as well developed in deposits exposed to frost for only a few hundred years as in those of greater age. The nature and size of patterns varies with the texture of the surface and subsurface deposits as well as with the topography. In some places, differences in frost patterns and in slope-movement phenomena are of assistance in delineating geological bodies. A more extensive treatment of patterned ground and mass wasting on Victoria Island is given by Washburn (1947, pp. 84-103).

Frost cracks and other patterned-ground forms are present in some outcrop areas. Remarkably straight frost cracks outline the natural bedrock jointing in some areas underlain by flat-lying lower Palaeozoic dolomite. They are up to about

3 feet wide, 2 feet deep, and several hundred yards long; many are bordered on either side by marginal bulges a few inches high consisting of tilted slabs of rock. As seen from the air or in air photos, some of these cracks display striking unidirectional, rectangular or rhomboidal patterns, whereas others are randomly oriented. Small, frost-induced dome-shaped structures composed of regularly oriented upturned slabs of rock were noted in some outcrop areas. These domes average about 10 feet in diameter and 3 feet in height.

Broken rock outcrops and fields of angular rock rubble are prominent features of the landscape of the region, and are especially noticeable in those parts of the area underlain by lower Palaeozoic dolomite. As in other Arctic regions, disintegration of rock into fragments can be explained most easily as the result of stresses induced by alternate freezing and thawing. It is possible that some of the shattered outcrops and felsenmeer originated prior to the last glaciation and survived the glacial invasion with little modification (Bird, 1959, p. 157). Moreover, intimate association of some block fields with certain minor morainal features suggests that some of the rock shattering may have been glacially induced. However, a considerable amount of rock fracturing has certainly taken place in post-glacial time. Thus, some fields of tilted angular blocks comprise disjointed remnants of glacially striated outcrops, and outcrops on the floors of some rock-cut late-glacial

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PLATE XVI. Stone circles illustrating weathering on a dolomite-rubble beach at an altitude of about 50 feet on the south side of Prince Albert Sound. Stones in the centres of the circles (e.g., left of pick head) have recently come to the surface and retain their original water-worn shape. The more angular stones in the right and upper left parts of the photograph have undergone fracturing and solution-pitting during a longer period of exposure on the beach surface.

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PLATE XVII. Pingo about 135 feet high on an island in a lake on northern Wollaston Peninsula, southwestern Victoria Island.

meltwater channels have distintegrated to rubble. On many raised beaches, fracturing of the surface layer of stones is graphically evident when they are compared with the water-worn pebbles and cobbles exposed in deep frost cracks or recently brought to the surface in frost polygons or circles (*see* Pl. XVI).

Several pingos were seen on Wollaston Peninsula in southwestern Victoria Island. These are more or less conical volcano-like hills with ice cores. Those seen in the area are a few tens of feet to more than 100 feet high, and are surfaced by various unconsolidated materials. All of them lie within present or former lake beds. The pingo illustrated in Plate XVII (lat. 70°03′N, long. 115°55′W) is about 135 feet high and 600 feet in diameter. Fractures in the top and sides expose up to 10 feet of thin-bedded silt containing layers of moss. The strata dip regularly outward at angles of up to 45 degrees. The ice core is not exposed. Another of these pingos is described and illustrated by Washburn (1950, p. 43 and Pl. 13, Fig. 2).

HISTORICAL SUMMARY

The surficial features and deposits of Victoria and Stefansson Islands described above have originated almost entirely since the climax of the last (classical Wisconsin) glaciation of the region. Earlier Pleistocene and late Tertiary events of apparently regional significance are recorded on Banks Island to the west (*see* Craig and Fyles, 1960). These include one or more 'old' glacial invasions, at least one interglacial interval characterized by sparse coniferous forests, and a late Tertiary and/or early Pleistocene interval (or intervals) of fluvial aggradation and heavy forest cover, which gave rise to the Beaufort Formation. The Victoria Island lowlands and the Shaler Mountains probably existed in more or less their present form (although perhaps at a different altitude relative to their surroundings) prior to the events listed above. On the other hand, the major valleys, now largely occupied by the bays and straits that border the islands, appear to have developed mainly if not entirely since deposition of the Beaufort Formation. These valleys, which may be bordered in part by fault scarps (Thorsteinsson and Tozer, 1960), probably constitute an ancient river system (Fortier and Morley, 1956) that has been modified by glaciation.

