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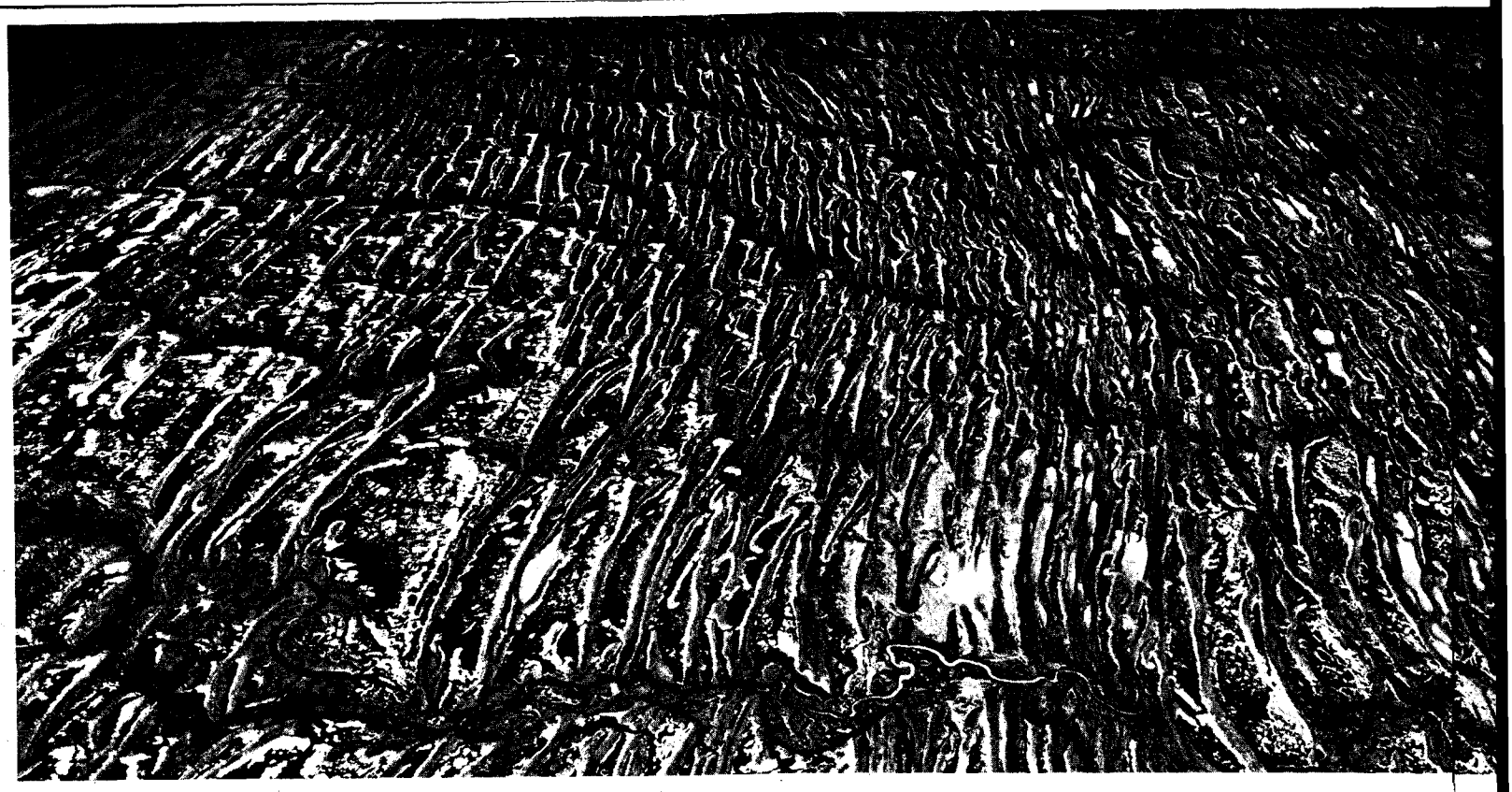
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# PHYSIOGRAPHIC SUBDIVISIONS OF CANADA

H. S. BOSTOCK

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## INTRODUCTION

Physiographically and geologically Canada is composed of two great parts: a core of old, massive, Precambrian crystalline rocks forming the Shield, and a surrounding crescent of younger, mainly stratified, rocks forming the Borderlands. In simple terms, the surface of the Precambrian core resembles that of an inverted dinner plate with its flat, slightly depressed centre and an outward shelving rim terminated by a steep edge. The younger rocks of the Borderlands surround the northern, western, and southern parts of the plate as segments of two concentric rings. The inner ring comprises a chain of lowlands, plains, and plateaux of generally flat lying sedimentary rocks overlying the gently shelving rim; the outer ring is formed of discontinuous areas of mountains and plateaux in which the younger rocks are deformed. On the northeast rim of the plate the Borderlands are absent; there the edge of the Shield is tilted upward and drops abruptly into the sea.

Part of the boundary between Canada and adjoining territories of the United States is natural, marked by lakes, rivers, or divides; much is, however, drawn at parallels or meridians. Canada has immensely long and irregular coastlines that embrace great bays, inlets, and channels within the general confines of her headlands and islands. Parts of these coastal waters are shallow and cover the continental shelves along the Atlantic, Pacific, and Arctic coasts.

Physiographically the Shield and Borderlands are divided into regions or provinces each comprising many smaller units. In the Borderlands physiographic boundaries are to a great extent indicated by distinctive changes in the topography and geology. For the Shield no such single controlling factor is evident, although the ages of orogeny form a basis for geological subdivision (Stockwell, 1965). Despite this, there are features that enable a physiographic division of the Shield into major and minor units to be made.

## THE SHIELD

### General Features

Viewed from some prominent summit the landscape presents an even, monotonous skyline interrupted by rounded or flat-topped monadnocks and ranges of hills. The smooth horizon is evidence of an old, almost all-subduing erosion surface; this is the most outstanding characteristic of the Shield and gives a similarity to the terrain whether it is seen in Labrador or the Northwest Territories. Only in scattered areas such as the Davis and Labrador Highlands, around Wager Bay, and Mealy Mountains is the relief mountainous, but even in these places remnants of an old erosion surface form the summits. Over the greater part of the Shield local relief is 200 to 300 feet. The greatest relief of more than 5,000 feet is found in the Davis and Labrador Highlands.

Many long periods of erosion have had a great influence in levelling the broad expanses of the Shield and reducing them to a nearly featureless surface even though parts are geologically distinct. Such features as

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# II

# Physiographic Subdivisions of Canada

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*Raised beaches on Hudson Bay Lowland.*

the East Arm Hills are no higher than the crystalline uplands on either side of them. The eastern edge of Kaniapiskau Plateau is a marked scarp that overlooks the sinuous ridges of the Labrador Hills, although some of their summits stand as high as the plateau surface.

*Drainage*

The surface of the Shield varies in detail, but as a result of glaciation a great proportion of it is taken up by water as lakes, ponds, and swamps. Although the percentage of area covered by water has not been accurately measured, it is known to exceed 25 per cent in many large regions; in some parts, such as the Thelon Plain or areas of Pleistocene lakes and marine submergence, the percentage is relatively small.

The drainage pattern varies widely and as yet no preglacial system has been deciphered even for the main streams. With a few exceptions such as Leaf River, the main streams flow in the direction of general slope of the land surface. The details of the tributary drainage, however, are disrupted by the local effects of glaciation including the tilting of the land surface, the grouping of the bedrock, and the deposition of surficial materials. Stream channels commonly follow elements of bedrock structure such as persistent fracture zones, major joint patterns, or the traces of soft strata; in places they are diverted across former divides dammed by glacial debris.

In many areas glacial movement transverse to bedrock topography and scattered deposition of glacial drift have formed a mosaic of ponds interspersed with small ridges and hummocks amongst which streams flow along tortuous courses. In contrast to this heterogeneous drainage, where drift deposits are scarce the streams show a trellis drainage pattern, developed to various degrees, in which the main lines follow long straight lineaments, major fracture zones, or the dominant joint systems in the massive rocks. Differences in the resistance to erosion of the strata or gneisses may also impress a drainage pattern guided by the sinuous twists of the folds with S-shaped lakes or concentric or radiating valleys. In other localities depositional features of glaciation may have been the overruling influence, imposing a strong parallelism upon the drainage in drumlin fields, the swells and troughs of drumlinoid features, or the irregularly parallel, congruent system of ridges and hollows of ribbed moraines. Indeed, in no other region of the world has glaciation more clearly placed its stamp upon the drainage pattern.

A comparison of the drainage patterns on each side of the boundary between the Shield and the Borderlands commonly reveals decided differences despite the over-all masking effect of glaciation. On the Shield the drainage generally shows a multitude of lakes and streams, their pattern controlled by the Precambrian bedrock; whereas on the adjacent Borderlands lakes are less numerous and often display bulbous outlines, and the Paleozoic bedrock imposes different stream patterns.

*Old Peneplains*

The general surface of the Precambrian rocks of the Shield dips at low angles under the bordering Paleozoic strata of the Arctic and Interior Plains, the southwest part of the St. Lawrence region, and particularly around

Hudson Bay Lowland and Foxe Plain. In some areas drilling has shown that the surface is undulating but in general it shelves gradually to great depth beneath the rocks of the Borderlands. Where the character of the Precambrian surface is well exhibited along the border its hills and valleys continue beneath the overlying Paleozoic strata. The strata fill hollows on the Precambrian surface, encroach on the ridges, partly mantle them, and leave only the summits projecting as inliers along the continuations of the ridges. The present surface of the Shield, at least in many areas near its borders, appears to be an exhumed pre-Paleozoic erosion surface.

Outliers of Paleozoic strata are widely scattered in the Shield (some lying far within its borders) generally in depressions or grabens. Some are in valleys such as that of Lake Timiskaming (Hume, 1925) where the Paleozoic strata were deposited on a relief of more than 200 feet, or in deep basins such as that of Manicouagan Lake (Rose, 1955) where several outliers are preserved at 1,200 feet or more below the surrounding Precambrian upland surface without evidence of tectonic movement to bring them to their present position. From the distribution of the Paleozoic outliers it appears that the Shield was peneplaned and the valley system cut in the bedrock before the Paleozoic. It seems that the Precambrian surface has been little changed since the removal of the Paleozoic cover, and that glaciation has only superficially modified its character (Ambrose, 1964).

Although the surface of the Shield seen today is mainly an exhumed surface once buried under Paleozoic strata many areas of Proterozoic sedimentary rocks show similar relationships to the surface of the crystalline Archean rocks beneath them (Ambrose, 1964). The surface of the Shield has had an ancient and complex history indeed. First there was the development and partial dissection of a peneplain on the Archean rocks in pre-Proterozoic time, then the burial and exhumation of this surface once or perhaps twice during the

