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PAPER 71-45

GEOLOGY OF MALPEQUE-SUMMERSIDE AREA, PRINCE EDWARD ISLAND

(Report, 2 maps and 5 figures)

V.K. Prest

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V. K. Prest

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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CONTENTS

Illustrations

ABSTRACT

This report deals with the surficial deposits and bedrock of a large area in western Prince Edward Island that includes Malpeque Bay and the city of Summerside. The reddish bedrock is dominantly sandstone with lessor amounts of conglomerate, mudstone, and mudstone breccia layers and lenses. All are terrestrial in origin and Late Pennsylvanian and Permian in age. Fossils are rare, but plant stems and imprints of fern-like leaves occur in some siltstone and sandstone beds, and scattered amphibian bone fragments in some breccia lenses. A small outcrop of basaltic rock, on an island in Malpeque Bay, is the only igneous rock exposed at the surface in Prince Edward Island.

During the last major glaciation the Island was scoured by ice from New Brunswick; this ice was responsible for the widespread mantle of basal till that contains plentiful igneous rocks only in the western end of the Island. During deglaciation, the ice sheet stagnated in eastern Prince Edward Island, but it remained active in the western end and hence ablation till and glaciofluvial deposits are of limited distribution in this region.

In western Prince Edward Island, the last active ice flowed south and southwest in Malpeque Bay, that is, landward from the Gulf of St. Lawrence. A component part of this ice may have come around the Gaspé Peninsula from northern Quebec although, at this phase of deglaciation, relative rise in sea level may have severed it from this source.

Glaciomarine and postglacial marine sand and gravel form significant deposits northwest of Malpeque Bay. Due to postglacial isostatic adjustments, these shoreline deposits are tilted upwards to the west. The marine limit attains a maximum altitude of about 60 feet in northwestern Malpeque map-area and slopes down to sea level in eastern Malpeque and Summerside map-areas. The sea is now encroaching on the land and salt marsh is forming in drowned estuaries and lowlands.

Valuable deposits of sand and gravel occur in western Malpeque map-area. These include both weathered conglomerate and late-glacial to early postglacial marine deposits. The only sizable peat bog in the map-areas is that northwest of Malpeque Bay. It covers an area of 2 miles x 1 1/2 miles and has a maximum thickness of about 21 feet. This bog is a potential source of peat moss, black earth and black muck.

RÉSUMÉ

Le présent rapport traite des dépôts meubles et de la roche en place d'une vaste région de l'ouest de l'île du Prince-Édouard qui comprend la baie Malpèque et la ville de Summerside. La roche en place, d'une couleur rougeâtre, est constituée essentiellement de grès avec, en plus petite quantité, des conglomérats, des pélites et des brèches pélitiques en couches ou en lentilles. Toutes ces roches sont d'origine terrestre et datent de la fin du Pennsylvanien et du Permien. Les fossiles y sont rares, mais des tiges de plantes et des empreintes de feuilles en forme de fougère se trouvent dans certaines couches de siltstone et de grès, et des fragments éparpillés d'os d'animaux amphibies se rencontrent dans certaines lentilles de brèche. Un petit affleurement de roche basaltique, dans un île de la baie Malpèque, constitue l'unique roche ignée qui affleure dans l'île du Prince-Édouard.

Au cours de la dernière glaciation majeure, l'île a été décapée par les glaces venant du Nouveau-Brunswick; ces glaces ont été la cause de la formation du manteau étendu de till, qui contient une grande quantité de roches ignées, uniquement dans l'extrémité ouest de l'île. Au cours de la déglaciation, la couche de glace a stagné dans l'est de l'île du Prince-Édouard, mais elle est demeurée active dans l'extrémité ouest de l'île, c'est pourquoi les dépôts fluvioglaciaires et de till sont très limités dans cette région.

Contrairement à l'opinion initiale de l'auteur sur le retrait des glaces du Nouveau-Brunswick dans l'ouest de l'île du Prince-Édouard, les dernières glaces actives se sont écoulées vers le sud et le sud-ouest de la baie Malpèque, c'est-à-dire vers la terre à partir du golfe Saint-Laurent. Une partie de ces glaces peut avoir contourné la péninsule de Gaspé venant du nord du Québec, bien qu'à cette phase de la déglaciation l'élévation relative du niveau de la mer pourrait l'avoir coupée de sa source.

Le sable et le gravier glaciomarins et marins postérieurs à la glaciation forment des dépôts importants au nord-ouest de la baie Malpèque. A la suite des ajustements isostatiques postérieurs à la glaciation, ces dépôts littoraux on été basculés vers le haut en direction ouest. La limite de l'avancée de la mer atteint une altitude maximum d'environ 60 pieds dans le coin nord-ouest de la carte représentant la baie Malpèque, et descend progressivement jusqu'au niveau actuel de la mer dans les coins est des cartes de Malpèque et de Summerside. La mer envahit maintenant la terre et des marais salants se forment dans les estuaires et les basses-terres ennoyés.

Des dépôts importants de sable et de gravier se trouvent dans l'ouest de la région représentée sur la carte de Malpèque. Ces dépôts comprennent à la fois des conglomérats altérés et des dépôts marins datant de la fin de la glaciation au début de la période postglaciaire. La seule tourbière de dimension notable dans ces régions est située au nord-ouest de la baie Malpèque. Elle couvre une superficie de 2 milles sur 1 1/2 milles et a une épaisseur maximum d'environ 21 pieds. La tourbière constitue un source potentielle de tourbe, de terre noire et de terre noire humifère.

GEOLOGY OF MALPEQUE-SUMMERSIDE AREA,
PRINCE EDWARD ISLAND

INTRODUCTION

The Malpeque and Summerside map-areas, together with parts of Egmont and Tormentine map-areas, are herein referred to as the Malpeque-Summerside region; this comprises a land area of 452 square miles. The region is bounded by O'Leary, Rustico and Charlottetown map-areas on which geological reports have already been published (Owen, 1949; Prest, 1964; Frankel and Crowl, 1970; Crowl and Frankel, 1970). Geological reports on northwestern and eastern parts of Prince Edward Island are also available (Prest, 1962; Frankel, 1966; Crowl, 1969). These reports contain references to earlier geological works on the Island, some of which include notes on the Malpeque-Summerside region.

Except for the easternmost parts of the Malpeque and Summerside map-areas, where the higher hills reach altitudes of 300 to 375 feet, the area is gently rolling to flat lying with altitudes in the order of 150 feet and local relief seldom more than a few tens of feet. Much of the western parts of the map-areas lie below an elevation of 50 feet and are swampy or brush covered.

