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SURFICIAL GEOLOGY OF THE MERASHEEN–HARBOUR BUFFETT–SOUND ISLAND MAP AREAS: AN UPDATE

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ABSTRACT

Surficial and terrain units in the Merasheen, Harbour Buffett and Sound Island map areas were mapped at 1:50 000 scale. The region is dominated by exposed bedrock, particularly along the coastline. Coarse diamicton is the most common Quaternary deposit, and represents both primary glacial sedimentation and reworked deposits. Ice flow was toward the south, paralleling the axis of Placentia Bay and the bedrock structure. Eskers and other glaciofluvial deposits flank the major rivers. Subsequent to Late Wisconsinan deglaciation, the marine limit reached ± 20 m asl. Modern gravel beaches and flats are currently forming along the coastline.

INTRODUCTION

This report is an update of the ongoing surveying program of the surficial geology and Quaternary landforms of the Avalon Peninsula and Isthmus (Catto, 1992, 1993, 1994). During the 1996 and 1997 field seasons, these investigations were extended to the area to the west. The 1:50 000 NTS map areas 1N/8 (Merasheen), 1N/9 (Harbour Buffett) and 1N/16 (Sound Island) were mapped in detail (Catto, *in press*). The work involved mapping from aerial photographs and stratigraphic and sedimentological field investigations, and builds upon the initial work of Kirby *et al.* (1988). This report is intended to accompany the three map areas mentioned above; it discusses the composition, material properties and genesis of the major types of surficial units identified in the mapped regions.

DESCRIPTION AND ANALYSIS OF SURFICIAL GEOLOGICAL UNITS

The terminology and symbols used for designation of the map units is the system developed by the Newfoundland Department of Mines and Energy. Map units are classified in terms of dominant genetic process and surface morphology. In locations where two or more sediment types are exposed within the boundaries of a single map unit, a composite unit symbol is used, with the dominant unit listed first. In areas where a unit is stratigraphically beneath a veneer or blanket of another, but influences the topographic expression or tonal qualities visible on aerial photographs, a compound symbol is used with the underlying unit symbol in the denominator.

The large number of map units represented by distinct terrain classification symbols precludes discussion of each individual unit. Therefore, the discussion is based upon the dominant genetic processes that each unit type represents. The unit types are discussed in order of diminishing prominence and areal extent.

EXPOSED AND VENEERED BEDROCK (R)

Exposed bedrock (R) and bedrock veneered with vegetation and thin, discontinuous soil (Rc) represent the most common surface material in the region. The areal extent of the bedrock units has been summarized by Colman-Sadd *et al.* (1990). Bedrock units include Precambrian volcanic and siliciclastic rocks, Precambrian granitic intrusions, and minor outcrops of Cambrian sedimentary strata. Devonian granitic rocks crop out on Red Island. The coastal topography is mainly the result of the pre-existing structural geology, marked by northeast–southwest-trending faults, such as the Paradise Fault.

GLACIGENIC UNITS (T)

Sediments mapped and interpreted as glacigenic units are the second most common surficial material in the region. These units are extensively exposed throughout the interior of the Sound Island map area, but only thin and small scattered outcrops are present along the coastline. Outcrops of glacigenic sediment are rare on Bar Haven, Merasheen, Long, and Red islands.

Sediments mapped and interpreted as glacigenic are diamictons, containing significant quantities of silty sand, medium to coarse sand, and larger clasts. Some of the diamictons were formed by direct deposition from ice during glacial advance or recession, and represent true glacigenic

units ("tills"). Others were deposited by sediment gravity flow beneath glacial ice, into subglacial cavities. Diamictons deposited as a result of supraglacial melt-out are also present.

These qualifications allow the glacigenic units to be mapped in terms of their geomorphic expression and texture, without specifying the precise mode of genesis. Although diamicton units, which have undergone any substantial modification after deposition from glacial ice, technically cannot be classified as tills, the units throughout the region have broadly similar physical properties. For practicality and ease of general discussion, all of the diamicton units associated with glacial activity were mapped as glacigenic units, and will be treated collectively here. Diamictons deposited by postglacial colluviation are treated separately, as colluvial deposits.