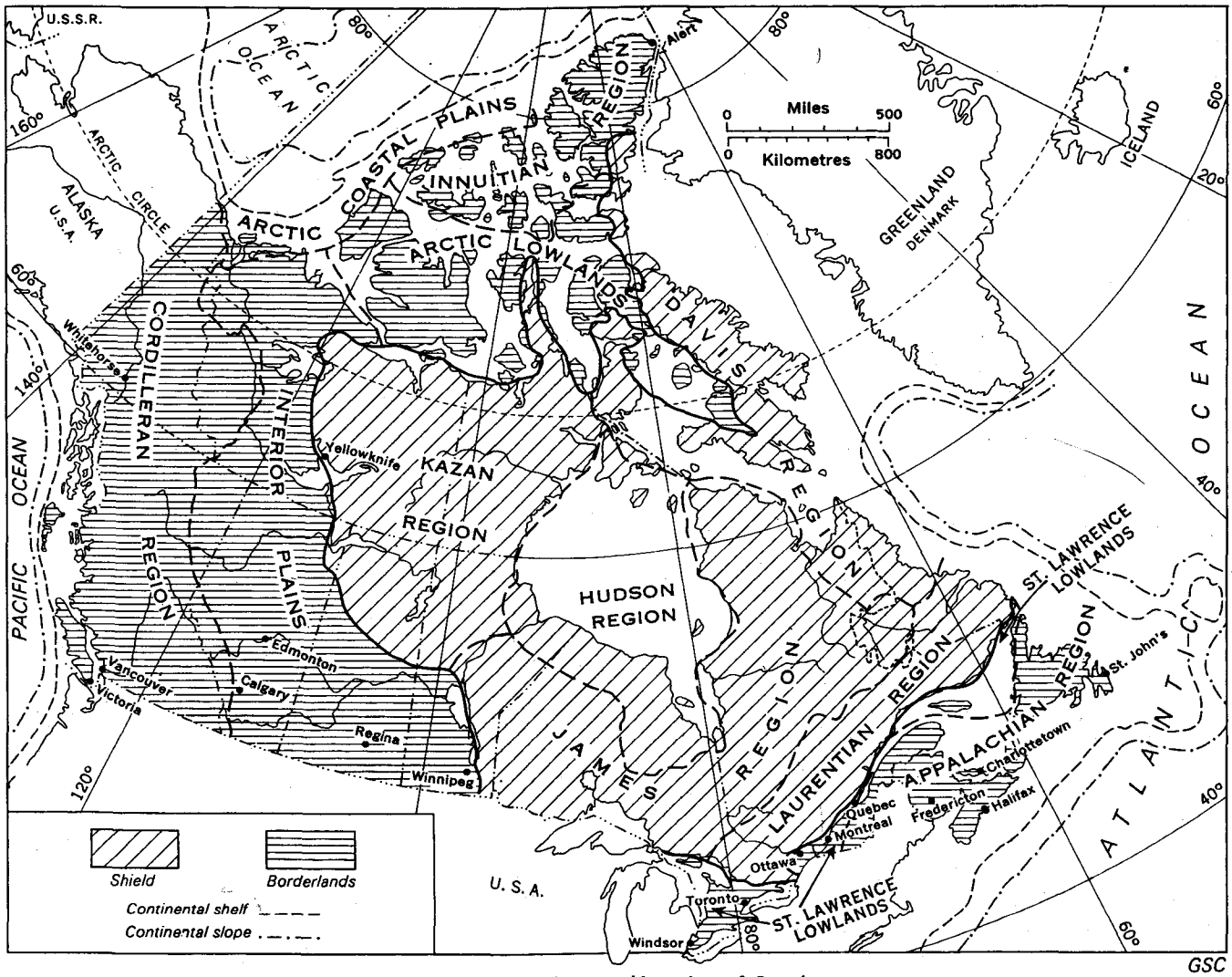



FIGURE II-1. Physiographic regions of Canada.

Proterozoic, followed by the exhuming of these several surfaces from beneath the cover of Paleozoic strata, and finally the scouring of the surface during the surges of Pleistocene glaciation.

*Subdivisions of the Shield*

Despite the general uniformity of its terrain, geological structure and evidence of orogenies show that the Shield is composed of different parts that were once probably as distinct physiographically as the Cordilleran Region and Interior Plains are today. The ancient boundaries are still geologically evident and in places are physiographically distinct. Accordingly, some geological boundaries transect terrain that forms a single physiographic unit.

Four types of terrain in the Shield are relatively easy to distinguish as physiographic units and coincide with particular geological characteristics: (1) plains, formed on areas of unmetamorphosed rocks more or less flat lying, such as the sandstone and conglomerate terrains of the Thelon, Athabasca, and Cobalt Plains or the terrain of flat-lying gabbro sills of Nipigon Plain; (2) hills, composed of low-grade metamorphic rocks, generally tilted or gently folded sediments or sills, such as the Bathurst, East Arm, Penokean, and Labrador Hills; (3) mountains, composed of particularly resistant massive rocks, such as the anorthosites of the Mealy Mountains which stand well above the surrounding terrain; (4) highlands, formed of broad uplifted areas of deeply incised massive crystalline rocks, such as the Labrador Highlands or the glacier-capped Davis Highlands. Other units are distinguished by less obvious characteristics, and in some places the boundaries are arbitrarily drawn to divide uniform but unwieldy units.

## Kazan Region

This region consists of great areas of massive rocks that form broad sloping uplands, plateaux, and lowlands — a rather expressionless terrane. Included in its northwestern part are hills formed of down-faulted and folded stratified rocks, and in its southern and central parts there are some sandy plains of flat-lying strata.

The largest unit of the region is *Kazan Upland,* which covers a wide expanse of rolling lake-spattered country, typical in general aspect of so much of the Shield. North of the Athabasca Plain the highest points are 1,500 to 1,900 feet in elevation with relief rarely more than 200 or 300 feet. The upland slopes gently and drains to Hudson Bay except along its western border where it drains into the Mackenzie River system. Towards Hudson Bay, but about 150 miles from the coast, the relief increases to 600 feet and the higher summits become separated and conspicuous. As much as 100 miles from the sea the upland was covered by the postglacial marine overlap that reached as high as 675 feet above present sea level (Lee, 1959). The area of overlap forms a coastal plain of little relief mantled largely by reworked drift deposits that obscure nearly all the bedrock.

*Athabasca Plain* forms a large embayment into the western part of Kazan Upland. The plain consists of nearly flat lying sandstones and has a rolling hummocky, lake-spotted, forested surface that rises from 900 feet elevation on the west to 2,000 feet on the east and has a local relief of 200 to 300 feet.

*Thelon Plain* lies in the central part of the region and includes areas of nearly flat lying sandstones and volcanic rocks that are characteristically expressed on the surface by sandy flats sparsely covered by vegetation.

Southwest of Thelon Plain, *East Arm Hills* are formed of down-faulted and folded, differentially eroded sediments and gabbro sills. On the north side the resistant sills dip southerly forming broad cuestas as much as 900 feet above Great Slave Lake, the surface of which is about 500 feet in elevation. Most intervening valleys are flooded by arms of Great Slave and other lakes. On the south side the hills are narrow and lower, ending abruptly at the long, straight, high, fault scarp bordering Kazan Upland.

In *Back Lowland,* east of Bathurst Hills near Thelon Plain, some upland areas are more than 1,000 feet in elevation. The lowland surface, however, is generally lower than that of Kazan Upland and Wager Plateau which border it on the south and east, particularly between Back and Ellice Rivers. Much is typical of the treeless Shield, but near the coast the surface is mantled by mud and silt of the postglacial marine overlap. Eskers are a typical feature of the inland areas.

The surface of *Wager Plateau* rises gradually from Chesterfield Inlet and Wager Bay to 2,000 feet elevation where it is deeply dissected. From Wager Bay northward the surface declines and loses its identity in low patches alternating with rugged areas of 400 to 700 feet elevation.

*Boothia Plateau* is underlain by crystalline gneiss forming a narrow north-trending prong of the Shield partly covered by outliers of Paleozoic strata. In the south its surface merges with Wager Plateau 2,500 feet above sea level; northward the surface declines as that of the adjacent lowlands rise.

*Bathurst Hills* (Bird and Bird, 1961) are composed of down-faulted, folded sediments and sills that lie within and extend south from Bathurst Inlet between higher upland areas of massive rocks. The softer strata have been eroded and in many places lie submerged beneath bays and channels, leaving the harder members, generally the sills, as long cuestas more than 1,000 feet in elevation. Marine silts and reworked deposits from the marine overlap mantle some of the lower parts. Southwestern Bathurst Hills form a prong of ridges termed the Peacock Hills. Some are rugged and reach more than 2,000 feet elevation standing as much as 600 feet above nearby lakes.

*Bear–Slave Upland* consists mainly of massive rocks though some stratified rocks lie in the northeastern part. Generally the peneplain surface is typical of the treeless,

bare-rock parts of the Shield. Numerous lakes fill the hollows, and rounded rocky hills, exhibiting a relief of a few hundred feet, are characteristic. Many monadnocks exceed 1,000 feet in relief, their summits reaching above 1,600 feet elevation.

The main part of the *Coronation Hills* area is low, extending along Rae and Richardson Rivers eastward into Coronation Gulf. The hills are formed of gently northward dipping sediments intruded by sills and dykes, the latter showing as islands in the Gulf. The hills and ridges rise more than 800 feet above sea level. In the southwest the ridges become more closely spaced until they merge to form the broad, relatively smooth topped uplands of the Coppermine Hills with altitudes of 2,000 feet. Southwest of Dismal Lakes massive rocks protrude through the sediments to form large rounded hills.

## Davis Region

Davis Region (Dunbar and Greenaway, 1956) extends from Ellesmere Island south and southeastward to northern Labrador. It is relatively narrow at each end but widens in the middle where crystalline Precambrian rocks surround flat-lying Paleozoic strata of Foxe Plain, a part of Hudson Region. The general aspect is one of a broad, gently warped, old erosion surface, shallowly etched by erosion along joint systems and zones of weakness. Surficial deposits are few except locally near Foxe Plain. Along the eastern coast relief is generally high. The region is divided into a northern or insular part and a southern or mainland part.

*Davis Highlands* (Ives and Andrews, 1963) are an elevated belt of deeply dissected crystalline rocks (Pl. II-1) that extend along the northeastern flank of Baffin and Bylot Islands and thence north over eastern Devon Island and Ellesmere Island as far as Bache Peninsula. Along this distance of some 1,200 miles the highlands are mountainous with remnants of an old erosion surface forming the summits or marked by a general accordance of peaks 5,000 feet or more above sea level. The old surface slopes gently westward in the north and southwestward in the south. Long arms of the sea penetrate the land as sounds or fiords, and on Baffin Island some cut through the highland into Baffin Upland. The highest parts are commonly crowned by ice caps; the largest is Penny Ice Cap along the border with Baffin Upland, at an elevation of 6,000 to 7,000 feet.

*Baffin Coastal Lowland* borders the Davis Highlands on eastern Baffin Island, extending from Henry Kater Peninsula to Eglinton Fiord. Its greatest width is about 25 miles, but generally it occurs as isolated, narrow strips at the ends of the peninsulas or islands.

*Baffin Upland* is also dominated by the high upland surface present on Davis Highlands. The old erosion surface slopes generally southwestward from 3,000 feet elevation near the highland and Barnes Ice Cap to near sea level around Foxe Plain. The border between Davis



PLATE II-1. Fiords and glaciers, Davis Highlands, Baffin Island.

Highlands and Baffin Upland is drawn where the dissection is shallower, the old erosion surface becomes dominant, and the drainage begins to flow southwestward.

*Hall Upland* on Hall Peninsula is separated from Baffin Upland by Cumberland Sound; the surfaces of these two uplands are similar. Hall Upland reaches 3,800 feet elevation on the northeast side and slopes southwestward into Frobisher Bay. South of the bay *Frobisher Upland* rises abruptly from the sea to 3,000 feet, then slopes southward into Hudson Strait. A similar but lower and more irregular terrain extends westward to Foxe Peninsula. The southwest part, with maximum elevations of about 1,200 feet, is included in the Frobisher Upland. The massive rocks that underlie all these uplands apparently continue beneath the sea and project as isolated areas of the Frobisher Upland in the rugged plateaux of Salisbury and Nottingham Islands.

The mainland part of *Melville Plateau* is largely a featureless smooth upland 1,500 to 2,000 feet above sea level, but with some rugged areas along its west border. On Southampton Island the upland surface is lower at the northwestern and eastern ends, but near the centre much reaches 2,000 feet elevation.

*Labrador Highlands* and *George Plateau* together resemble the highlands and uplands of Baffin Island. They exhibit parts of an old erosion surface that is cut on massive rocks and slopes inland. The highlands are deeply incised by valleys and fiords along the sea coast; they include several ranges such as Torngat Mountains, the highest and most rugged area of the eastern mainland of Canada. These ranges commonly reach 3,500 feet above sea level and occasionally 5,000 feet. The old erosion surface occurs as undulating, generally westerly sloping remnants around which glaciation has sculptured cirques, rugged peaks, and deep U-shaped valleys and fiords where the cliffs drop precipitously into the sea. In the north some deep valleys traverse the highlands and connect with others in George Plateau, whose streams drain into Ungava Bay. Inland, the old surface becomes more continuous and somewhat less undulating. It forms the main features of George Plateau sloping towards Ungava Bay and Whale Lowland. The highest parts of the plateau are generally between 1,000 and 2,000 feet elevation, but are somewhat higher near Labrador Highlands. Much is covered by areas of drumlinized drift, particularly the lower parts.