Figure 1. Sea stack and coastal cliff near Seaview, north coast Malpeque map-area, 1954. By 1968 the stack was reduced to less than half this size and a new stack was forming at the point. Inlet to Cousins Pond is behind this point. (GSC photo - 201764)

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Bedrock is exposed along parts of the coast and on some tidal flats. There are limited natural exposures in the higher eastern parts of the map-areas, but elsewhere they are rare. The road-building programs of the past two decades, and the consequent opening of many borrow pits, have resulted in innumerable, though commonly short-lived, exposures that have served to enhance our knowledge of rock types in the drift-covered interior. In particular, construction work of all types has provided many exposures of the generally calcareous mudstone breccia lenses which, in turn, have provided many bone fragments indicative of a limited amphibian fauna in this region in Early Permian time, that is, about 250 to 275 million years ago.

The bedrock is almost everywhere mantled by basal till ranging from about a foot to about 30 feet in thickness, but generally in the order of three to eight feet. Locally, glaciofluvial, glaciomarine or marine deposits rest directly on the bedrock but generally basal till intervenes. Though the last major ice sheet scoured the island rocks it did not erode deeply and only modified the topography slightly. All significant hills and valleys clearly pre-date the last glaciation and the stream patterns reflect the bedrock structures.

ACKNOWLEDGMENTS

Officials of the Department of Industry and Resources in Charlottetown were always cooperative and thereby facilitated the field work. The late B. Graham Rogers in particular provided the 1954 field party with office space, logistical help, and much useful information. The farm residents were always cordial in granting access to their lands for which the author is very grateful.

BEDROCK GEOLOGY

The most comprehensive analysis of the lithology, sequence, age, and structure of the bedrock of Prince Edward Island is that by Frankel (1966) based mainly on studies in the southeastern part of the Island. He related the oldest strata, exposed on Governor Island in Hillsborough Bay, to the Upper Pennsylvanian period (ca. 290 million years ago). Elsewhere in southeastern Prince Edward Island the strata are Permian (275-225 million years) and perhaps younger. On the basis of lithology and limited fossil content, Frankel divided these rocks into informal rock-stratigraphic units designated A (oldest), B, and C (youngest). He further subdivided unit A into A_1 (oldest), A_2 and A_3. Unit A, and particularly the A_2 beds, have yielded sparse vertebrate fossils which clearly relate the enclosing bedrock to the Lower Permian (Langston, 1963).

More recently, Frankel has suggested the widespread distribution of sub-unit A_2, with its abundant breccia lenses, over much of the Summerside and Malpeque map-areas (Frankel and Crowl, 1970). Calcareous mudstone breccia is, indeed, widespread in these areas but some of the breccia may belong to sub-unit A_1, which also contains breccia lenses; the present writer, however, has not found it possible to indicate the boundaries of these sub-units. Also, unit A_3, as well as some Upper Pennsylvanian rocks, may be exposed in the Malpeque–Summerside region. For instance, Stephanian spores have been reported at a depth of only 20 feet in an exploration drill-hole near MacDougall in the southwest corner of Malpeque map-area

(Barss et al., 1963). Delineation of the Pennsylvanian-Permian contact and of the boundaries between sub-units A_1, A_2 and A_3 in the present map-areas, and farther west, must therefore await more detailed field work and an island-wide appraisal of all the data on hand. The writer believes that unit B strata may also be present in Malpeque map-area but concurs that unit C strata, or at least its conglomeratic member, is not present, being confined to the east by graben and fold structures in Rustico map-area.

The conglomerates in Summerside–Malpeque area are composed of pebble to gravel-sized stones that display a great variety of shapes including numerous well-rounded ovoid, discoid and spindle forms, but they are mainly somewhat irregular in outline. These conglomerates may therefore be termed sharpstone conglomerates, similar to those of stratigraphic unit B in eastern Prince Edward Island, as compared to the roundstone conglomerates of unit C (Frankel, 1966). In Summerside–Malpeque region the conglomerate pebbles, mainly less than three inches long, are composed of acidic to intermediate, streaky-banded to massive, porphyritic flowstones, with quartzite, quartz and a scattering of other rock-types.

Conglomerate crops out north of Crapaud in the southeast corner of Summerside map-area and, more extensively, in the Arlington–Conway area west and northwest of Malpeque Bay, with a less important occurrence on Seacow Head (west of Borden) and minor conglomerate on Mill Point in southeastern Malpeque Bay. The sharpstone conglomerate north of Crapaud may or may not be the stratigraphic equivalent of the Arlington–Conway

Figure 2. Calcareous mudstone breccia (channel filling) in thin-platy sandstone; south shore Malpeque Bay, 1954. By 1968 only a few small blocks of this breccia remained on the tidal flats. View to the north-northeast from road end north of Sherbrooke corner, Summerside map-area. (GSC photo 201765).

conglomerate. North of Crapaud the pebbles comprise about 50 per cent flowstones, 25 per cent quartzite, 22 per cent quartz and 3 per cent "others". The Arlington-Conway "gravels" are comprised of about 58 per cent flowstones, 29 per cent quartzite, only 8 per cent quartz and about 5 per cent "others". Pebble-types in the conglomerate north of Crapaud, however, differ somewhat from those in the conglomerate nearby to the east at Westmorland (Frankel and Crowl, 1970), yet these conglomerate occurrences would appear to be one and the same stratigraphically.

The Arlington-Conway conglomerate and its extension westward into O'Leary map-area is a very useful horizon marker in the predominantly sandstone sequence of rocks. Its trend outlines and substantiates the Egmont Bay anticlinal structure. Mudstone is present in the Malpeque-Summerside region at more than one stratigraphic position, but these are similar in appearance and do not, by themselves, serve as horizon markers except very locally. Mudstone is most prevalent along or near the east side of Egmont Bay; this mudstone horizon is believed to lie beneath Northumberland Strait to the south of Summerside map-area.

Casual observations on both planar and trough crossbedding in the sandstones of the Malpeque-Summerside region indicate that the sediments were deposited by streams flowing toward the east and northeast; their source area was therefore from the Appalachian highland areas in what is now New Brunswick.

The only surface exposure of igneous rock presently known on Prince Edward Island is that outcropping in places along the easternmost 300 to perhaps 600 feet of George Island in the northern part of Malpeque Bay. (Recently an occurrence of basaltic rock in 20 feet of water was located off the southwestern end of George Island by M.L.V. Thomas of the Ellerslie Biological Station.) The George Island surface exposure was first described by Gesner (1846, p. 22) as a large mass of volcanic or trap rock (compact trap, amygdaloid and breccia) that he thought occupied an area of 100 acres. He noted that it partly vitrified the host rock which therefore resembled hard, burnt brick. Ells (1885, p. 18E) refers to the occurrence as a small trap dyke that penetrated and slightly altered the sandstone. Picher (1948) reported the trap to be well exposed along the shore but concealed by soil inshore. He considered the trap to be a dyke about 10 feet thick, striking north (magnetic) and dipping 15 degrees east. He reported that the rock was fractured into angular blocks three to twelve inches across. Laboratory tests indicated that the rock would make high-grade aggregate, but Picher estimated there was less than 30,000 cubic yards of this material above water level.