The diamictons vary in matrix composition from silty sand to medium sand. Within the matrix, silt content ranges from <5 to 20 percent, and clay is commonly absent. The coarse texture of the diamicton matrices indicates that they were derived from the Precambrian rock units exposed inland. In contrast to the finer grained matrices of diamictons exposed north of Southern Harbour on the Isthmus of Avalon, composed, in part, from sediments derived from the floor of Placentia Bay, the coarse matrices of the diamictons in the Sound Island map area provide further evidence indicating that glacial flow was southeastward toward Placentia Bay. The proportion of pebbles and larger clasts varies between 40 and 65 percent. Throughout the region, the pebbles and cobbles dominantly are locally derived. Generally, the diamictons are texturally homogeneous, without distinctive lenses or stratification.

At several exposures, the alignment of the large pebbles and cobbles was measured, in order to ascertain the direction of sediment transport and to assist in interpretation of the genesis of the diamictons. Results from these clast-fabric analyses were variable for the region's diamictons, with vector orientation strengths varying from weak (principal eigenvalue = 0.4) to moderately oriented (principal eigenvalue = 0.7). These variations indicate that the sediments mapped here as "glacigenic" represent both primary basal tills (having moderately oriented fabrics) and deposits modified by flow (having weakly oriented fabrics).

Veneers ('v') and eroded veneers ('ev') are the most common surface expressions involving diamictons, especially in coastal areas. The topography of these sediments reflects that of the underlying bedrock. Slopes vary from gentle to moderately steep. The deposits are dominated by coarse clasts, and in most areas have undergone surface weathering and pedogenesis. Most till veneers support regosolic or acidic brunisolic soils.

Thicker accumulations of glacigenic sediments (maximum thickness 7 m) are mapped as hummocky ('h'), eroded and dissected hummocky ('he'), or eroded ('e'). The hummocks are poorly defined, and generally are less than 5 m in height and less than 15 m in width. Areas of hummocky topography are marked by gentle to moderate slopes. Eroded hummocks and accumulations of eroded till are present on gentle to moderately steep slopes.

Oriented landforms composed of diamicton are mapped as lineations ('l'), eroded lineations ('el'), drumlinoid topography ('d'), and ridges of rögen moraines ('r'). Lineations are present in the interior areas of the Sound Island map area, and in the northwestern part of the Harbour Buffett map area, north of the head of Paradise Sound. The lineations range in length from 50 to 200 m, in width from 10 to 40 m and in height from 2 to 6 m, and are composed of coarse-grained diamicton. The lineations are aligned toward the southeast.

Drumlinoid topography and rögen moraines are confined to the western part of the Sound Island map sheet. Drumlinoid features are poorly developed, with maximum heights of 5 m, widths of 15 m, and lengths of 30 m. The long axes of the drumlinoids are aligned toward the southeast. Rögen moraines are aligned with their axes trending southwest–northeast, and the morphology indicates flow toward Placentia Bay (southeast), in conformance with the orientations of the drumlinoid features. The rögen moraines have maximum heights of 8 m, and maximum lengths of 50 m, with moderate to steep slopes.

ICE-FLOW INDICATORS

The distribution of erratics indicates that ice flow was southward and southeastward, toward the northern part of the Burin Peninsula and Placentia Bay. No erratics derived from Red Island or the Avalon Peninsula were observed on the mainland.

Bedrock units were striated by glacial erosion. Striations, developed primarily on Precambrian units, are aligned toward the south and southeast, indicating ice flow from the interior of Newfoundland toward Placentia Bay. Glacially modified bedrock forms, ranging in scale from features less than 10 cm in length through roches moutonnées to flyggbergs more than 100 m long are present throughout the region. The directions of glacial flow indicated by these features coincide with those indicated by the striations, where these are present, ranging from southward to southeastward. On Merasheen, Long and Red islands, glacially eroded bedrock features indicate southward flow, parallel to the axis of Placentia Bay.

ORGANIC UNITS (O)

Organic units are defined as those composed mostly of organic materials resulting from the accumulation of plant

material containing a minimum of 30 percent organic material by weight. They are associated with fens and bogs developed above relatively impermeable bedrock and glacigenic materials. The surfaces of the units are generally level, forming veneers ('v'). Although the organic deposits throughout the region are generally thin (<2 m), the perhumid moisture regime of eastern Newfoundland provides suitable environmental conditions for the accumulation of organic material, causing the organic deposits to become progressively thicker. At present, however, thicknesses and organic composition are not sufficient to support large-scale commercial utilization.