*Whale Lowland* is a broad, irregular, drift-covered area drained by Whale River. Scattered hilltops range from 2,000 feet elevation in the south to 800 feet in the north. Its boundaries, determined largely by the limits of drift cover, are arbitrary.

## Hudson Region

Hudson Region includes Hudson Bay Lowland, Hudson Bay itself, Southampton Plain, the Belcher Islands, and Richmond Hills. It is composed of the partly submerged blanket of unmetamorphosed, mainly flat lying Paleozoic and Proterozoic strata that form the main central depression on the surface of the Shield.

*Hudson Bay Lowland* is a low, swampy, marshy plain with subdued glacial features and a belt of raised beaches that border the bay *(Frontispiece)*. Paleozoic strata mantle the massive or stratified Precambrian rocks, and slope gently northeastward and eastward into Hudson and James Bays. Elevations of 200 to 400 feet are reached along the edge of the Severn and Abitibi Uplands; part of its south border is marked by an escarpment overlooking Abitibi Upland. A most conspicuous feature is Sutton Ridge, an inlier of Precambrian strata that rises to 600 feet elevation, about 500 feet above the surrounding surface.

*Southampton Plain* (Dunbar and Greenaway, 1956), formed on flat Paleozoic strata, is rather irregular but well drained. It is generally less than 300 feet in elevation and is bordered by two higher outliers of Precambrian rocks of Melville Plateau: that on Southampton Island reaching 500 feet and the other at the north end of Coats Island, 700 feet.

*Belcher Islands,* ranges of hills projecting through the waters of Hudson Bay, are formed from the resistant strata of a thick section of Proterozoic sedimentary and volcanic rocks elaborately folded into long curved hairpin-shaped structures. The higher summits reach about 400 feet above the sea and are truncated by an old erosion surface. *Richmond Hills,* including the Nastapoka Islands and other islands to the north, are mainly a group of east-facing cuestas of Proterozoic sedimentary and volcanic rocks.

Within the main area of *Hudson Bay* the average depth of water is 100 metres, but in the north-central region it reaches 230 metres. The general bathymetric configuration of Hudson Bay is saucer-shaped, particularly in the peripheral areas. Long ridges and valleys disrupt the pattern, however, and in some places, the more continuous, sinuous trends resemble a submerged river system. Echogram soundings clearly show steep-walled valleys as much as 30 metres high that extend beyond present estuaries. The floor of one valley, which is 80 miles west of the Ottawa Islands and trends northerly, lies 330 metres below sea level, almost 200 metres below the level of the adjacent sea floor. It appears to owe its configuration to subaerial erosion along a structural trend.

Other linear trends comprise topographic highs, the most prominent of which is the northerly trending ridge parallel to and 75 miles west of the deep trough mentioned above. The highest part of this arcuate ridge, the Central Shoals, lies at a depth of about 30 metres and may be bedrock controlled. Other smaller ridges are apparent and are thought to be submerged interfluvial areas. In northeastern Hudson Bay adjacent to Digges Islands, a steep-walled, linear trough about 490 metres deep is

thought to have resulted from subaerial erosion and glaciation along a fault.

## James Region

The greater part of James Region exhibits the characteristic features of the Shield that are apparent in the major uplands and plateaux of Kazan Region but are less apparent in Davis Region. It is divided into a number of units mainly on arbitrary grounds, but also includes small distinct units such as Nipigon Plain and the Labrador Hills. The physiography of northern Quebec and Labrador has been described by Hare (1959) from a study of airphotographs. His map has been used extensively in preparing this report, but his boundaries have been simplified and some names added.

*Severn* and *Abitibi Uplands* are similar; both are underlain by crystalline Archean rocks and both have broad rolling surfaces that rise gently from Hudson Bay Lowland in the north reaching about 1,500 feet in their higher parts near the southwest and southern borders. Most of the uplands lie between 900 and 1,200 feet elevation. Large areas in southwest Severn Upland and northern Abitibi Upland are mantled by glacial lake deposits.

*Nipigon Plain* is formed on nearly flat lying Proterozoic gabbro sills and sediments surrounding Lake Nipigon. It lies at an elevation of 900 feet and is deeply dissected so that remnants of the resistant sills stand as scattered hills. *Port Arthur Hills* are also formed of Proterozoic sills and sediments tilted to the south forming cuestas and ridges some of which extend as promontories into Lake Superior. They reach summits of 1,500 feet and in places rise 800 feet above the lake and adjacent valleys. Michipicoten Island is formed of stratified rocks and forms a link with the *Penokean Hills,* which are composed of folded sediments. Most summits of the latter are 800 to 1,000 feet in elevation, but two points reach at least 1,500 feet, giving a maximum relief of about 900 feet. *Cobalt Plain* is composed of flat-lying clastic sediments with ridges and hills formed by gabbro sills or inliers of Archean crystalline rocks.

The surface of *Eastmain Lowland* joins those of Abitibi Upland and Larch Plateau. It is generally lower than either of these units, however, and large areas are covered by the Pleistocene marine overlap, particularly near the border of James Bay. Lakes are few and muskeg prevails. As a whole the plain has a gently westward sloping surface, broken here and there by hills. In the highest part northwest of Lake Mistassini, lakes are 1,200 feet above sea level.

*Larch Plateau* has an undulating surface with elevations of 500 to 1,500 feet (Stevenson, 1965). Bedrock is widely exposed and drift is thin over most of its surface. Areas on the west side were covered by the postglacial marine overlap, however, and much of the low-lying southeast part is cloaked with drumlinized till. In the south drainage is westward to Hudson Bay, but farther north a large area is drained to Ungava Bay by Leaf and Larch Rivers. Leaf River starts within 30 miles of Hudson Bay at an elevation of about 500 feet; as it flows northeastward the hills in the heart of the plateau rise from 600 to more than 1,000 feet.

*Povungnituk Hills* include the Cape Smith and Povungnituk Ranges. Their rocks are largely Proterozoic volcanic rocks and gabbro sills similar to those of Richmond and Labrador Hills. The folded strata form a series of east–west ridges and valleys with a relatively high relief in the western part but of more subdued character in the east where the summit surface of the hills virtually merges with the Larch and Sugluk Plateaux.

*Sugluk Plateau* at the northern tip of Ungava Peninsula is separated from Larch Plateau by Povungnituk Hills. In places along the north coast the plateau drops precipitously as much as 1,700 feet into the sea. To the west it slopes gently and was covered by the postglacial marine overlap. Inland its slightly undulating surface reaches elevations of 1,900 feet.

The general aspect of *Lake Plateau* is that of a rolling plain with numerous lakes (Hare, 1959); isolated hills of bedrock (some of rugged character) stand about 500 feet above the general surface. In the northwest the elevations are between 1,500 and 3,000 feet. The southern part is generally higher with less relief and ranges from 2,500 to 3,000 feet, whereas to the northeast the elevations are generally lower, between 1,400 and 2,100 feet.

*Kaniapiskau Plateau* forms the core of Lake Plateau and is composed of rugged hills of massive rocks in which fracture systems are conspicuously etched. Parts reach elevations of more than 3,000 feet. Its eastern border forms an escarpment overlooking Labrador Hills but elsewhere its surface merges with that of Lake Plateau.

The *Mistassini Hills* consist of subparallel hills, ridges, and valleys; the valleys are partly filled with the waters of Lake Mistassini. Summits are more than 3,500 feet in elevation in the Otish Mountains, and stand 2,500 feet above Lake Mistassini. Most ridges are north-facing cuestas formed of sedimentary rocks and gabbro sills and generally have a subdued aspect, particularly around the lake.

*Labrador Hills* cover the main part of the belt of folded Precambrian sedimentary and volcanic rocks along the east side of Larch and Kaniapiskau Plateaux. It is a belt of sinuous ridges and valleys formed by downwarped folded and faulted strata. The summit elevations range from 2,400 feet in the south and central parts to 1,200 feet in the northern part. In the northern end the

relief is subdued but towards Koksoak River it is bolder and as much as 300 feet. Farther northward again the belt of hills becomes narrow and merges with the adjacent plateau areas. There the valleys are generally floored with drift, tills, drumlins, and sand.

### Laurentian Region

This region comprises uplands and highlands that rise abruptly above the St. Lawrence Lowlands along its southeast border. The strong relief at the border is partly caused by fault scarps, in contrast to the western and northern margins of the Shield where the peneplain surfaces dip gently under the overlapping Paleozoic strata of the Interior Plains and Arctic Lowlands.

*Laurentian Highlands* rise abruptly above the St. Lawrence Lowlands, or the water of the St. Lawrence River and Gulf. The southeastern edge is deeply, and in places widely, incised by several large rivers that gather volume in the high undulating interior and drop rapidly into the river or the gulf. As a result, the southeastern border has a mountainous appearance, the relief commonly at 1,000 to 2,000 feet. In many parts of the interior the surface is also mountainous, but the evenness of summit levels is commonly apparent. This old erosion surface has a relief of 1,000 to 1,500 feet, somewhat higher than that of the adjacent Abitibi Upland to the north. Much of the upland surface lies at about 2,000 feet elevation but here and there broad areas have summits at 3,000 feet, and in a few parts at 4,000 feet. Laurentian Highlands extend south of Ottawa River and include the spur of hills formed of Precambrian rocks that cross St. Lawrence River to form the Thousand Islands and join with Adirondack Mountains of the United States.

*Mecatina Plateau* is a large area of varied terrain — a rough undulating region with deeply dissected margins. Its surface rises rapidly from the coast to elevations of 700 to 1,200 feet and thence slopes gently to about 1,800 feet along its inland borders. Much of the western and inland parts is drift covered.

Northwest of Mecatina Plateau and bordering on James and Davis Regions is an area of broken terrain composed of upland and plateau units with intervening lower areas. *Hamilton Upland* is a composite unit of three bold, rugged areas of hills, each as much as 2,500 feet in elevation, that stand 500 to 1,000 feet above the surrounding lake and drift-covered plateau surface. Southeast of the upland, drift-covered areas form *Hamilton Plateau*. *Melville Plain,* which contains Lake Melville lying practically at sea level, is an irregular lowland, mainly about 500 feet in elevation; a few hills reach 1,000 feet. It is much dissected by river valleys entering from the west. *Mealy Mountains* rise abruptly above the south side of the Melville Plain and reach their highest elevation of 3,700 feet in the east. An old erosion surface truncates their summits and slopes downward to the west. Cirques are reported in the highest part (Hare, 1959).

## THE BORDERLANDS

The Borderlands, which contain a great variety of physiographic provinces, are divided into easily recognized subdivisions, many with long established names. They include the Innuitian Region, Arctic Coastal Plain, and Arctic Lowlands in the north; the Interior Plains and Cordilleran Region of western Canada; and the St. Lawrence Lowlands and Appalachian Region in the east.

### Innuitian Region

This is a region of varied topography — on the average more rugged than that of the surrounding provinces — developed from the thick assemblages of deformed sedimentary rocks and minor intrusions. The region is roughly triangular, covers an area of about 210,000 square miles, and forms part of the outer ring of the Borderlands between the Shield and the Arctic Ocean. According to E. F. Roots it is characterized by two curving belts of relatively rugged terrain separated by extensive and discontinuous tracts of more subdued topography. The landscape shows the effects of several interrupted or superimposed physiographic cycles, but most of the landforms are in an intermediate or comparatively youthful stage of development and reflect directly the rock composition, geological structure, and recent vertical movements of the Innuitian system.

The northernmost mountain belt comprises the *Grantland* and *Axel Heiberg Mountains,* which include the British Empire and United States Ranges of northwest Ellesmere Island and the mountainous central and western Axel Heiberg Island. They consist mainly of long ridges of folded Mesozoic and Paleozoic strata, with minor igneous intrusions. The local relief is as much as 4,000 feet, and the highest summits reach 8,200 feet above sea level. In central Axel Heiberg Island and northwestern Ellesmere Island the mountains are nearly buried by ice sheets through which the peaks project as rows of nunataks. On their northwestern flank the mountains pass rather abruptly into a narrow seaward-sloping plateau; on the east and southeast sides they pass with decreasing ruggedness into the elevated dissected edge of the Eureka Upland. At the south end of Axel Heiberg Island, however, the ridged terrain is apparently continuous with that of the inner mountain belt of Eureka Upland. The ranges and ridges are transected by numerous parallel-sided, steep-walled cross valleys, some straight and angular, and some smoothly curving. In northwest Ellesmere Island these make impressive fiords and trough-like valleys with glaciers at the head.