On Victoria and Stefansson Islands, the only clear record of events prior to the climax of the last glaciation is provided by sub-till deposits north of Prince Albert Sound. An 'old', possibly 'early' Wisconsin, glacial invasion is recorded by till at the base of these exposures. During a non-glacial interval that followed this glaciation and preceded the last glacial invasion of the region, fluvial and lacustrine materials accumulated under climatic conditions suitable for growth of tundra vegetation. This tundra interval is classified as an 'early' Wisconsin interstadial on the basis of its radiocarbon age (date number I(GSC)-30, 28,000± 1,500 years).

During the climax of the last glaciation of this region, Victoria and Stefansson Islands were entirely covered by the Laurentide ice-sheet[1]. Details of the northwestern boundary of the ice-sheet remain to be unravelled, but ice must have filled Viscount Melville Sound to the north and extended to, but perhaps not across, Banks Island to the west (*see* Craig and Fyles, 1960). Radiocarbon dates indicate that this glacial invasion[2] was approximately synchronous with the classical Wisconsin glaciation of southern Canada and northern United States, in the opposite (southern) peripheral part of the Laurentide ice-sheet.

The ice covering the western part of Victoria Island may not have been very thick, even during the glacial climax. As the ice thinned, it withdrew from the higher parts of western Victoria Island, but still occupied the low ground. With further thinning, the main ice-margin retreated to the southeast but

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[1] A possible, doubtful exception is the interior of the northern part of Prince Albert Peninsula.

[2] Ice advance: less than 28,000 years ago (*see* discussion of sub-till deposits); ice retreat: 13,000 to 10,000 years ago (*see* p. 36, regarding marine submergence).

active ice-tongues, fed by the ice-sheet to the south and east, remained in the depressions now occupied by the various arms of the sea. The moraines of western Victoria Island accumulated along the margins of these ice-tongues; when subjected to more detailed study these moraines may provide evidence of glacial advances, retreats, and still-stands such as are known from the southern periphery of the ice-sheet. Lakes were impounded at various places along the edges of these ice-tongues and meltwater streams followed successive courses along or away from the ice edge as changes in the glaciers progressively modified the routes by which water could escape to the north and west.

In the eastern lowland parts of the region, the ice probably flowed in a general northwesterly direction in the early stages of wastage of the ice-sheet. With continued wastage (from west to east and north to south) the ice covering the lowland became progressively thinner, and the direction of ice flow across these lowlands was deflected, to an increasing degree, by minor irregularities in the ground beneath and in the ground to the east and south whence the ice was coming. Locally, the direction of ice flow changed radically or even was reversed. Within the thin marginal part of the ice-sheet, ice flowed more actively through shallow depressions than across adjoining higher ground. These active flows took the form of fan-shaped lobes trending northward, westward, or southwestward. Locally, such active lobes readvanced over recently exposed ground.

Apparently the last ice on the island covered the low ground bordering the east and southeast coasts while ice-tongues still occupied the adjoining depressions of M'Clintock Channel and Queen Maud Gulf. The ice that built the fan-shaped drumlin field in southernmost Victoria Island was younger than other ice movements recorded in the vicinity, but probably retreated prior to complete deglaciation of the eastern part of the island. This southern lobe emanated from the deep trough to the south now occupied by Bathurst Inlet and flowed northwest and then west across the southern tip of Victoria Island and thence into Dolphin and Union Strait (*see* Craig and Fyles, 1960).