Fibric deposits are the most common surface forms, dominated by *Picea mariana* (black spruce) and *Larix laricina* (larch), and are associated with fens containing standing water. Peat deposits from these fens are dominated by weakly decomposed sedge, spruce, and larch fragments. Small thicknesses of discontinuous mesic deposits having an intermediate degree of decomposition are present beneath some of the fibric deposits in inland areas.

GLACIOFLUVIAL UNITS (G)

Glaciofluvial landforms include ridged esker deposits, with some ('re') or large amounts ('er') of erosional modification, and eroded gravel units with lesser sand ('e'). These deposits, composed primarily of coarse pebble gravel and lesser amounts of coarse to medium sand and granules, represent the main sources of aggregate in the mapped region. The thickest (to 15 m) and most areally extensive deposits occur along Piper's Hole River and the Swift Current Estuary. Those lying within the boundaries of Piper's Hole Park, and those adjacent to the estuary, are not available for exploitation. Additional lesser glaciofluvial deposits are present flanking Sandy Harbour River, Black River, North Harbour River, and the headwaters of Mother's Brook.

The glaciofluvial deposits represent sedimentation by streams associated with glaciers in subglacial and ice-marginal environments. The river flow followed the present topography, directed seaward toward Placentia Bay.

Ice-wedge casts are present in the glaciofluvial deposits at the mouth of the Piper's Hole River, at 11 m asl (Tucker, 1979). The pseudomorphs are located below the marine limit of approximately 20 m asl, and thus formed subsequent to initial deglaciation during marine regression. Marine waters regressed below 0 m asl in Placentia Bay in the early Holocene reaching a minimum of approximately 20 m below present sea level (Shaw and Forbes, 1995). The evidence indicating rapid marine regression suggests that the Swift Current site would have been subaerially exposed shortly after deglaciation.

MARINE UNITS (M)

Marine units represent both deposits formed during higher sea-level stands (terraces, 't'; eroded terraces, 'et'; terraces with surface ridges, 'rt'; veneers, 'v'), and deposits currently forming at sea level (beach ridges, 'r'). These deposits are dominated by coarse sand and gravel. Marine waters inundated coastal areas following deglaciation, with greater submergence in the northernmost embayments (± 20 m asl at Come-by-Chance and Swift Current) than along the more southerly shores (<5 m along the southern part of Merasheen Island). Fine-grained deposits associated with higher sea level are present at Swift Current.

The modern coastal deposits and landforms of the region have been described in detail by Catto and Hooper (1995) and Catto *et al.* (*in press*). The coastline is dominated by rock cliffs, gravel pocket beaches, and narrow, steep mixed sand and gravel and gravel barachoix and attached beach ridges. Tombolos are present at several localities, particularly on Bar Haven and King's islands. Currently, sea level is rising throughout Placentia Bay. As sea levels continue to rise, sediment deposited at higher elevations will undergo reworking. Previously submerged banks will become submerged under deeper water, resulting in the elimination of reworking of these sources. Overall, the net effect of rising sea level will probably be to diminish the available supply of sediment in the system. However, the current rate of sea-level change (approximately 5 mm per annum) is not sufficiently large to cause serious problems in the immediate future.

The Swift Current Estuary is dominated by deposits of glaciofluvial sand and gravel ('Ge'), formed when the retreating glaciers stood in elevated marine waters at the head of the inlet, approximately 20 m asl. Reworking of these deposits proceeded during the early Holocene, as sea levels fell steadily to more than 15 m below present ca. 9000 BP (Liverman, 1994; Shaw and Forbes, 1995). These readily erodable deposits provide a source of sediment for the formation of offshore, nearshore, and shoreline bars and spits.

The shallow waters of the area are a consequence of the distribution of the glacial and glaciofluvial deposits, and the postglacial fluctuation of sea level. The period of low sea levels during the early Holocene resulted in the construction of deltas, terraces, and meandering fluvial landforms, all of which are now submerged and provide sediment platforms suitable for the establishment of salt marshes and eelgrass communities. Although other parts of Placentia Bay had a similar sea-level history, none had the combination of ample supplies of sediment and deep embayments necessary for deltaic development and sediment-bank accumulation.