The inner belt of rugged topography extends the length of the Innuitian Region from northeast Ellesmere to the west end of Parry Islands, and is developed throughout on subparallel, gently curving folds in Paleozoic carbonates, shales, and sandstones of the Franklinian Geosyncline. The topography is on the whole less rugged than

that of the outer mountain belt; it is most mountainous in northeast Ellesmere Island where *Victoria and Albert Mountains* reach elevations above 6,500 feet and carry an extensive ice sheet and numerous glaciers. Well-developed valley and ridge topography, with ridge tops 3,500 to 4,000 feet in altitude and a local relief up to 2,500 feet, trends south to southwest across Ellesmere Island and then swings abruptly westward continuing, with interruptions, to Melville Island. The tops of the ridges become progressively broader, and the flat or undulating summit surfaces become the dominant feature of the landscape as the ridged upland passes into the little dissected Parry Plateau.

*Eureka Upland* comprises an elongated area of relatively subdued topography in central and western Ellesmere Island and eastern Axel Heiberg Island, and lies between the two major mountain belts of the Innuitian Region. In large part it has a rolling and ridged surface controlled by underlying folded strata, but with altitudes generally less than 3,000 feet. There are extensive areas of low dissected plateaux and gently rolling low uplands developed on soft late Mesozoic and Tertiary sandstone and shale. The uplands are cut by trench-like depressions, curving, sinuous, or branching in plan, forming great dendritic drainage systems with floors that extend gradually beneath the sea to depths of more than 300 metres in Nansen Sound and Norwegian Bay.

The terrain of *Parry Plateau* is strongly ridged on Bathurst Island. The ridges are broad, flat topped and straight sided, average less than 800 feet above sea level, and separate wide flat-floored longitudinal valleys transected by rugged, ravine-like cross valleys. Farther west on Melville Island where the plateau surface dominates the landscape, the average elevation increases to more than 1,000 feet. A few hills at 2,500 feet elevation in the western part of the island carry four small ice caps, and cliff-walled fiord-like bays and straits cut deeply into the uplifted plateau surfaces.

In the western Queen Elizabeth Islands, Parry Plateau is bounded on the north by *Sverdrup Lowland,* a region of low relief developed on a structural basin of generally soft, poorly consolidated, and little deformed Mesozoic rocks. For the most part the land surface is a rolling, scarped lowland less than 500 feet above sea level. Locally areas of low upland and dissected plateau reach 1,200 feet elevation and elsewhere extensive areas of plain lie only a few feet above sea level. Among the distinctive landforms are dissected domes and ring structures developed on gypsum anhydrite piercement diapirs and igneous intrusions. About half the total area of Sverdrup Lowland is covered by water; the sea floor is nearly flat and lies at depths of 200 to 500 metres over large areas, with a relatively abrupt rise to the island shores. This suggests an extensive period of erosion controlled by a wave-base level below that of the present seas.

## Arctic Coastal Plain and Continental Shelf

*Arctic Coastal Plain* includes the coastal terrain along the shores of the Arctic Ocean from Meighen Island to Alaska. The plain borders and lies seaward of the Innuitian Region, Arctic Lowlands, Interior Plains, and Cordilleran Region. Although there is a general similarity of landscape throughout the province, each section has distinctive physiographic characteristics.

The *Island Coastal Plain,* the section extending from Meighen Island to Banks Island, is underlain by the Beaufort Formation of unconsolidated Tertiary or early Pleistocene sands and gravels. On Meighen Island this formation has been uplifted 600 feet and eroded to form a hilly terrain that carries an ice cap whose summit is more than 800 feet above sea level. On Ellef Ringnes, Borden, Brock, and Prince Patrick Islands the coastal plain is low, remarkably flat, and uniform, with a network of consequent streams (incised at most a few feet) draining seaward. The inland boundary of the coastal plain, as much as 100 feet above sea level, is marked in places by a low ridge or scarp facing seaward or inland. There are scattered remnants of the coastal plain surface in Sverdrup Lowland. On Banks Island the coastal plain is characterized by low rolling hills and well-organized drainage, with alluvial plains and low westward-sloping terraces bordering the master stream valleys that bear witness to several stages of erosion and uplift. Inland at an altitude of about 300 feet the plain merges with the Victoria Plain.

On the mainland the Arctic Coastal Plain is represented by Mackenzie Delta and Yukon Coastal Plain. *Mackenzie Delta* has a compound character and includes not only the delta of the present river but remnants of earlier deltas and complex fluviatile-marine features such as Cape Bathurst (Mackay, 1958). The delta plain is remarkable for its multitude of lakes and channels, and the older parts for the scores of pingoes, some of large size, which form the most outstanding features of the landscape.

Immediately west of the mouth of Mackenzie River, *Yukon Coastal Plain,* which lies considerably higher than the Mackenzie Delta, appears to be largely an erosion surface cut in bedrock mantled with a thin veneer of recent sediments. Towards the west, the plain decreases in elevation and is drift or lake covered along the coast to near Herschel Island. West of the island to the Alaskan border, the plain is formed of coalesced deltas and alluvial fans built by streams flowing from the British Mountains and of coastal lagoons.

Arctic Coastal Plain extends beneath sea level to merge with *Arctic Continental Shelf.* Offshore from Meighen, Ellef Ringnes, Borden, and Prince Patrick Islands the sea floor is shallow and slopes both seaward and towards the channels which separate the islands where the slope is steeper, more irregular, and reaches depths of about 300 metres. It is evident that the exposed part, or Arctic Coastal Plain, is but a part of an emerged sur-

face of deposition which, in the main, antedates the formation of the deep channels between the islands. Below about 300 metres the drowned headlands that extend seaward from each island group merge with the continental shelf proper. The continental shelf is a nearly plane surface (sloping seaward at about 12 feet per mile) whose inner part is smoothly continuous with the flat channel floors at a depth of 450 metres and whose outer edge, 80 to 120 miles from the headlands of the outermost islands, breaks sharply and cleanly at a depth of 750 metres to fall away as a relatively steep continental slope which descends smoothly to the Arctic Ocean basin. North of the mainland the continental shelf is shallower, and the general slope of Yukon Coastal Plain continues unchanged beneath sea level, reaching a depth of only 100 metres at a distance of 50 or more miles from shore. There the shelf breaks away rapidly to an irregular, relatively dissected continental slope that drops steeply to oceanic depths beneath Beaufort Sea.

## Arctic Lowlands

The Arctic Lowlands are formed on the flat-lying or nearly flat Paleozoic and late Proterozoic sedimentary rocks, lying between the Shield and the Innuitian Region. They include Lancaster Plateau, Foxe Plain, Boothia Plain, Victoria Lowland, and Shaler Mountains.

In the northeast the surface of *Lancaster Plateau* slopes gently southward from about 2,500 feet on southern Ellesmere Island, across central Devon Island to average elevations of 1,000 to 2,000 feet on Somerset Island and Brodeur Peninsula of northwestern Baffin Island. Its general uniformity is continuous without apparent deflection across the wide channels of Jones and Lancaster Sounds and Prince Regent Inlet. Farther south the surface descends still lower until on both sides of the Gulf of Boothia it forms the surface of *Boothia Plain* reaching sea level and apparently dips beneath it at Committee Bay.

*Foxe Plain* is low, smooth, and underlain by Paleozoic strata. It forms a very shallow basin-like area on the old surface of the Precambrian rocks which is partly covered by very shallow seas. On Baffin Island the plain is divisible into three parts, the Great Plain of the Koukdjuak, Soper Highland north of Koukdjuak River, and Putnam Highland to the south. The last reaches 600 feet elevation. Conspicuous features of the Great Plain of the Koukdjuak are a broad belt of emerged beaches stretching north-south on the easterly part and numerous, circular lakes on the central part of the plain.

West of the narrow finger of crystalline rocks of the Shield forming Boothia Plateau, the east side of the *Victoria Lowland* appears to have the same tilted surface as that forming Lancaster Plateau and Boothia Plain, the general elevations decreasing to the southwest and south across Prince of Wales Island, the southwest coast of which is very low. Little is known of the water depths in M'Clintock Channel, but it may be that the channel floor is a part of the lowland surface below present sea level, for to the west the surface rises again to form the low east coast of Victoria Island ultimately reaching 2,500 feet elevation in the central part of Shaler Mountains in the interior of the island. *Shaler Mountains* are composed of later Proterozoic stratified rocks intruded by gabbro sills which form cuestas and are capped by flat-lying volcanic rocks. Farther west, the elevation of the general surface of Victoria Lowland decreases gently, and in central Banks Island it merges with Arctic Coastal Plain. On eastern Banks Island and throughout much of Victoria and Prince of Wales Islands, the smooth undulating ancient erosion surface of the lowland is covered by a variety of glacial deposits, with extensive areas of drumlinoid ridges that impart a characteristic grain to the minor topography. Belts of very thick, rough moraines form irregular hills on southwestern Victoria Island and on both sides of Prince of Wales Strait comprising the most rugged topography within the Victoria Lowland.

## Interior Plains

Interior Plains are underlain by flat-lying later Proterozoic, Paleozoic, Mesozoic, and Tertiary strata, occupying the region between the Shield on the east and the mountains of the Cordilleran Region on the west. They join with the St. Lawrence Lowlands of eastern Canada through the United States of America and are separated from the Arctic Lowlands by Amundsen Gulf. The southern part is semi-arid grass land; the central part is tree-covered; the northern part is tundra. The region is divided into several units, those in the north being smaller and more varied than those in the south.

*Horton* and *Anderson Plains* form the Arctic slope where drainage is directly to the Arctic Ocean. Anderson Plain is covered by a sheet of glacial drift and outwash, the main feature which distinguishes it from the somewhat higher Horton Plain where bedrock is generally exposed. Horton Plain is underlain by nearly flat lying Paleozoic and late Proterozoic sediments and its surface reaches elevations of 1,200 to 2,000 feet, the higher parts being in the south. Much of the western part of the plain is rocky, but in the eastern part rolling areas of drift occur. With few exceptions the lakes are small and scattered. Throughout, as the streams gather size, they become entrenched 200 to 400 feet below the surface. In the north some late Proterozoic strata are slightly folded and faulted giving rise to a rolling surface of low scarps and scattered mesas. Melville Hills, which include Mount Hooker, 1,600 feet in elevation, form the divide between Horton River and the sea. Anderson Plain (Douglas, *et al.*, 1963; Mackay, 1958) is characteristically undulating and rises inland. Large parts of its higher levels are rocky, but extensive areas of outwash from an ice front that lay near its southeast border cover much of the surface and several entrenched run-off channels wind across the plain. On the north along the coast it includes the low, flat, lake-dotted

Capes Bathurst and Parry but inland it rises abruptly along an escarpment 600 to 1,000 feet in elevation. As elevations gradually increase southward the main stream valleys and lake-floored run-off channels lie at elevations of 500 to 700 feet whereas the surrounding surface is about 800 to 1,000 feet.

*Peel Plain* (Douglas, *et al.*, 1963) lies southwest of Mackenzie River. The southwest part is a broad, shallow hollow about 400 feet in elevation, some parts with innumerable small lakes and others without any. On the northeast the surface rises to Grandview Hills which reach 1,500 feet elevation at their eastern end. Arctic Red River is entrenched across Peel Plain, and Ontaratue River rising on its surface also follows a deeply incised course to Mackenzie River. The southwestern part of the plain is underlain by Mesozoic sediments whereas Paleozoic strata form the hills in the north and east.