The land is believed to have been lowest relative to the sea (i.e., seashore stood at the marine limit) at the time of deglaciation and subsequently to have risen gradually to its present level. Evidence has yet to be found either of prolonged still-stands at shore levels higher than the present or of intervals of resubmergence. Study of pollen samples that may provide information on climatic conditions during the early post-glacial interval of submergence has yet to be undertaken. Washburn (1947, p. 69) noted the absence of ice-shove ridges amid the raised strand lines on Mount Pelly and suggested that the climate during the submergence may have been milder than the present one. Ice-shove ridges are, however, included among the raised marine features elsewhere on the island.

The few radiocarbon dates presently available support the view that the maximum, initial submergence of the land by the sea decreased in age across the region from northwest to southeast. Thus, shells of *Yoldia arctica* collected at an altitude of 230 feet (within about 50 feet of the marine limit) near Peel Point in northwesternmost Victoria Island have been assigned an age of 12,400 ± 320 years (date number I(GSC)-18). Marine molluscan shells collected about 50 miles to the southeast some 220 feet above present sea-level and between 50 and 100 feet below the marine limit have an age of 11,310 ± 150 years (date number GSC-48). A still younger age of 9,710 ± 150 years (GSC-42) has been assigned to marine shells about the same distance below the marine limit some 200 miles farther to the southeast; this sample was collected at an altitude of about 450 feet, 40 miles east-southeast of the head of Prince Albert Sound. A similar regional change in age of high marine features is indicated by radiocarbon dates from the northern part of the continental mainland south and southeast of Victoria Island. Thus, high marine shells from the Coppermine region south of western Victoria Island have yielded dates up to 10,500 years (five dates quoted by Craig, 1960), whereas those from the Shepherd Bay-Pelly Bay area some 500 miles to the east do not exceed 8,900 years in age (five dates quoted by Craig, 1961).

Radiocarbon dates from two localities in western Victoria Island seem to indicate that much of the uplift of the land from the initial maximum submergence to its present level relative to the sea took place early in post-glacial time. Marine pelecypod shells with a radiocarbon age of 8,895 ± 220 years (date number I(GSC)-20) were collected about a mile northeast of Holman post from a river bank a quarter of a mile from the seashore and at an altitude of about 25 feet. The shells were contained in dark fetid clay that lies beneath a few feet of gravel and sand of deltaic or shoreline origin, which accumulated when the seashore stood 30 or 35 feet above its present level and some 250 feet below the marine limit. The shell-bearing clay probably relates to a shoreline stand only a few feet above the same level, although it is alternately possible that the sea-level was appreciably higher.

In a similar occurrence at the head of the east bay of Richard Collinson Inlet (northwestern Victoria Island), marine pelecypod shells were found in silt underlying gravel that forms a prominent beach terrace about 20 feet above the present seashore and about 250 feet below the marine limit. A sample of these shells collected from a stream-eroded bank 10 to 15 feet above sea-level has yielded a radiocarbon age of 10,220 ± 150 years (GSC-43). Although it seems probable that the shells relate to a sea-level stand at or a few feet above the 20-foot shoreline, it is nonetheless possible that they represent an appreciably higher sea-level. To gain further information regarding the age of the 20-foot shoreline, a sample from the base of 2 feet of peat resting on clay along the inland edge of the shoreline terrace has also been dated. The large divergence between the age of this peat (2,200 ± 45 years, date number GSC-19) and that of the shells (quoted above) has left the problem unresolved.

Evidence that the seashore level has fallen but little in the southern part of the map-area during the last 2,000 years is provided by the radiocarbon age (1,830 ± 80 years, date number GSC-17) of plant material enclosed in river sediments 2 feet above sea-level at the mouth of Tree River about 60 miles south of the southern coast of Victoria Island (lat. 67°41′N, long. 111°51′W). This sample, collected by B. G. Craig, lay within estuarine deposits graded to a seashore within 10 or 20 feet of present sea-level.

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