Milligan (1949) gave more details on the geology, describing the occurrence as a dyke of fine-grained olivine dolerite about 10 feet thick, striking north-northwest, dipping 15 degrees toward the northeast, and occupying an area of 9,900 square yards. He noted that it was intruded into red sandstone which was altered from 20 to 30 feet from the contact (presumably the footwall). He reported the dyke to be heavily fractured by two joint systems and to be cut off on the north by a northeast-striking shear or fault zone about five feet wide.

The writer believes the occurrence is a sill rather than a dyke, and that it strikes about N. 160°E. or N. 170°E. and dips 10 degrees east. The hanging-wall sandstone was seen on a small exposure at the southeast tip of the outcrop area and appeared to be 'baked'. It was not in tight or direct chilled contact with the underlying trap rock due to a joint plane, but

Figure 3: Basaltic rock and breccia, George Island, Malpeque Bay. Dark-green and dull-red volcanic rocks (on the left) and intrusive breccia (on the right); the latter contains fragments of the volcanic rocks together with blocks of altered sandstone. View to the northeast with Hog Island in the background from small point on north side of the igneous rock exposure. (GSC photo - 201766)

the subjacent rock was very dense and finer grained than seen elsewhere. The hard trap rock is much broken by joints and appears about ten feet thick. Examination of thin sections of the rock under a microscope indicate that the rock is an olivine basalt. The olivine occurs as small phenocrysts variably altered to chlorite (serpentine). The groundmass is comprised of lath-shaped crystals of basic plagioclase (bytownite) with olivine, chlorite, a bright brown biotite, and much magnetite. The amygdules in the dark green basalt are mostly white but some are pale greenish due to chlorite (G. S. C. X-ray film 23874). The white amygdules are of the clay mineral saponite and the zeolite mineral analcite, or mixtures of these minerals (G. S. C. X-ray films 40460, 40465). Some include minor amounts of calcite. The olivine phenocrysts in the amygdaloidal basalt are less altered to chlorite (serpentine), but are much altered to "iddingsite" and magnetite. The groundmass of the amygdaloid is also different in that it does not show the pronounced mat of lath-shaped plagioclase but rather shows irregular to equidimensional plagioclase that is much altered to a cloudy white material (kaolin?), and also contains more abundant magnetite.

Two samples of the basaltic rock were analyzed by the Analytical Chemistry Section, Geological Survey of Canada, with the following results:

	GSC-344/70 (%)	GSC-345/70 (%)
SiO_2	41.7	41.4
Al_2O_3	9.8	9.6
Fe_2O_3	4.7	4.7
FeO	7.5	7.6
MgO	12.1	12.3
CaO	11.3	11.3
Na_2O	3.3	3.3
K_2O	0.9	0.8
H_2O/T	3.3	3.1
CO_2	<0.1	0.1
T_1O_2	3.05	3.04
P_2O_5	0.76	0.82
MnO	0.18	0.18
Total	98.6	98.2

Beneath the dark-green to dull-red, fractured basalt, along the south side of the outcrop promontory, there is a layer some 20 to 30 feet thick that appears to be an intimate mixture of diverse brecciated rocks, massive amygdaloidal and vesicular basalt, and much included red sandstone and siltstone. The whole weathers readily to a variably soft, earthy mass that may be mistaken for slumped glacial drift. What is considered to be a washed or clean exposure of similar material, in part at least, forms the northern point of the outcrop area (Fig. 3). The writer regards this occurrence of mixed rock types as footwall basalt and breccia rather than a cross-cutting fault or shear zone. The breccia includes irregular bodies of 'baked' sandstone much of which has irregular to rounded cavities believed to result from gases that escaped from the igneous rock as it cooled. As well as the cavities in the sandstone, there are tiny channels or stringers of somewhat altered sandstone that appear to be the result of escaping gases or hot solutions. On close examination, much of the red breccia is seen to consist of greyish rock fragments up to 1/4 inch across in a fine-grained, variably reddish matrix. Thin section examination reveals the greyish fragments to be mainly highly altered volcanic rocks, some of which contain olivine microphenocrysts. The purple-red breccia contains more fragments of 'red bed' sediments than the brick-red breccia and the matrix is more highly hematitic. The breccia matrix is a mixture of sharply angular quartz and fresh feldspar grains with comminuted rock fragments in a highly hematitic cement. The hematite has replaced a very fine grained granular matrix. The irregular and sharply angular shapes of both rock and mineral grains are also, in part at least, due to replacement by iron-bearing solutions. There is no orderly arrangement of the individual quartz and feldspar grains but rather they are jumbled with the rock fragments. This, together with the 'gas' cavities in large sandstone inclusions in the breccia zone, suggests that the sedimentary rocks were unconsolidated or very weakly consolidated at the time of the intrusion by the basaltic magma. Paleomagnetic determinations made on the igneous rocks suggest that they were intruded into the 'red beds' in late Upper Permian time and possibly prior to a period of minor folding (Larochelle, 1967).

Folding

In a regional sense, although both are folded and faulted, the strata strike in a northwest direction from the southeast corner of Summerside map-area to the northwestern corner of Malpeque map-area. The strata dip very gently toward the northeast but this is not generally evident because of the complexity of primary depositional features which vary greatly from place to place and over very short distances. The strata are, however, also gently folded into broad, open anticlines and synclines which trend northeastward; these folds, of course, also plunge gently in this direction. The configuration of the coastline in western Prince Edward Island reflects these major, gentle fold structures. A major anticlinal axis, trending about N. 60°E. through Egmont Bay, is believed to pass through the hamlet of Poplar Grove in northwestern Malpeque area. The adjacent syncline, on the southeast, extends through Cape Egmont but its northeastward trend is rendered obscure by the presence of a near-parallel major fault extending along the Ellis River, which is believed to displace the fold axis southeast of Wellington. The extension of the fold axis is believed to pass through Darnley Basin in eastern Malpeque map-area, but its trend across Malpeque Bay and west to the fault is unknown. Still farther southeast the fold structures become more open or gentle; there is probably a smaller anticlinal fold extending up Bedeque Bay and passing through Summerside and Irishtown to the vicinity of Campbell Pond on the north coast. The axis of the adjacent, minor synclinal fold on the southeast may pass through Seacow Head on the south coast and Southwest River and New London Bay on the north coast. Perhaps the coastal configuration of Sevenmile Bay and the opposing Orby Head coast, in Rustico map-area, reflects another gentle anticlinal fold for which there is limited field support. Farther southeast, at least along the south coast, the major structure is so 'open' or gently undulating that it is essentially homoclinal with a very gentle dip to the north. The apparent homoclinal attitude of the strata along the south coast may be the southwestern end of the gentle but major syncline postulated by Frankel (Frankel and Crowl, 1970) the axis of which, if projected, would intersect the south coast near Birch Point in Tormentine map-area. Within this broad, open synclinal basin, or on this major homoclinal structure, there may be minor flexures perhaps only a few miles in length. Seismic profiles, taken in the eastern part of Northumberland Strait by K. Kranck of the Bedford Institute of Oceanography (pers. comm.), revealed several fold structures with lengths of only a few miles. Perhaps only the Egmont Bay anticline and the Cape Egmont syncline should be regarded as regional folds with counterparts to be expected in New Brunswick.