*Peel Plateau* rises in steps between Peel Plain and Mackenzie Mountains. The surface of the first step truncates the upturned edges of the Paleozoic and Mesozoic strata and is, therefore, an erosion surface. Above, a second step or terrace rises in parts of the plateau and on top of this a group of undulating, rounded plateaux of nearly horizontal strata form a third step. These plateaux are separated from Mackenzie Mountains by a broad, shallow but poorly defined valley. In the southwest some areas of the plateau appear unglaciated but most of its surface is covered by thin drift deposits with small scattered lakes lying in the hollows. Remnants of one or more large, entrenched, meltwater channels wind across the plateau from the east to Snake and Peel Rivers.

*Colville Hills* (Douglas, *et al.*, 1963) embrace several ridges of Paleozoic strata that stand above the general level of the surrounding plains. The hills and ridges enclose hollows with several large lakes in a net-like pattern whose meshes are 10 miles or more across. The lower ground within the meshes lies at 800 to 1,000 feet elevation, whereas the rather sinuous ridges have summits up to 2,200 feet.

*Great Bear Plain* (Douglas, *et al.*, 1963) is largely composed of Mesozoic strata. Its rolling surface is generally below 1,000 feet elevation, but a number of small subcircular plateaux and hills such as the Scented Grass and Grizzly Bear Hills, rise above this, reaching elevations of about 1,500 feet.

The south-facing escarpment of Cartridge Mountains forms the southern boundary of Great Bear Plain and overlooks *Great Slave Plain* whose surface of Paleozoic strata has generally little relief. Low scarps of resistant carbonate strata and small shallow lakes are characteristic of much of the surface below 1,000 feet elevation. Its central part, however, contains Horn Plateau underlain by Cretaceous strata, an outlier of the Alberta Plateau to the south.

*Alberta Plateau* (Holland, 1964) is composed of Cretaceous sediments and consists of a ring of plateaux separated by wide valleys. The plateaux include Cameron Hills and Caribou Mountains. On the north these hills form a high disconnected escarpment with summits between 2,500 and 3,200 feet elevation overlooking Great Slave Plain. On the east they overlook the north end of Saskatchewan Plain. On the southeast they embrace Cheecham Hills, 2,500 feet in elevation, and from there the south border of the plateau extends along the flanks of hills on the north side of the Athabasca River to join the Foothills of the Rocky Mountains. A smooth upland surface is the main feature of all the hills. They are generally higher to the southwest at about 4,300 feet elevation. The two main valleys that occupy more than 50 per cent of the area are termed the *Fort Nelson* and *Peace River Lowlands.* The rivers and their main tributaries are more or less entrenched into the valleys which rise from less than 1,000 feet in the north and northeast to about 2,500 feet elevation in the west.

South of Athabasca River, *Alberta Plain* (Acton, *et al.*, 1960) also largely composed of Mesozoic sediments but with some of Tertiary age in the west and south stretches southeastward to the International Boundary. Although virtually the continuation of the Alberta Plateau, it has a more even surface, with a few widely separated groups of low hills such as the Neutral, Cypress, and Porcupine Hills. Much of the plain is about 2,500 feet in elevation, river valleys entrenched 200 to 400 feet, and hills rising to 3,500 feet or more. Cypress Hills reach 4,700 feet and parts of their summit are believed to have escaped glaciation.

The eastern edge of the Alberta Plain (Pl. II-2) referred to as the Missouri Coteau constitutes a step down to *Saskatchewan Plain.* The Coteau, well marked at the International Boundary by a line of low, rounded hills partly formed by Tertiary sediments, gradually becomes indefinite northwestward. East of the Coteau, Saskatchewan Plain, formed on Mesozoic sediments and lower and smoother than Alberta Plain, is gently undulating and rolling, its surface ranges from 1,500 to 2,600 feet above sea level and relief is about 300 feet in the hillier parts. Saskatchewan River is now entrenched in bedrock across the plain. By the end of the Pleistocene its waters had incised a broad valley along a southeasterly course now only occupied by a comparatively small stream, the Qu'Appelle River. In the northwest the Ile-à-la-Crosse Lowland (Acton, *et al.*, 1960) around Peter Pond Lake forms a detached area generally below the surface of southern Saskatchewan Plain but is here included with it.

On the east, Saskatchewan Plain is bordered by the Manitoba Escarpment overlooking *Manitoba Plain* which is underlain by Paleozoic sediments. Streams flowing eastward have cut deep valleys in the escarpment dividing it into a line of separate hills, the highest of which, Riding Mountain, stands nearly 1,000 feet above Manitoba Plain. The surface of the Manitoba Plain has an elevation of about 800 feet and is very gently undulating to flat. It is largely covered by lakes and includes most of Lake Winnipeg. In the southern part its features have been

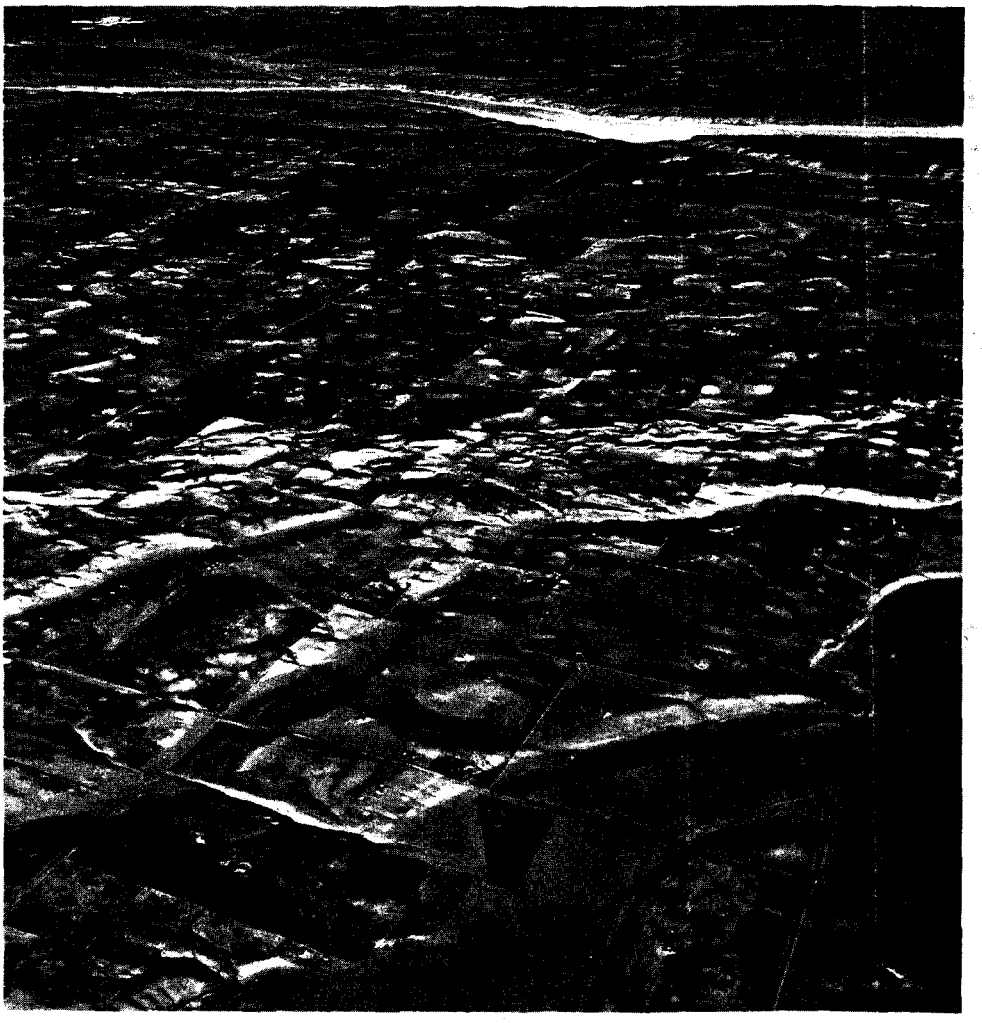


**PLATE II-2**

**Alberta Plain and Missouri Coteau, with glacial moraine, near Assiniboia, Saskatchewan.**

smoothed over by the deposition of the clays and silts of glacial Lake Agassiz. The beaches of this lake, marking successively lower water levels, wind along the lower part of Manitoba Escarpment.

## Cordilleran Region

### *General Features*

The Cordillera in Canada is divided longitudinally into three great belts, the Eastern System, the Interior System, and the Western System (Bostock, 1946 and 1961; Holland, 1964). Each has its own characteristic geology and likewise its physiography. The Eastern System is composed almost entirely of folded sedimentary strata. The Interior System is made of folded sedimentary and volcanic strata, massive metamorphic rocks, all intruded by large or small bodies of igneous rocks, with local areas of flat-lying volcanic rocks. In the Western System the largest unit, the Coast Mountains, is composed mainly of plutonic rocks whereas other parts contain a mixture of folded volcanic and sedimentary strata intruded by scattered bodies of massive igneous rocks. The three great systems are further divided into areas and subdivided into mountains, ranges, plateaux, hills, valleys, trenches, basins, plains, etc.

The Cordillera is also divided transversely into a number of segments by east–west belts of relatively low terrain. The broad northern part of the Interior Plateau, the most southerly and also the main feature, separates the two main segments of high and mountainous terrain in British Columbia. At the sixtieth parallel an area of low terrain including Liard Plateau, Liard Plain, and Yukon Plateau separates the Rocky and Cassiar Mountains from the Mackenzie, Selwyn, and Ogilvie Mountains to the north. The latter group, in turn, is separated from the Richardson Mountains by Porcupine and Peel Plateaux. The British Mountains in northern Yukon Territory are separated from the Richardson Mountains by the broad saddle that connects Porcupine Plateau and Yukon Coastal Plain.

### *Old Erosion Surfaces*

Probably the most notable feature of the physiography of the Cordillera is that remnants of an old erosion surface



PLATE II-3

Unglaciated part of Yukon Plateau and Yukon River near Dawson, Yukon Territory.

are nearly always evident. This surface may not be the same in all parts, and indeed many features suggest that there are surfaces of different ages. An old surface is most conspicuous in the plateau areas of the Interior System. It has been referred to as a peneplain but its relief is not sufficiently low over large areas to qualify as such. Generally the accordant summits give an impressively even skyline, but the surface is undulating with some higher rounded summits. Locally, particularly in northern Yukon Territory, upland ridges are flat topped, and their structures bevelled to a remarkable degree. On the west flank of Coast Mountains the surface is impressive where it rises from Hecate Strait, truncating the island hills, bridging the fiords, and bevelling the mountain summits. On the higher peaks of the inland ranges it has been destroyed by erosion.

The old surface is thought to have been formed largely in the beginning of the Tertiary or possibly in the late Cretaceous, and to have gone through a complicated subsequent history of uplift, warping, subsidence, and renewed uplift that is just beginning to be understood in a few parts of the Interior System (Lay, 1940 and 1941). In the early Tertiary the old surface of erosion was uplifted, the rivers entrenched, and sediments deposited in the valleys and hollows. Early Tertiary volcanic rocks, chiefly lavas, then filled the valleys. They were later down faulted, warped, and bevelled by erosion accompanying renewed uplift and dissection. Lava has been extruded here and there up to the present.

*Unglaciated Areas*

Large unglaciated areas cover most of northwestern Yukon (Map 1253A) and give an indication of the character of the plateaux of the Cordillera before Pleistocene glaciation. There the topography is sculptured by the normal processes of subaerial erosion at northern latitudes. The classic area is that around Klondike River in Yukon Plateau where relief is 2,000 to 3,000 feet, and the metamorphic rocks are much the same as in the adjoining glaciated areas. The unglaciated plateau area is composed of long ridges spreading from a central divide, separated by closely spaced small creeks that merge into larger streams,

the valleys gradually widening. The gradients are even and uninterrupted by rapids or lakes. The valleys are V-shaped with sides flaring upwards and diminishing in steepness until the broad, rounded ridges of the upland are reached. These may be broken in places by castle-like outcrops on or near their summits. The general drainage is dendritic among smaller streams, but a few larger streams are straight, following some linear structural feature. Persistent bedrock terraces along many of the larger valleys are mantled by variable thicknesses of gravel, sand, and soil, and follow more gentle gradients than the present streams. In places stream reversal and capture are apparent. Lakes are generally lacking; a few ponds occur due to ice pushing on the valley flats, to damming of the rivers by lava flows, and to landslides; oxbow lakes occur along the larger rivers.