The northwestern arm of Placentia Bay, and the Come-by-Chance estuary to the north-northeast, are under the

influence of low mesotidal–high microtidal regimes. Changes in sea level are thus unlikely to effect major changes in the tidal regime in the immediate future. Under a continuation of the present climate, the accumulation of detrital materials and sediments in the salt marshes and eelgrass subregions of the Swift Current Estuary is likely to proceed at a sufficient rate to mitigate the effects of sea-level rise. Hence, the rising sea level will not cause a significant change in the character of these subregions. The embayment is sufficiently sheltered to preclude the possibility of enhanced storm wave activity due to rising sea levels.

The westernmost part of the bouldery tidal flat complex at Come-by-Chance lies within the Sound Island map area. This complex represents a tidal flat conditioned by glaciofluvial sedimentation. The boulders, cobbles and the majority of the coarse and medium pebbles present are too large to be moved by the tidal currents or even the storm waves that affect this coast today. Consequently, the tidal flat has developed as a result of superficial reworking of the previously deposited glaciofluvial fan. The sediment assemblage present (particularly in textural terms) thus reflects primarily the latest Wisconsinan glaciofluvial environment, and is a relict assemblage.

The tidal flat is marked by meandering and anastomosing tidal channels, small washover fans, bank collapse sequences and sedimentary successions resembling those of coarse-sediment oxbow lakes in abandoned channels. The tidal flat is bounded at its seaward margin by a cobble-dominated steep mid-bay barrier beach. At present, marine transgression is permitting enhanced reworking of the cobble gravel barrier, and local breaching and overwashing of the barrier has led to an increase in marine energy levels, evident in the uppermost sediments of the tidal flat succession.

FLUVIAL UNITS (F)

Fluvial units are present in the narrow, steep valleys of wandering and braided streams throughout the study region. Geomorphically, the deposits form veneers ('v') over bedrock, glacigenic deposits, or glaciofluvial sediments. The deposits are laterally discontinuous, and consist of longitudinal bars, lateral bars, and thalweg accumulations of gravel and coarse sand. Pebble gravels are the most common sediments present, generally in moderately to well-sorted units 1 to 1.5 m thick. All of the mappable fluvial units were formed postglacially.

COLLUVIAL UNITS (C)

Colluvial veneers ('v') are uncommon in the region. They are generally associated with failure of glacigenic, glaciofluvial, or fluvial sediment on steep slopes adjacent to river valleys. The units are coarse-grained diamictons. Roughly undulating surfaces characterize these units. Eroded surfaces are common, and remobilization of previously colluviated material ubiquitous. Mass movements are not a significant geological hazard in the region, with the exception of the Piper's Hole River area where highway construction on steep slopes has resulted in disturbance to sediments.

LACUSTRINE UNITS (L)

A single occurrence of lacustrine sediment is present, surrounding an unnamed pond in the northwestern part of the Sound Island map area (UTM 945155). This unit was deposited in shallow water during a higher stage of the pond, and forms a planar veneer ('vp') over eroded diamicton. It was not investigated during the field survey.

SUMMARY

Mapping of the Merasheen–Harbour Buffett–Sound Island map areas has resulted in the identification of eight types of surficial units. The region is dominated by exposed bedrock, particularly in coastal areas. Glacigenic sediments are the most common type of Quaternary unit, with till veneers, hummocky terrain, lineations, drumlinoid features, and rögen moraines present in interior areas. Erratics, striations, glacially eroded bedrock features, drumlinoids, lineations, rögen moraines and fabric analyses of primary glacial tills all suggest that ice flowed southeastward and eastward towards Placentia Bay. On Merasheen, Long and Red islands, flow was southward, paralleling the axis of the bay. No evidence of westward flow was observed.

Organic deposits are common throughout the interior of the region, primarily fibric veneers developed in fens overlying glacigenic deposits and bedrock. Glaciofluvial deposits flank several of the major rivers, and indicate that subglacial streams flowed parallel to the modern topography. Marine deposits initially developed following deglaciation, when sea level stood at ± 20 m asl. Modern marine deposits fringe the coastline. Lesser amounts of fluvial, colluvial and lacustrine sediments are also present.

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Note: Geological Survey file numbers are included in square brackets.