Jointing and Faulting

Eastern parts of Malpeque and Summerside areas are characterized by a reticulate drainage pattern that reflects a prominent joint system. In the homoclinal southern part of Summerside area the joints are parallel to, or are at right angles to, the strike of the strata but, where fold structures are evident, as in eastern Malpeque area, the joints tend to maintain their regional trend and hence diverge somewhat from the trend of the more local strata. Down-faulting has taken place along some of the joints and, because of the gentle fold structures, these may result in major 'lateral' displacements of formerly adjacent units, but as good horizon markers are lacking, the amount of such displacements cannot be determined. The joints appear to be mainly related to a major graben structure in adjoining Rustico area which itself is perhaps related in origin to emplacement of the Hillsborough Bay salt dome still farther southeast (Williams, 1967, p. 4).

The presence of major faults in the Maritime Provinces has been gleaned mostly from pre-Pennsylvanian rocks but some faults are known to have involved the Pennsylvanian (Pictou) strata. On Prince Edward Island, even the Permian strata have undergone gentle folding and extensive faulting (Frankel, 1966; Frankel and Crowl, 1970). In New Brunswick, northwest of Moncton, major northeast-trending faults displace pre-Pennsylvanian rocks both horizontally and vertically (Gussow, 1953; Roliff, 1962; Webb, 1963). These faults may well extend, in the subsurface, to Prince Edward Island and Roliff (1962, Fig. 11) shows three such faults in the Malpeque–Summerside region. As the history of faulting in the Maritimes is one of frequent recurrence along pre-existing breaks (Webb, 1963) evidence of the trace of these faults should be looked for in the Island's Pennsylvanian and Permian strata. Unfortunately the sparsity of outcrops and the general lack of good horizon markers in the Malpeque–Summerside region makes it difficult to identify faults. According to Roliff's Figure 11, one of the pre-Pennsylvanian faults extends from Egmont Bay along the course of the Percival River to cross the northwest corner of Malpeque map-area north of Conway. No surface evidence of this fault has been found by the writer. Roliff's second fault trends northeast more or less along the course of Trout River and through the hamlet of Northam. The writer believes that the trend of Trout River and the Egmont Bay coastal bluff north of Red Head marks the trace of this 'Northam fault', and its position is so indicated on the accompanying geological maps. It is believed to involve the surface rocks though there is no conclusive evidence of displacement across it. Judging by the regional structure and the stratigraphy indicated in the Imperial Porthill and MacDougall test holes, there may be a west side downward displacement of a few hundred feet along the Northam fault. More certainly this Northam fault is present at depth for Imperial Oil Company intersected granite at 4625 feet in the Porthill well, collared about 1 3/4 miles northwest of the fault trace, but encountered only Carboniferous (Horton) strata to 9082 feet in the MacDougall hole 2 3/4 miles southeast of the trace. Also, much of the Hillsborough formation and the underlying Horton Group encountered in the latter hole were not present in the former (Howie and Cumming, 1963, Table 1) and a sudden change in the trend of magnetic contours off Red Head may indicate the locus of a fault with granite on its western side (Geol. Surv. Can., Aeromagnetic series map 7039G).

The third fault trace shown by Roliff (1962) follows the course of the Ellis (Grand) River. Like the 'Northam fault', this 'Ellis River fault' is believed by the writer to involve the Island 'red beds'. During the course of field work in 1954 a fault was interpreted as controlling the trend of the Ellis River estuary on the basis of differences in the overall lithology of bedrock exposures on either side of the river and an apparent disturbance or increase in fissility of the bedrock along the river as compared to other exposures. Northeast from the Ellis River estuary the fault may curve northward toward George Island, where Prince Edward Island's only occurrence of igneous rock outcrops at the surface and beneath the water. Southwest from Ellis River estuary the fault would pass west of Days Corner and very close to the collar of the Imperial Wellington drillhole which may have been collared in or near a fault zone (R. D. Howie, pers. comm.). The fault may leave the south coast near the hamlet of Cape Egmont. It is interesting to note, in connection with the exposure of igneous (basaltic) rock on George Island, that sills of similar basaltic rocks were intersected between depths of 4780 and 5920 feet in the Wellington drillhole.

In summary, the structure and stratigraphy of Prince Edward Island remains somewhat obscure for the ubiquitous continental red beds provide few, if any, reliable horizon markers, are poor in fossils of all kinds, have primary and major secondary depositional features with dips in excess of any known fold structures, and are much jointed and faulted. Thus, pending an island-wide appraisal of the red beds, only a tentative working picture is presently available.

SURFICIAL GEOLOGY

GLACIAL HISTORY

There is scant evidence of more than one glaciation of Prince Edward Island and none has been seen in the Malpeque–Summerside region. During the last major glaciation (the Wisconsin glacial period) the island was scoured first by ice flowing eastward from New Brunswick. Later, during deglaciation, ice flow was in diverse directions in various parts of the Island. This was in response to thinning of the former centres of outflow with resulting flow from other areas of still active ice, and also in response to rising sea level with consequent ice flow toward the deeper bays and channels of the encroaching sea.

In the Malpeque–Summerside region evidence of the early, main ice flow is provided by a few striations along the north shore in the northeast corner of Malpeque map-area. Perhaps also a few of the striae recorded by Chalmers (1895, p. 67 M) in Summerside map-area as "stoss side west" also represent the early ice flow. The Malpeque striae trend at about N. 95°E. to N. 115°E. and are in line with similar-trending and more widespread striae in northern Rustico map-area and beyond to the east and southeast. It was formerly reported (Prest, 1957, 1964) that this ice flow was from the east (Cape Breton Island) and that the N. 95°E. to N. 115°E. striae in northeast Malpeque area marked the western limit of westward ice flow. The true eastward flow of ice has since been determined in southeastern Prince Edward Island on the basis of 'ice shadows' or miniature crag-and-tail features (Frankel, 1966). Also, whereas it was formerly believed, mainly on the basis of the distribution of erratics in and on the drift mantle, that all evidence of the early glaciation in western Prince Edward Island was from the west (Chalmers, 1895, Map 558; Goldthwait, 1924, p. 80; Owen, 1949; Prest, 1957, 1962) – and hence most striations were referred to western ice, – it is now known that most of the numerous striated surfaces in Malpeque–Summerside region reflect the late, ice-flow trend during deglaciation rather than the early flow.