*Glacial Features*

Glacial ice covered the Cordillera with the exception of the area referred to above and some minor areas. In many ranges only the highest peaks projected above the ice, which left its imprint on the topography as both erosional and depositional features. Conspicuous in the mountains are cirques, arêtes, and horns, and along the valley sides ice-margin channels have been cut in bedrock, kame terraces, and moraines. On the valley floors are a host of features mainly formed of surficial materials: pitted till, outwash plains and terraces, drumlin fields, simple and compound eskers, lake terraces, and all manner of fluvial-glacial features.

Great U-shaped valleys furrow the country, most impressive where filled with lakes or inlets of the sea. A belt of long lakes stretches along the western or dry side of the Interior System from Kluane Lake in Yukon Territory to Taseko Lakes in British Columbia. Another zone lies on the eastern side, on the relatively wet western slopes of the mountains from Mayo Lake in the north to Shuswap and Kootenay Lakes in the south. It is, however, in the fiords of Coast Mountains that these glacially scoured valleys are most spectacular. Cut in a terrain formed almost wholly of hard crystalline rocks the fiords follow a pattern mainly controlled by fracture and joint systems on a grand scale. Many are several tens of miles long and in cross-section are deeply U-shaped as much as 2 miles wide, with a relief of 6,000 feet in places. Their floors may sometimes lie at more than 600 metres below sea level, rising seaward to a sill of small rock islands.

*Trenches*

Four great linear valleys, each at least 300 miles long, trend northwesterly through the Cordilleran Region, some of which delineate major physiographic and geological provinces. These are the Southern and Northern Rocky Mountain Trenches of British Columbia and the Tintina and Shakwak Trenches in the Yukon, which are impressive features where narrow, straight and steep-walled. The floors vary in width from less than a mile to more than 15 miles and are drained by several rivers whose low divides lie in the trenches. The floors are remarkably uniform in elevation rising gradually from about 1,800 to 3,000 feet except for Tintina Trench, much of which is near 1,000 feet elevation. A number of similar, smaller, and shorter trench-like valleys occur in the Interior System, such as the sinuous, northerly trending Purcell Trench of southern British Columbia and Teslin Valley in Yukon Territory.

*Volcanic Features*

In the Interior and Western Systems constructional landforms have been produced by volcanic processes. The most abundant are the plains, plateaux, and mesas formed from extrusion of basic lava, the Plateau basalts. Most striking, however, are three great shield volcanoes in the northwestern part of Interior Plateau and a group of similar volcanoes, such as at Edziza Peak, in Stikine Plateau. Also in the Stikine Plateau are a number of tuyas — flat-topped volcanoes which erupted in the midst of the Pleistocene ice (Mathews, 1947). A large number of small volcanoes and cinder cones occur singly, in line, or in groups. These range in age from pre-Pleistocene to within a few hundred years of the present, and vary in height from a few tens to a few hundreds of feet.

## *Eastern System*

*Porcupine Mountain Area*

In the light of recent studies in physiography and geology in northern Yukon Territory a re-grouping of the physiographic units is made here. The Porcupine Plateau and its subdivisions formerly in the Northern Plateau and Mountain Area are termed the Porcupine Mountain Area and placed in the northern part of the Eastern System whose units they resemble. The ranges heretofore called the Northern Ogilvie Mountains are also similar and included in the Eastern System. The British Mountains and Old Crow Range are retained in the Interior System constituting the Brooks Range Area.

*Richardson Mountains* comprise a group of ranges having rugged peaks up to 5,500 feet elevation in its northern core. The narrow, lower southern ranges characteristically exhibit smooth, rounded profiles. These mountains do not appear to have been glaciated, but a tongue of Laurentide ice extended through them from the east via McDougall Pass.

*Porcupine Plateau* is almost entirely unglaciated. The northernmost part, Old Crow Plain, has an elevation of about 900 feet and is underlain by unconsolidated sills and peat. Closely spaced lakes and ponds have an oriented, rectangular pattern apparently produced by the prevailing winds (Plate II-4). Old Crow River and its tributaries meander elaborately and are entrenched in youthful valleys into the plain. In Eagle Plain, in the southern part of the plateau, long, even-topped ridges have broad, gently

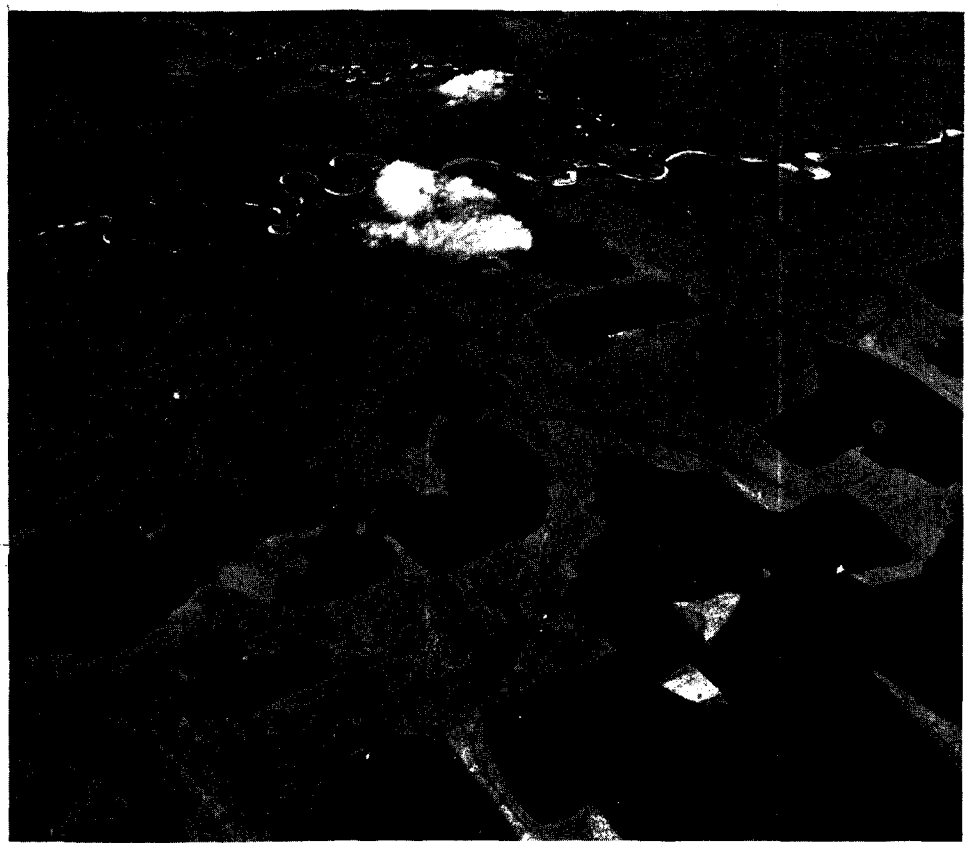


PLATE II-4

Old Crow Plain, northern Cordilleran Region, Yukon. View northward, Old Crow River and rectangular lakes.

rounded summits typical of unglaciated areas. Relief reaches a maximum of about 900 feet in the highest part at the south where some ridges are 2,500 feet in elevation. Around the perimeter of the plateau the surface rises, notably in the west where bordered by the *Porcupine Ranges*. These ranges are underlain by folded stratified rocks that form linear ridges, hills, and low mountains, separated by broad irregular valleys. In Keele and Nahoni Ranges the summits exhibit remnants of an old erosion surface.

### *Mackenzie Mountain Area*

*Taiga Ranges* and *Wernecke Mountains* comprise the westernmost part of Mackenzie Mountain Area. Taiga Ranges are separated from the Porcupine Plateau and Ranges by the broad, irregular valleys of Peel and Ogilvie Rivers. They were only slightly glaciated and their highest peaks and ridges reach 7,000 feet elevation. Wernecke Mountains are formed of phyllite and massive, nearly horizontal carbonate carved by glaciation into very rugged massive mountains. They are divided into several ranges by broad northwesterly trending valleys.

The interior part of *Mackenzie Mountains,* the Backbone Ranges, is a sea of peaks and ridges reaching to 8,500 feet. Some contain small alpine glaciers, and have been sculptured by alpine and valley glaciers. The more easterly ranges, the Canyon Ranges, are lower, divided by wide valleys or cut by deep canyons. During the Pleistocene ice from the east penetrated the valleys but otherwise the mountains show only local alpine and valley glaciation. Mackenzie Mountains, in the precipitation shadow of the Selwyn Mountains to the west, are relatively dry. The timberline is low, and the mountains present an aspect of bare, rock-covered slopes with a few cliffs.

*Mackenzie Plain* is a broad, rolling, drift- and tree-covered plain lying between Mackenzie and Franklin Mountains into which Mackenzie River is entrenched for part of its course. *Franklin Mountains* form a series of linear relatively low ranges and ridges, largely of resistant carbonates, that reach elevations of about 5,000 feet. They were over-ridden by ice moving from the east.

*Liard Plateau* south of Mackenzie and Franklin Mountains lies between South Nahanni and Liard Rivers. It is a region of tree- and tundra-covered hills, mostly less than 4,500 feet in elevation, and underlain mainly by shale and sandstone. Many summits are flat because of the attitude of the strata but extensive remnants of former erosion surfaces are evident. The valleys are narrow and deeply incised.

### *Rocky Mountain Area*

This area extends more than 850 miles from Liard River to the Forty-ninth Parallel, and includes the Rocky Mountain Foothills, which form the eastern front of the southern part of the Cordillera, and the Northern, and the Southern Rocky Mountains. Each is divisible into

numerous subparallel ranges. The *Foothills* generally rise abruptly above the Interior Plains and are mainly linear ridges and hills of Mesozoic sandstones with some mountainous parts. The *Northern Rocky Mountains* are broadest and highest around Mount Churchill (10,500 feet in elevation) in the Muskwa Ranges. There the terrain is as rugged as any other part of the Rockies, having been carved by glaciation from great sections of stratified rocks. A number of alpine glaciers occur around the higher peaks. The Rockies are narrow where crossed by Peace River. To the south the Hart Ranges of the *Southern Rocky Mountains* rise gradually and form a long saddle of relatively subdued mountains with summits 6,000 to 9,000 feet in elevation. The Continental Ranges are broader and elevations increase to that of the highest peak, Mount Robson, at 12,972 feet. A number of high peaks on the continental divide cluster around Columbia Icefield — the largest of many alpine glaciers in the Rockies. Southward, peaks up to more than 10,000 feet elevation occur at intervals or in groups along the mountain backbone to near Crowsnest Pass, where they are generally lower, rising again south of the Forty-ninth Parallel. Continental Ranges are characterized by linear ranges with great cliffs and precipitous faces of bare grey rock, sculptured by glaciation from thick sections of carbonate strata.

## *Interior System*

### *Brooks Range Area*

*British Mountains* rise close to the sea, abruptly from the narrow Yukon Coastal Plain on the north and become lower inland, towards Porcupine Plateau. They comprise a maze of V-shaped valleys fingering among branching ridges. Many streams have cut courses radially across the ridges, and the valley of the largest, the Firth River, completely traverses the mountains. Only small areas in the highest part near the Alaskan Boundary are rugged. There the summits reach about 6,000 feet elevation and seem to have remained unglaciated. Southwest of Old Crow Plain *Old Crow Range* is a subdued range of large rounded hills commonly crowned by castle-like outcrops of granitic rocks.

### *Northern Plateau and Mountain Area*

*Ogilvie Mountains* lie between Tintina Trench and Taiga Valley, south of Taiga Ranges. They are composed of sedimentary strata intruded by granitic stocks. Their highest peaks and ridges reach 7,000 feet elevation. During the Pleistocene these mountains contained alpine and valley glaciers which coalesced into continuous ice fields in their eastern part.

*Yukon Plateau* is a major physiographic unit containing many subdivisions. It is gently basin-like, its central parts lying at about 4,000 feet elevation. The surface rises towards the borders of the plateau and also lies at higher elevations in the local mountain ranges, such as the Pelly Mountains. The plateau is drained by the vast headwaters of the Yukon River system. Near its headwaters the river is entrenched about 2,200 feet below the plateau surface which lies at about 4,400 feet elevation. It declines at grades of 3 or 4 feet per mile, with few rapids, to less than 900 feet at the Alaskan Boundary. During the Pleistocene ice encroached from the mountains on all sides except the northwest but did not cover the Klondike Plateau.