The late ice flow was generally southwest across the map-areas, but also southward in part of Malpeque Bay and westward along Northumberland Strait. This latter direction of late ice flow is also the reverse of the late glacial ice-flow trend earlier envisaged by both Chalmers (1895, Map 559) and Prest (1957). Even after westward ice flow was indicated by crag-and-tail

Figure 4: Scoured and striated bedrock surface south of Mills Point, southwest shore Malpeque Bay, 1954. Ice flow was toward the southwest (away from observer): note the wedge, nail-head and hammer-head striae. Till directly overlies this surface in the adjacent shore cliff. Following initial exposure by shoreline erosion, such surfaces may be protected by tidal zone debris for many years; elsewhere they rapidly disappear. (GSC photo - 201767)

features in one location west of Bordon in Northumberland Strait, the author, lacking further concrete evidence, was unwilling to accept the concept of ice flow in Malpeque Bay from the northeast and north (Prest et al., 1968). The weight of evidence from nail-head striae on the shores of Malpeque Bay, however, indicates that the last ice movement was from the Gulf of St. Lawrence. It is not yet known whether this ice flow was from a remnant mass of New Brunswick ice situated in the gulf, and cut off by marine invasion southward along Northumberland Strait, or from a similarly isolated lobe of Laurentide ice from around Gaspé Peninsula. Alternatively it was an active lobe of late, northward-retreating ice as envisaged by Goldthwait (1924). Radiocarbon datings suggest that the sea had effectively severed New Brunswick ice from Island ice by about 13,000 years B.P. (GSC-160), and it is believed that ice remained on western Prince Edward Island at the time of the marine invasion (Prest, 1962).

In any case, glaciation in toto was responsible for a widespread blanket of sandy to clayey till, depending upon the character of the local bedrock and derived mainly from it. Where conglomerate has been scoured by the ice, the till contains a variable assortment of hard stones that may be confused readily with those brought to the Island by an advancing glacier, especially where the conglomerate pebbles are angular. Their size and composition, however, generally serve to distinguish them from the glacial erratics. Only in the western end of Prince Edward Island, around Malpeque Bay, and along part of the north coast, is there a significant addition of true foreign stones or glacial erratics. Potassium-argon dating of some of these foreign stones indicates that they are mainly derived from New Brunswick. On the other hand, two glacial erratics collected east of Malpeque Bay were probably derived from the Precambrian terrain north of St. Lawrence River. One of these, an anorthosite, was so determined by megascopic and microscopic examinations supported by a K-Ar whole rock analysis. The Precambrian age of the other boulder, a granite, was determined on biotite with but scant hornblende as an impurity. More age-datings must be done before any safe inferences may be drawn about the relative prevalence of Appalachian versus Precambrian stones in the drift of Prince Edward Island, and hence about the provenance of various parts of the Island ice.

GLACIAL DEPOSITS

Ground moraine

The bedrock of the Malpeque–Summerside region is blanketed by a mantle of ground moraine consisting almost entirely of lodgement or basal till; only very locally is sub-stratified or stratified drift intercalated with the till. Ablation till, which is more loose-textured and sandy than lodgement till, is only of minor importance. Four small areas of a variable, loose, sandy or rubbly till that may be ablation till are shown on Map 00-1971. The lodgement till ranges from a thin layer, almost entirely involved in soil development, to some 30 feet thick, but it is only three to eight feet thick over most of the region.

The basal till varies from a somewhat-sandy clay till to a clay-poor sand till according to the character of the local bedrock over which the glacier flowed. As the character of the end members of the till series is so contrasting, and has an important bearing on land use, these two phases, and an intermediate phase, were mapped separately, as was done for Charlottetown map-area (Prest, 1964). These tills are termed clay phase, clay sand phase and sand phase. Although their contacts are gradational, these three till phases are shown on the map by line boundaries. As recognized in the field the clay-phase till, though definitely clayey, is readily seen to contain much sand; the sand-phase till, in contrast, does not appear to contain much clay. The clay-sand phase appears to contain more or less equal amounts of both clay and sand.

In actual fact it is not the relative abundance of clay- and sand-size materials alone that determines the physical properties or the appearance of the till. The amount of silt and very fine sand relative to the amount of clay, together with the water-content of the tills, are important parameters. Wet-method laboratory analyses reveal that the actual clay content of the average clay-phase till in the Malpeque–Summerside region is only about 5 per cent more than that of sand-phase till, namely 22 versus 17 per cent, but the combined clay plus silt contents are in the order of more than 60 versus less than 40 per cent. Thus, the clay-phase till is really a clay-silt till. The clay-sand phase till also has about 20 per cent clay but a clay plus silt content commonly around 55 to 50 per cent. As such, clayey-sand tills become more sandy, the clay plus silt content decreases to 40 per cent below which point the till becomes a sand-phase till. In the more sandy tills the silt content is constant at about 20 per cent but clay decreases as sand increases. Thus, in spite of the importance of silt in the sub-division of the tills into three phases, it is the 'clay' that is the more apparent in the field and has led to the clay versus sand terminology.

In very wet or very dry weather the arbitrary classification of tills in the field by sight and feel (Frankel, 1966; Crowl, 1969) results in over-emphasis on clay, or on sand, respectively. As already mentioned, the amount of moisture together with the grain-size distribution is important in determining the appearance and properties of the till. For instance a sand till exposed in an excavation for a high school in Summerside, during moist autumn weather conditions, had the cohesive or tough characteristics of typical clay-phase till and displayed 30-foot near-vertical cut-banks. This was partly due to the low amount of silt and large size of the sand grains; the clay content was sufficient to form a firm bond with the large sand grains. Had there been much silt or had the sand been very fine, the low clay content would have been insufficient to provide a firm bond, thus resulting in the lower cohesive strength that is normal for sand-phase till. However, had the weather been hot and dry for a prolonged period to promote desiccation of the till, the clay would have been less effective as a bonding agent and some slumping of the excavation walls would have resulted.

The natural moisture content of the tills in Malpeque-Summerside region varies from about 9 to 12 per cent by weight and even seemingly very dry field samples retain 1 to 4 per cent water.