On the northeast and east Yukon Plateau is bordered by *Selwyn Mountains,* which were extensively glaciated and comprise many rugged ranges separated by broad valleys. A few alpine glaciers occur on the highest summits between 7,000 and 9,000 feet elevation. Mount Keele, at 9,700 feet elevation, is the most outstanding peak.

*Hyland Plateau* is formed of rolling hills rising to 4,000 feet elevation and broad valleys, some aligned with structural features. The whole plateau was glaciated; the drift deposits form a widespread mantle and clog the main valleys. Along the southern boundary with Liard Plain are four isolated mountain groups reaching above 5,000 feet elevation. *Liard Plain* is a low-lying area into which Liard River is entrenched. The plain is less than 3,000 feet in elevation and much is at 2,000 feet. It is mantled with glacial and outwash deposits, including a great compound esker.

### *Central Plateau and Mountain Area*

*Stikine Plateau* forms the southern continuation of the Yukon Plateau. It notably has a number of late Tertiary and Pleistocene volcanoes, the most prominent of which are the great shield volcano of Level Mountain, a low, dome-shaped mass reaching 7,101 feet whose lavas cover more than 700 square miles, and Mount Edziza, a complex cone, 9,143 feet in elevation.

*Cassiar* and *Omineca Mountains* form a belt of massive crystalline rocks, whose highest peaks are about 8,000 feet in elevation and carry a number of alpine glaciers. *Skeena Mountains* to the south and west are somewhat lower in general elevation and are composed largely of folded stratified rocks of uniform resistance so that structure is an important factor in determining the positions of mountains and valleys. Southwest of Skeena Mountains the *Nass Basin* is an area of low relief with a gently rolling floor for the most part lying below 2,500 feet elevation. The basin is almost encircled by mountains, but large gaps connect it with Skeena River valley and the sea via Nass River valley.

*Hazelton Mountains* comprise a group of ranges traversed by Skeena River. They are largely underlain by folded sedimentary and volcanic rocks and isolated intrusions of igneous rocks in contrast to the almost wholly granitic terrain of Coast Mountains to the west and the sediments of Skeena Mountains to the east. The highest peaks range between 8,200 and 9,200 feet in elevation.

### *Southern Plateau and Mountain Area*

The main unit is the *Interior Plateau* which extends half the length of British Columbia north of the Forty-

ninth Parallel. Three large shield volcanoes stand near the middle of the western side, and flat-lying Tertiary to Recent lava flows form the bedrock over large parts. The plateau surface generally lies between 4,000 and 5,000 feet in elevation, rising from Fraser Basin in the northeast where the general level is below 3,000 feet to above 6,000 feet in Columbia Mountains. *Fraser Basin* has a flat, gently rolling surface mainly covered by glacial drift into which the Fraser River system and other main streams are commonly incised more than 1,000 feet. The glacial deposits include well-developed drumlinoid features, pitted terraces, simple and compound eskers, and large areas have glacial lake deposits.

*Columbia Mountains* contain many peaks more than 10,000 feet in elevation and are generally as high as the Southern Rocky Mountains east of the Trench. They constitute the main area of the interior wet belt of British Columbia. They were ruggedly sculptured during the Pleistocene glaciation, and their higher parts still contain many glaciers. *Columbia Highlands* to the west are lower and less rugged.

## *Western System*

### *Coast Mountain Area*

This area includes the Coast Mountains and the Cascade Mountains. The former are composed of crystalline gneisses and granitic rocks in contrast to the Rocky Mountains which are made up of stratified rocks. The two great mountain groups also differ in that the summits of the Rockies are relatively blocky whereas the peaks and ridges of the Coast Mountains are commonly serrate with tooth-like pinnacles. Only Peace and Liard Rivers traverse the Rocky Mountains, whereas nine or more large streams cross the Coast Mountains.

*Coast Mountains* include three major divisions, the Boundary, the Kitimat, and the Pacific Ranges. *Boundary Ranges* extend from southwestern Yukon along the boundary of the Alaskan panhandle. Their summits form a belt of rugged peaks generally 7,000 to 10,000 feet in elevation capped by several large ice fields. These ranges are cut into several segments by great transverse valleys containing Taku, Stikine, and Iskut Rivers. In places relief along the sides of the valleys reaches 9,000 feet. Large glaciers move down tributaries from nearby ice fields to 500 feet above sea level; in Alaska several reach the sea. The *Kitimat Ranges,* their peaks rarely above 8,000 feet elevation, form a saddle between the higher Boundary and Pacific Ranges. Glaciers are few and small. *Pacific Ranges* form the main southern part of Coast Mountains. Many peaks are between 9,500 and 11,000 feet elevation; the highest, Mount Waddington, is 13,177 feet elevation. Like the Boundary Ranges, the higher peaks are surrounded by ice fields; many large glaciers extend to low elevations but none reaches the sea. They are also cut into segments by great transverse valleys and fiords or inlets, the largest being those of the Klinaklini and Homathko Rivers.

*Cascade Mountains* are separated from the southeast part of Coast Mountains by Fraser River Canyon and continue into the United States. They are composed of the Skagit, Hozameen, and Okanagan Ranges. The highest peaks reach 8,000 to 8,500 feet elevation. In Skagit and Hozameen Ranges the high ridges are serrate, whereas lower ones are rounded by glaciation. In the Okanagan Range, although deeply cut by cirques, the summits still show the rolling contours of an old erosion surface rising from the Interior Plateau.

### *Outer Mountain Area and Coastal Lowlands*

The Outer Mountain Area includes the St. Elias Mountains and the Insular Mountains forming Queen Charlotte and Vancouver Islands. The Coastal Lowlands border the Outer and Coast Mountain Areas.

*St. Elias Mountains* are the highest mountains in Canada and with their great peaks ranging upwards to the 19,850 feet elevation of Mount Logan, they are one of the great mountain belts of the world. In the *Icefield Ranges,* the heart of the mountains near the Alaska boundary, the main peaks stand as somewhat isolated blocks separated by broad valleys filled by ice fields to 8,000 feet or more. As the limit of permanent snow is at about 7,000 feet, these mountains present great masses and expanses of ice and snow. Mount Logan is the highest point of a large block on which at least four others rise to more than 18,000 feet. This tableland in consideration of the elevation of the long saddles comprising Mount St. Elias at 18,008 feet, Mount Lucania at 17,150 feet, and Mount Steele at 16,439 feet, suggests the former presence of an even erosion surface. The ice fields are the source of many great valley glaciers that radiate to the sea along the Alaskan Coast and inland towards Shakwak Trench in Canada. The lesser peaks, many more than 10,000 feet, tend to form groups or ridges between the valley glaciers. Northeast of Icefield Ranges the lower *Kluane Ranges* with peaks up to 8,500 feet flank Shakwak Trench. These ranges are much less rugged than the Icefield Ranges and contain only small alpine glaciers.

*Hecate* and *Georgia Lowlands* bordering Coast Mountains are formed by an old erosion surface that emerges from the sea bevelling hills of crystalline gneissic and igneous rocks and rises gradually inland. The limit is arbitrarily drawn at about 2,000-foot contour. Even in its lower parts the lowland has been dissected by glaciers and bedrock is exposed. Inland much of the surface is covered by muskeg. *Georgia Lowland* includes an area of soft folded strata along the east and south sides of Vancouver Island where differential erosion has formed cuesta-like ridges below 2,000 feet elevation. It includes the islands of the Strait of Georgia and a fringe of the mainland. *Fraser Lowland* adjoining Fraser River is composed largely of unconsolidated material with some hard bedrock forming rolling hills up to 1,000 feet

elevation. Part is formed by the Fraser Delta.

*Queen Charlotte Ranges* are the backbone of Queen Charlotte Islands, and in the southeast their summits reach above 3,500 feet elevation. These ranges and Skidegate Plateau to the northeast were glaciated by a local ice sheet (Holland, 1964). *Queen Charlotte Lowland* is formed of gently dipping Tertiary strata covered by a veneer of glacial till and thick outwash deposits in its northeast part. Inland, it rises southwestward to between 500 and 1,000 feet above sea level.

*Vancouver Island Ranges* form the main body of the island and their higher peaks reach 7,000 feet elevation. They were sculptured by local alpine glaciers but some ice came from the mainland to the east carving deep U-shaped valleys. *Nahwitti Lowland* on the north end of Vancouver Island is a rolling lowland carved of slightly folded strata, generally lying below 1,000 feet elevation. On the west coast of Vancouver Island a narrow, broken lowland forms *Estevan Coastal Plain*. It is underlain mainly by gently dipping, soft Tertiary strata forming a low and flat plain, but parts are cut on relatively massive rocks forming low hills and reach about 250 feet above sea level.

## Pacific Continental Shelf

Off the British Columbia coast the Pacific Continental Shelf is narrow and its surface drops abruptly to ocean depths along a nearly straight line that closely parallels the headlands of the outer islands. West of Queen Charlotte Islands the rim of the shelf hugs the shore and at its closest point, 4 miles from land, descends below 1,000 metres. Off Vancouver Island the edge of the shelf is generally 20 miles or more to sea, reaching a maximum of nearly 50 miles at the entrance of Juan de Fuca Strait and a minimum of about 6 miles off Brooks Peninsula.

North of Queen Charlotte Islands, at Dixon Entrance, a broad channel, generally 200 to 400 metres deep, extends towards Portland Canal and branches among the Alaskan Islands. The width of Dixon Entrance is believed to have been occupied by Pleistocene ice moving from the Coast Mountains and the Alaskan Islands. The channel contains a transverse bank as shallow as 40 metres in the middle part, near the outer end.

At the entrance of Queen Charlotte Sound the edge of the shelf has four short but deep embayments at oceanic depths. From these, three broad channels more than 200 metres deep extend landward to near the islands off the mainland coast. The channels are separated by two broad banks. The northern and smaller one is a little less than 125 metres deep, whereas much of the larger one is less than 40 metres deep on its landward part. The north channel projects into Hecate Strait and lies mainly on the east or mainland side thereby leaving a broad shallow area shelving gently easterly and stretching across most of the strait. In the north the shallows nearly reach the islands of the mainland coast so that Hecate Strait is no more than 20 metres deep for about 4 miles. The southern channel extends towards the straits between Vancouver Island and the mainland. The straits are narrow, surround many islands, and contain numerous deep holes and channels more than 200 metres deep. This is characteristic also of many channels and fiords along the coast. These conditions extend through to the Strait of Georgia, a large part of which is occupied by an irregularly shaped basin, at 400 metres or more in several places.

## St. Lawrence Lowlands

The St. Lawrence Lowlands borders the Shield on the southeast extending from the west end of Lake Huron and the head of Lake Erie northeasterly to the Strait of Belle Isle. It comprises three units; the West St. Lawrence Lowland, the Central St. Lawrence Lowland, and the East St. Lawrence Lowland. The province is floored by unfolded Paleozoic strata and the west and central lowlands are plain-like areas. The East St. Lawrence Lowland, though formed of widely separate parts, maintains the same general plain-like form and structure. The whole province was affected by Pleistocene glaciation and its surficial deposits and features are common phenomena.

*West St. Lawrence Lowland* is broken into two parts by the Niagara Escarpment which extends from Niagara River in a sinuous westerly and northwesterly course to Bruce Peninsula and the Manitoulin Islands. The escarpment is a northeasterly facing cuesta and is the result of the resistance to erosion of Silurian carbonates that dip gently southwest. The escarpment attains an elevation of about 650 feet in the south and a relief of 250 to 300 feet. Along the south shore of Georgian Bay it attains an elevation of 1,700 feet, about 1,000 feet above the bay. The surface west of the escarpment slopes gradually southwestward through an area of rolling topography of low relief to the level of Lake Erie, 572 feet above sea level. East of the escarpment the land rises gently northward from Lake Ontario at 246 feet elevation, to a maximum height of 1,000 feet south of Georgian Bay. At several places east of Lake Simcoe the boundary with the Shield is marked by a low escarpment. The Precambrian rocks of the Frontenac Axis separate West and Central St. Lawrence Lowlands.

*Central St. Lawrence Lowland* includes the area between the Ottawa and St. Lawrence Rivers, straddles the St. Lawrence as far as Quebec City, and extends a short distance beyond on the north shore only. East of the St. Lawrence River the lowland is bounded by 'Logan's Line,' a fault zone that marks the northwestern border of the hilly Appalachian Region. North of Ottawa and St. Lawrence Rivers the flat-lying Paleozoic strata underlying the lowland are either faulted against or lie upon the crystalline rocks of the Shield. The land is rarely more than 500 feet above sea level, except for the seven Monteregian Hills formed of intrusive igneous rocks.

*East St. Lawrence Lowland* includes Anticosti Island, the Mingan Islands, and several small areas bordering the Gulf of St. Lawrence and Strait of Belle Isle, and the Newfoundland Coastal Lowland. Anticosti Island is about 125 miles long with a maximum width of about 35 miles. It is a south-dipping cuesta of carbonate strata. Wave-cut terraces up to 400 feet elevation occur on both north and south sides, being generally wider on the south side. The Mingan Islands and two areas on the north coast of the Strait of Belle Isle are composed of southerly dipping Paleozoic strata. In all probability a great part of the floor of the Gulf of St. Lawrence around Anticosti Island and extending to the Newfoundland Coastal Lowland constitutes a submerged part of the East St. Lawrence Lowland. *Newfoundland Coastal Lowland* is formed of a belt of soft, mainly unfolded Paleozoic strata that extends along the northwest coast of Newfoundland Island and includes Port au Port Peninsula in the southwest. Most of the belt is less than 400 feet in elevation although the summit on Port au Port Peninsula is at 1,160 feet elevation and east of St. John Bay is 2,075 feet.

## Appalachian Region

The Appalachian Region in Canada is divided into a large number of physiographic units, which here are grouped together and somewhat generalized. The physiography is dominated by a well-developed peneplain, probably of Cretaceous age, which is generally highest in the northwest and slopes gently southeastward to the ocean. The various subdivisions are formed by the differential erosion of soft and hard rocks to form lowlands, highlands, and uplands. Seaward the Appalachian Region is bounded by the Atlantic Continental Shelf.

On the island of Newfoundland the Appalachian Region comprises three highland, two upland, and four lowland areas. The highlands are collectively called the *Newfoundland Highlands.* As a rule they are rugged with steep slopes, and are formed of crystalline Paleozoic and Precambrian rocks. Their elevations vary from 600 to 2,670 feet. The upper surface, formed by the peneplain, slopes gently southeastward. The western border of the highlands may be precipitous or pass without sharp break to the higher areas of Newfoundland Coastal Lowland. Two small lowland areas occur within the highlands area, the St. Georges Lowland lying along the southwest coast and the Grand Lake Lowland extending from White Bay to Grand Lake. Both lowlands are underlain by little metamorphosed rocks and seldom exceed 200 feet in elevation.

The *Atlantic Uplands of Newfoundland* lie between 600 and 1,000 feet elevation and represent parts of the peneplain occurring at lower levels because of the southeasterly slope rather than because the rocks are less resistant than those underlying the adjacent highlands. Where stream erosion has cut deeply, the uplands are rugged and rocky but elsewhere they present a rolling terrain of low relief. The uplands surround the small Bay d'Espoir Lowland which is underlain by soft Paleozoic sediments.

The *Newfoundland Central Lowland* is underlain mainly by Paleozoic strata but includes a few intrusive bodies that form prominent hills. It extends from sea level up to 500 feet elevation; inland it is surrounded by the uplands carved from igneous rocks. The surface is gently rolling and generally immediately underlain by glacial drift.

Nova Scotia is divisible into three highland areas, three uplands, and several small lowlands. As in Newfoundland the same peneplain is present on the highlands and is also apparent on the uplands. *Nova Scotia Highlands* include Cobequid Mountains in the west, the Antigonish Highlands in the centre, and the Cape Breton Highlands to the northeast. Cobequid Mountains have a flat to rolling surface, are about 10 miles wide, and reach elevations of about 900 feet. Antigonish Highlands are more dissected than Cobequid Mountains, but have the same type of surface and reach about the same elevations. The Cape Breton Highlands are deeply dissected around the margins, but the interior has a remarkably flat surface lying at elevations of 1,300 to 1,500 feet.

The uplands of Nova Scotia include North Mountain and the Atlantic Uplands of Nova Scotia. *North Mountain* is a narrow, flat-topped ridge, averaging about 550 feet high, formed of hard Triassic basalt. It extends along the southeast side of the Bay of Fundy for 120 miles and rises abruptly above the Annapolis Lowland. The *Atlantic Uplands of Nova Scotia* lie along the entire southeast coast for some 350 miles and contain small irregular lowland areas on Cape Breton Island. The old peneplain surface is a main feature and slopes across it from elevations of about 600 feet on the northwest side to the shore of the Atlantic on the southeast.

The principal lowlands of Nova Scotia are: the Cumberland Lowland, part of the larger Maritime Plain, but lying on the north and east sides of Cobequid Mountains; the Minas Lowland surrounding Minas Basin and Cobequid Bay; and the Annapolis Valley. These lowlands are areas of soft, late Paleozoic and Triassic sediments.

New Brunswick falls naturally into three large units, highland, upland, and lowland areas. *New Brunswick Highlands* are U-shaped, with the west arm covering much of the central part of the province, the curved part occupying the southern part, and the east arm bordering the Bay of Fundy. In as much as the surfaces of the accordant summits of the highlands represent the southeast-sloping peneplain, the northwest parts reach elevations greater than 2,000 feet and are higher than those bordering the Bay of Fundy, which are only about 1,000 feet. Along the Bay of Fundy the highlands present considerable diversity. They are composed of ridges of hard rock with minor lowlands of weak strata.

*Chaleur Uplands* lie astride the provincial boundary of Quebec and New Brunswick. They are 800 to 1,000 feet

high, developed on folded Paleozoic strata. The uplands present remarkably uniform, concordant summits whose regularity is broken only by a few hills and ridges rising slightly above the general level. Valleys such as those of Saint John and Restigouche Rivers are deeply entrenched into it. The boundary between the New Brunswick Highlands and Chaleur Uplands is not well defined but the latter are considerably lower than Notre Dame Mountains of Quebec to the north.

*Maritime Plain* stretches around the coast of New Brunswick and Nova Scotia from the south shore of Chaleur Bay nearly to Cape George. It extends inland as far as New Brunswick Highlands and includes Prince Edward Island and the Magdalen Islands. The plain is an area of low relief. Inland it reaches 600 feet elevation and slopes gently towards the coast. The underlying rocks are mainly flat or gently dipping strata through which, particularly in the Magdalen Islands, small intrusions stand as prominent hills. It probably extends beneath the Gulf of St. Lawrence to join with St. Georges Lowland of Newfoundland.

The Chaleur Uplands are bounded on the north by *Notre Dame Mountains,* which extend from near Thetford Mines to Gaspé Bay, a distance of some 400 miles. The eastern part is also known as the Shickshock Mountains, the highest elevations being in excess of 4,000 feet in the north. To the southwest the summits are lower and merge with Eastern Quebec Uplands. Mountain tops present the flat to undulating surface of the old peneplain. In the southwestern part of Appalachian Quebec are two other highland areas separated by part of the Eastern Quebec Uplands. The western of these, the *Sutton Mountains,* is a continuation of the Green Mountains of Vermont; they are 40 miles in extent and have a maximum of 3,175 feet. *Megantic Hills* lie astride the International Boundary and are part of the larger White Mountains of the New England States. Sutton Mountains and Megantic Hills are both developed on anticlinoria and are highest in the south. To the northeast they blend with *Eastern Quebec Uplands* which has a maximum elevation of 1,000 feet decreasing gradually to the northwest and merging with the East St. Lawrence Lowland without a distinct topographic break.

## Atlantic Continental Shelf

Adjoining the Grenville and Appalachian Regions and forming the continental margin of North America, are the Gulf of St. Lawrence and the Atlantic Continental Shelf. The floor of the *Gulf of St. Lawrence* is relatively flat and featureless with gentle rises, one of which breaks surface as Magdalen Islands, and linear lows which represent old, glacially deepened river valleys. The main feature, the Laurentian Channel, is 60 miles wide, steep-sided, and flat floored. It shelves from depths of 200 metres near Quebec to 400 metres as it extends across the continental shelf to the ocean basin. A major tributary joins it from the Strait of Belle Isle.

The *Atlantic Continental Shelf* is generally shallow, less than 200 metres and slopes gently at a gradient of less than 1:1000, to where the gradient increases sharply to more than 1:40. The shelf is divided by Laurentian Channel; to the south is the Scotian Shelf and Georges Bank, the part to the north is the Grand Banks.

*Scotian Shelf* has an average width of about 125 miles. Along its length and lying some 10 to 80 miles offshore is a series of 200-metre depressions such as La Have Basin and Emerald Basin. A nearly continuous ridge or 'bank' 40 to 120 metres deep extends along the seaward edge of the shelf, divided by low saddles into Browns Bank, La Have Bank, Emerald Bank, Sable Island Bank, and Banquereau Bank, and culminating at Sable Island, a low, sandy island 25 miles long. The banks are composed of flat-lying beds and are like mesas produced by erosion. Many submarine canyons occur in the continental slope and the continental rise, the largest of which is The Gully heading in the shelf about 25 miles east of Sable Island. The *Grand Banks,* north of Laurentian Channel, are up to 300 miles wide and 450 miles long. Northeast of Newfoundland relief is 100 to 200 metres, exceptionally large for a continental shelf. The shelf break lies at 300 metres, which is abnormally deep. The southern part of Grand Bank includes low depressions and several smaller banks, Saint Pierre Bank, Green Bank, and Whale Bank. Virgin Rocks is a shoal 130 miles southeast of Avalon Peninsula rising to within 18 feet of the ocean surface. It is part of a dissected bank which rises 200 to 300 feet above the shelf floor.

*Flemish Cap,* 400 miles east of Newfoundland, is considered part of Atlantic Continental Shelf but is separated from Grand Banks by a channel 650 fathoms deep. A broad ridge, 60 to 100 miles wide, extends southeasterly from the Grand Banks down the continental slope towards the Mid-Atlantic Ridge. This feature, the Southeast Newfoundland Ridge, is part of the continental rise and marks the boundary between the Newfoundland Basin to the north and the North American Basin to the south.

The southern part of *Labrador Shelf* extends about 400 miles from the coast and includes an area, relatively shallow and undulating, the deeper parts of which lie near 250 metres and large shallower areas lying at less than 80 metres. Between Hamilton Inlet and Hudson Strait the shelf is about 75 miles wide dropping from a rim at 250 metres to the depths of Labrador Sea. This part has a line of broad banks near 80 metres depth which are separated from the coast by wide hollows at 200 metres or more depth.

*Davis Shelf* lies beneath Davis Strait and Baffin Bay between Canada and Greenland. Off Baffin Island, below Cumberland Peninsula and Cape Chidley, it is generally shallow being little more than 900 metres deep in many parts. The shelf is, however, deeper and wider than farther north and its surface slopes to a depth of about 600 metres before the steep edge is reached some 100 miles or more off Hall Peninsula. Opposite Hudson Strait

the sea floor also drops to oceanic depths of about 3,000 metres and an embayment with depths of 600 metres or more leads across the shelf. At the head of Baffin Bay east of Devon Island, it is also comparatively shallow, few parts reaching 600 metres. The soundings although scattered suggest a rolling surface sloping mainly southeasterly from 300 to 500 metres. Off Lancaster Sound a broad channel 800 metres or more deep extends towards the northern part of the basin in the central part of Baffin Bay where depths of 2,000 metres or more are reached. Along the northeastern coast of Baffin Island the slope into the basin steepens and a narrow shelf up to 30 miles wide with a somewhat sinuous rim at 200 metres deeper drops abruptly into the basin. Three channels extend across the shelf off Pond Inlet, Buchan Gulf, and Home Bay.

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