End moraine

The only feature recognized on Prince Edward Island that might be an end moraine is a slightly elongate, hummocky, boulder-strewn ridge northeast of the Bideford peat bog in western Malpeque map-area. Local relief is about 15 feet but the surface attains an altitude of 50 to 55 feet above sea level which, in this location, is about 10 feet above the postglacial marine limit. Thus, most of the moraine surface has been modified by wave action with deposition of gravelly sand containing sparse shell fragments as a surrounding or flanking deposit. Many huge glacial erratics, on the ridge, the largest being about 12 by 8 by 5 feet, were probably ice-rafted into position but others, above the marine limit and implanted in stony sand till, must have slid off the ice itself. The till and the associated gravels of the ridge carry a surprisingly large proportion of foreign stones compared with till or gravel in other parts of Prince Edward Island.

Several large, but shallow, bulldozed test pits in the moraine and modified moraine reveal a complex of stony sand till, sand and gravel. Only sand and gravelly sand occur along the gently sloping southwest side of the ridge whereas variably stony sand till prevails above the marine limit and in places below it, along the steeper northeast or proximal side of the ridge where the till overlies stratified sand and gravel. It would appear that during a period of marine transgression in northwestern Prince Edward Island an ice lobe overrode stratified sediments, presumably marine, blanketed them with stony till, built a low bouldery ridge, and contributed debris to the sea at the ice front. The ice readvance may have been a minor fluctuation of a late-glacial, debris-laden lobe of remnant ice in southern Gulf of

St. Lawrence. Alternatively, it was a freshening of northern ice, the Acadian Bay ice lobe of Goldthwait (1924, p. 78-81), that brought the stony debris to the Island's northern shores. In either case it was related to the ice that slightly earlier had moved southward and southwestward across Malpeque Bay but which post-dated the earlier and main eastward flow across Prince Edward Island.

Glaciofluvial and glaciolacustrine deposits

In Malpeque–Summerside region, unlike north-central and eastern Prince Edward Island, deposits attributable to glacial meltwater are uncommon. There are no complex systems of anastomosing and interconnecting meltwater deposits. In the southwest corner of Malpeque map-area a short, low ridge of gravelly sand, made up almost entirely of local rock materials, resembles an esker or elongate kame. Two small nearby areas of sand have been mapped as kames, although they have little topographic expression. Perhaps these sand deposits and the gravel ridge represent a small, irregular ice-marginal pond and its outlet. No other meltwater deposits were recognized in the Malpeque map-area.

Summerside area (including Egmont and Tormentine parts of Prince Edward Island) is similarly devoid of complex systems of eskers, kames, kame terraces and the like, but it does contain a few areas of featureless sand that are considered to have been deposited in shallow, ice-walled ponds near the margin of the decaying ice cap. The largest area, to the north-northwest of Borden, blankets the hillside at elevations between 50 and 155 feet and is probably an erosional remnant of a formerly more widespread deposit. Other similar but smaller areas of ice-contact deposits of sand occur east of Borden, east of Kensington, and north and northwest of Wellington. Sand deposits along Dunk River are considered to be valley-train deposits formed by meltwaters from the last ice remnants on the western flank of the uplands of central Prince Edward Island.

EARLY POSTGLACIAL AND MARINE HISTORY

In order to comprehend the occurrence of elevated marine deposits in Malpeque–Summerside region, one must appreciate the character and behaviour of the earth's crustal rocks. The earth's crust, although rather rigid, yields under prolonged stress such as the load of an ice sheet. The crustal rocks bend downward, and at depth 'rock' materials are displaced laterally, by viscous flow. Crustal depression may be in the order of 1,000 feet or more depending on the thickness and duration of the ice load. During deglaciation, the strong and somewhat elastic crustal rocks may first rebound quickly but the rate of rebound decreases rapidly with time as the 'rock' materials at depth return to their former place. The initial rebound may be in the order of 10 to 20 feet per century but it may take as much as 5,000 years to recover one half of the initial depression. At present it is believed that the crustal recovery or isostatic rebound, following ice retreat from the Maritimes, is more or less complete. In fact, the coastal areas are undergoing submergence due to world-wide or eustatic sea level rise, to the loading effect of the seawater on the broad shallows off the present coasts, and probably also due to deep-seated tectonic phenomena (Grant, 1970).

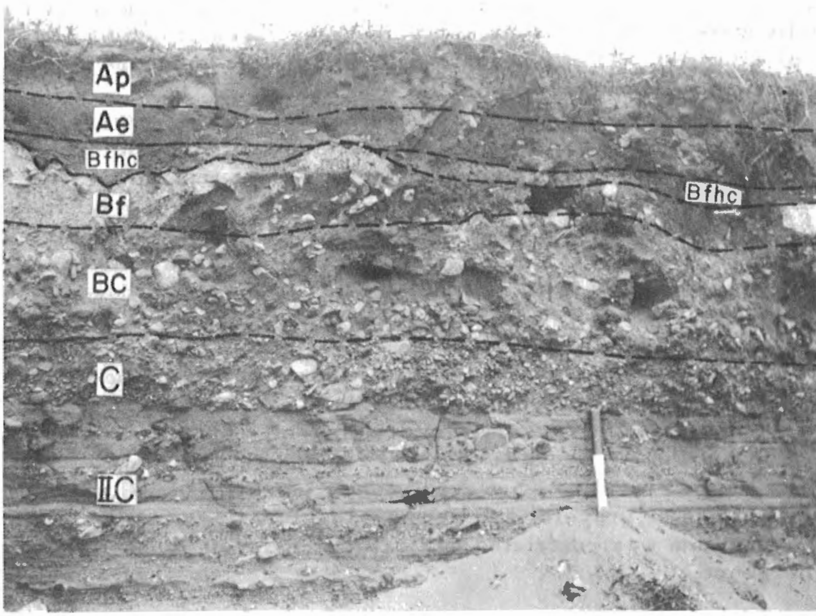
As the ice sheet receded from western Prince Edward Island about 12,500 to 13,000 years ago (GSC-101; GSC-160) the sea had already invaded the Gulf of St. Lawrence. Although eustatic sea level was still about 200 feet lower than at present due to water that remained locked up in the world's ice sheets and glaciers, the Prince Edward Island coast was sufficiently depressed to allow the sea to overlap part of the present island. The upper limit of this submergence, known as the 'marine limit', is about 75 to 80 feet along part of the west coast of the Island but, due to differential tilt of the land, drops off eastward. Within the present map-areas the marine limit is at an elevation of about 55 feet along a broadly curving line extending through Mount Carmel in Egmont area to Ellerslie and Freeland in western Malpeque. The zero isobase of emergence, or the line east of which there was no overlap by the sea, probably passes through Tryon in Tormentine area and Breadalbane in eastern Summerside, then passes east of the map boundary and curves northward into the extreme northeast corner of the Malpeque map-area.

It is believed that the mapped marine deposits represent the interval from about 13,000 years to 6,000 years ago.

EARLY POSTGLACIAL AND MARINE DEPOSITS

The postglacial marine invasion of coastal parts of the Malpeque-Summerside region resulted in the formation of beaches, bars, spits and shallow-water bottom beds that today range from the marine limit down to sea level. These deposits are generally composed of sand and are derived mainly from the local till mantle and the Island bedrock. Along the north shore of western Malpeque area, however, there is interbedded sand and gravel much of which was derived from beyond the Island. The most important occurrence of this gravel is situated southeast of Poplar Grove; this gravel laps onto the end moraine described earlier, and along its northeast side passes beneath the till of the moraine proper. The gravels are composed of up to 35 per cent foreign stones (mostly granitic, volcanic and gneissic rocks) which, together with about 30 per cent hard calcareous sandstone and mudstone breccia, provide a good source of gravels for the western part of the Island. In terms of the whole deposit, however, the stone content is only about 10 per cent. Widely scattered fragments of shells attest to the marine origin of the gravels that lap onto the moraine ridge. As earlier mentioned, this sand and gravel represents a winnowing of glacial debris near the margin of a late-glacial ice lobe; the deposits grade from gravel in the northeast to sand in the southwest. The commercially desirable 'hard' stones range from pebble-size to cobble-size. A scattering of boulders, within as well as on the gravels, are believed to have been ice-rafted into position. The boulders are commonly 2 to 3 feet across but some are as much as 8 or 10 feet in length.

East and northeast of Poplar Grove, the beaches and bars contain fewer foreign and hard calcareous breccia stones than near the moraine, but nevertheless provide gravel for local road use. On the immediate south side of the road junction, a mile northeast of Poplar Grove, a pit that was dug to a depth of about 7 feet in a sandy gravel bar encountered grey, unoxidized and partially cemented stony gravels with about 20 per cent foreign stones and a high content of calcareous breccia and sandstone. It is probable that this stony, lime-cemented gravel was close to the bedrock surface. The pit



LEGEND

0 - 0.5 ft.	Ap horizon	Dark, reddish-brown
0.5 - 1.0 ft.	Ae	Dark, yellow-brown
(thin, discontinuous)	Bfhc	Firm, dark brown (ortstein)
1.0 - 1.5 ft.	Bf	Light, yellow-brown
1.5 - 3.0 ft.	BC	Light-red gravelly layer
3.0 - 3.5 ft.	C	Reddish gravel layer (poorly stratified)
3.5 - 7.0+ ft.	IIC	Yellow-red gravelly sand (well stratified)

Note: 'red-bed' stones break down in the soil zone.

Figure 5: Soil profile (Kildare series - fine sandy loam) developed on marine gravel; halfmile north-northeast of Freeland corner, Malpeque map-area. Gravel pit on east side of highway north of Eel Creek. (GSC photo 201768)

has since been filled and the surface graded. Elsewhere along the bar, the deposit is predominantly sandy although there is a noticeable content of foreign stones. There is an occasional large boulder in the gravel as well as on the bar surface. Pits in the bar northeast of Freeland also revealed gravel beds with 5 to 10 per cent pebble- to cobble-size foreign stones. Many huge foreign boulders, up to 7 feet long, taken from the bar surface or from its basal part, have been dumped into, or abandoned in, the Freeland pit. About 60 to 65 per cent of the smaller stones are of local derivation; most of the remainder are granitic and other foreign rocks.

The southeastward extension of the gravelly raised beach and bar system of western Malpeque map-area is exposed on Lennox, Bird, and George Islands in Malpeque Bay. On the north shore of Lennox Island well-bedded sand and gravel deposits overlie sandy till and underlie a 4-foot rubble or till-like layer that may well relate to the ice advance that built the end moraine farther northwest. The only other marine deposits that were noticeably gravelly were small remnants of a raised beach near the marine limit northeast of Ellerslie. They were only 3 to 5 feet thick and were largely removed during road construction in 1953 and 1954.

Elsewhere in Malpeque–Summerside region, the features mapped as raised marine deposits are composed mainly of sand, though foreign pebbles may readily be found. They are generally less than 5 feet, and seldom more than 10 feet, thick. Sandy marine deposits may be present and have gone unnoticed in some of the wooded coastal areas. Thin marine sand or rubble may be incorporated in the soil zone and also have gone unnoticed. In all probability extensive areas of marine sand have been removed by erosion since the land became emergent and especially since these coastal areas have been cleared for farming. But some coasts were erosional rather than depositional shores and glacial debris has been stripped from the bedrock by wave-action leaving behind only a scattering of foreign stones or local patches of rubble. Such is the very thin drift or soil-covered area mapped as 'outcrop' in the Poplar Grove–Conway–Freeland region. Large tracts of ground below the marine limit, however, appear never to have had any covering of marine sands or gravels, and erosional features are similarly lacking. Perhaps wave-action was restricted by floating ice during most of the period of land emergence.

POSTGLACIAL HISTORY AND DEPOSITS

Peatland

Plants probably returned quickly to western Prince Edward Island as the ice sheet receded from its shores about 13,000 years ago. The oldest dated vegetal material, however, is only 9,880±150 years B.P. (GSC-773). This organic material was collected from the base of a 20-foot-deep peat bog (Portage bog) that is crossed by the highway west of Portage, in O'Leary map-area, and about 4 miles west of Conway in the northwestern corner of Malpeque map-area. The dated material was a jelly-like substance, known as gyttja, representing an algal ooze deposited in a pond that pre-dated the formation of mossy peat. However, as the base of this peat bog is between elevation zero and five feet, whereas the marine limit here is nearly 60 feet, the freshwater vegetation could not have begun to accumulate before there had been some 55 feet of land emergence. This may account for part of the 3,000-year gap in the record of age-dated postglacial materials, but certainly not for all of it. It is possible that the freshwater pond did not form immediately as the land emerged from the sea, but perhaps one to two thousand years later due to a change in drainage conditions. Such a change might have resulted from the postglacial rise of sea level, relative to the land, and consequent rise in the groundwater table inland from the shore; the pond was replaced later by sphagnum moss whose growth has since kept pace with the rise in groundwater level.

Organic sediment from the base of Bideford bog, north of East Bideford, might be presumed to date older than that from the Portage bog as its base is at an elevation of about 25 feet and the bog area would have been cut off from the sea after sea level fell from an elevation of 50 to 25 feet. On the other hand, internal drainage of this area might have precluded the formation of organic deposits for a long period of time. A radiocarbon dating gave an age of only 8000±140 years (GSC-1494), hence either the deepest and oldest part of the bog was not sampled or this bog too reflects the rise in groundwater table consequent on the rise of relative sea level.

The Bideford bog has a humped surface with a maximum elevation of 45 to 50 feet and a depth of about 21 feet. Test-boring samples gave the following sequence (R. J. Mott, pers. comm.):

0-20 cm	sphagnum moss (growing layer)
20-600 cm	poorly to moderately decomposed peat with some stem fibres and roots
600-625 cm	woody, fibrous peat
625-635 cm	silty organic material
635-640 cm	organic material with silt, sand and pebbles
>640 cm	coarse sand and pebbles

Peat bogs situated well above the area of marine overlap, and hence unaffected by sea level changes, might date older than those within the range of marine overlap providing the bog sites did not have good internal drainage when the area was first deglaciated. To date, no test-borings have been made in any of the small peat bogs above the marine limit such as those north of Richmond in western Malpeque area.

Some coastal peat bogs clearly owe their origin to the gradual rise in sea level that has occasioned a change in the height and slope of the groundwater table inland from the shore. Thus some low areas that at one time had good internal drainage, and supported woodland, became boggy and sphagnum moss flourished. Some of the wet woodlands such as those north and northeast of Sunbury Cove are destined to be replaced by peat bogs in the next few centuries. Moss peat will then overlie tree root horizons and woody peat as now occurs in some of the older large coastal bogs in Cascumpeque Bay adjoining the northwest corner of Malpeque map-area.

The Bideford bog is the most extensive area of peatland in the Malpeque–Summerside region and may serve as a source of peat moss for garden and nursery purposes in future years. In 1941 the Connell Exploration Company attempted to drain part of the bog and recover peat moss for surgical dressing purposes. The drainage-ditch grid killed the growing sphagnum moss over a considerable area and shrub vegetation has since invaded the relatively dry peat surface. The bog west of Miscouche is about half a mile in circumference and is a potential source of peat moss or black earth by reason of its highway location and proximity to Summerside, but it has not been tested by the writer for either material. Several of the smaller bogs may also prove valuable as sources of black earth or black muck for local garden purposes. These materials represent the decay or humification products of moss peat and other vegetal materials, during the life of the bog.

Beach, tidal flat, barrier island and dune deposits

The outer coast of western Malpeque map-area is comprised of two elongate barrier islands, sometimes referred to as off-shore and baymouth bars. These islands are the result of the rise of relative sea level over the past several thousand years in an area of copious sand supply. Thus they occur seaward from, and more or less parallel to, the early postglacial marine deposits described above. Longshore currents have carried great quantities of sand from these islands eastward to the coast of eastern Malpeque area and along the Rustico coast. This transfer of sand from the barrier islands has been responsible for the white-sand beaches that contribute to Prince Edward Island's popularity as a tourist area.

The off-shore islands are complex structures. Each island is made up of a number of elongate, sub-parallel, straight to curving beach ridges that are progressively younger toward the sea. A younger beach ridge may curve around and cut-off one or more of the older ridges. The most elongate and best-developed beach ridge is that alongside the present-day beach. On Hog Island this attains a maximum elevation of about 15 feet. The beach ridges comprise an intimate combination of wave-tossed and wind-blown sand. At various times during the development of the beach ridges, a combination of high tides and storms enabled the sea to break over the ridges and form numerous washover channels, leading down to the inner lagoon, and to deposit overwash sand in the channels and in the lagoon. The beach ridges have been further modified by the interplay of wind and vegetation which has resulted in blow-outs and small ovoid dunes that give the barrier island a very hummocky and pitted surface. In places, the beach ridges are barely discernible or have been removed completely. Due to the anchoring effect of the dune grass, and limited other vegetation, the dunes may reach an altitude of up to 30 feet in spite of their coastal exposure. Where blow-outs and washover channels lie close to sea level, they are commonly swampy and are breeding places for mosquitoes — a somewhat incongruous situation for such sandy terrain. Areas of dune sand, other than on the barrier islands, are uncommon. Wind-blown deposits occur west of McKay Pond and on Royalty Point. In the latter place the sand dunes overlie both bedrock and till up to an elevation of about 30 feet and the wooded dunes provide the setting for a popular campsite close to an excellent beach off the point.

In northwestern Malpeque area the combination of sea level rise and long-shore currents has resulted in ever-shifting channels and bars in the past as at present. For instance, on Hog Island, a broad, low, flat area in the barrier island separates two ridged and duned parts that were formerly separate islands. This low area is reputed to be the site of the former harbour entrance to Malpeque Bay; an elderly resident from Keirs Shore, Princeton told the writer in 1954 that his father had sailed through that entrance about 100 years ago. The present-day storm beach on the seaward side of this old, filled channel is the only major feature in the half-mile wide area of sand that effectively blocks the former channel, although occasional storms appear to break over it. Waves from Malpeque Bay washed seaward over this low area during Hurricane Hazel in 1954.

The intertidal sands and silty sands of northwestern Malpeque area are intimately related to the barrier island complex. Wind and waves continually transfer sand from the surface and seaward side of the islands to the lagoon side where they continue to be shifted by tidal currents and storm waves. Elsewhere around Malpeque Bay, the intertidal sands have been derived directly from postglacial marine deposits or from the scour of till or bedrock; in the latter two cases the tidal zone sands are reddish.

Along the south coast, intertidal deposits are prominent but only very locally form bars and spits that rise above sea level, as in Egmont Bay and Salutation Cove near Summerside. Again, much of the intertidal deposits were derived from the rather limited occurrences of postglacial marine sand in this region.

Salt marsh and continguous marshland

Salt marsh (marine marsh) and contiguous brackish-water marsh occurs in many of the sheltered coves and inlets of the Malpeque–Summerside region and is the habitat within, or immediately above, the tidal zone for plants that either prefer or tolerate salt. Sea-shore plants, by retarding the flow of tidal currents, help to trap sandy, silty and organic debris and, over a period of time, the resulting mixture of living and variably decayed plant and animal matter, together with fine sediment, forms a mixed vegetal-mineral mat. Once established, this material resists erosion and may, in places, be buried by overriding sands as the shoreline transgresses inland. But, more commonly, the vegetal-mineral mat is ripped-up and destroyed by storm waves or tumbled into more sheltered parts of the marshland where it may become an integral part of the newly forming organic mat. With the rise in sea level of the past several thousand years, salt marsh has been transgressing inland as a temporary shoreline deposit. Landward from the true salt marsh in some low, coastal areas there are large, brackish-water swamps with a specific flora of salt-tolerant plants; these swamps and their vegetal-mineral mat are included with salt marsh on the Malpeque–Summerside maps of the surficial deposits.

The organic-mineral mat may rest on glacial or postglacial deposits including peat and is generally much younger than the deposits it overlies. But, in part, it is forming contemporaneously with the freshwater peat of adjacent peatland where growth is controlled by the rise in the groundwater table as the sea slowly transgresses the land. Salt marsh deposits are thus the youngest unit in the surficial deposits and range in age from a few years to about three thousand years.

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