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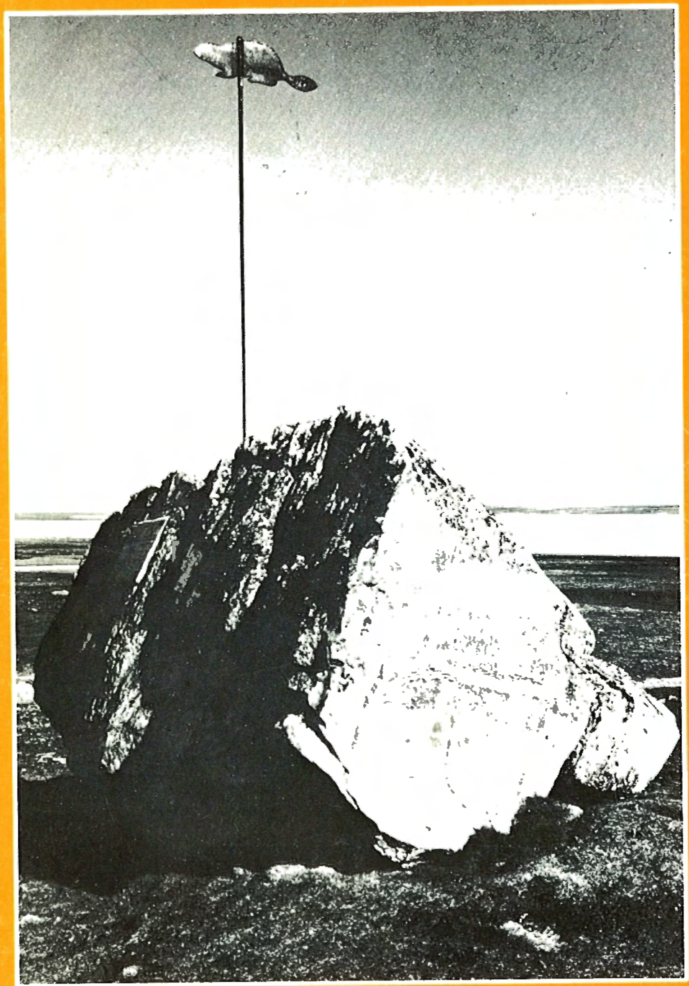

# QUATERNARY GEOLOGY OF CENTRAL MELVILLE ISLAND, NORTHWEST TERRITORIES

D.A. HODGSON
J.-S. VINCENT
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Canadian Government Publishing Centre
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Hull, Québec, Canada K1A 0S9

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Geological Survey of Canada
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Ottawa, Canada K1A 0E8

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| | |
|---|---|
| Cat. No. M44-83/16E | Canada: $6.00 |
| ISBN 0-660-11598-0 | Other countries: $7.20 |

Price subject to change without notice

**Cover illustration**

*Parry's Rock, Winter Harbour, Melville Island*

*This 4 m-high Hecla Bay Formation sandstone erratic is surrounded by raised beach deposits overlying Winter Harbour Till. The rock was probably deposited at the same time as the till by grounded ice at the northern margin of an ice shelf covering Viscount Melville Sound ca. 10 000 years ago.*

*Lieutenant W.E. Parry led the first recorded voyage through the heart of the Arctic Islands. His expedition wintered in 1819-20 offshore from the rock and left the first of several inscriptions (right face). A later inscription notes M'Clintock's arrival in 1852 (upper left of right face). The site also became an important 'mail-box' for explorers' records. The weather vane was added during the 1908-09 wintering of the Canadian Government Ship* ***Arctic****. The commander, Captain J.E. Bernier, unveiled a plaque (left face) commemorating the taking possession of the whole of the Arctic Archipelago for the Dominion of Canada on 1 July 1909.*

**Critical Reader**

*J.T. England*

Original manuscript received: 1981 - 11 - 13
Final version approved for publication: 1983 - 02 - 9

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# QUATERNARY GEOLOGY OF
# CENTRAL MELVILLE ISLAND, NORTHWEST TERRITORIES


### *Abstract*

*Moderately to completely weathered Devonian clastic rocks cover much of central Melville Island, including Dundas Peninsula. The principal Quaternary deposits are till and ice contact gravels, which occur in central and southeastern Dundas Peninsula. Deltaic and marine nearshore and beach sediments are scattered along lowland coasts.*

*Continental ice sheets, dispersing from the south, reached their maximum limits on central Melville Island during at least three episodes; only the age of the last advance has been determined. The oldest and most extensive glaciation recognized covered at least southern Dundas Peninsula up to 300 m a.s.l. and deposited Dundas Till plus a major belt of ice contact deposits. During a subsequent glaciation, ice from Parry Channel overlapped the south-central coast of Dundas Peninsula up to 100 m a.s.l. and deposited Bolduc Till. This deposition may have occurred at the same time that ice entered Liddon Gulf from the south, depositing Liddon Till to 100 m a.s.l. on the outer gulf coast.*

*At 11 700 ± 100 BP, all coasts were rising after crustal depression by ice assumed to have occupied Parry Channel and possibly covered the central Queen Elizabeth Islands. Maximum emergence on the south coast is at least 90 m; on all coasts farther north a prominent (and highest) water plane is recorded at about 55 m a.s.l. Subsequent to this initial emergence, ice from Parry Channel readvanced over, and retreated from, the south coast of Dundas Peninsula probably between 10 340 ± 150 and 9670 ± 150 BP, depositing Winter Harbour Till up to 120 m a.s.l. Because shoreline emergence was not significantly interrupted by this readvance, it is concluded that offshore this ice sheet was probably floating. Local ice caps existed at undetermined times on the uplands of Melville Island, north of Dundas Peninsula.*

### *Résumé*

*Des roches dévoniennes, modérément à complètement altérées, recouvrent de grandes étendues de la péninsule de Dundas et de la partie centrale de l'île Melville. Les principaux dépôts quaternaires sont du till et des graviers de contact glaciaire que l'on trouve au centre et au sud-est de la péninsule de Dundas. Des sédiments deltaïques, ainsi que des sédiments marins littoraux et prélittoraux, sont également parsemés à basse altitude le long des régions côtières.*

*Au moins à trois reprises, des glaciers continentaux, venant du sud, ont atteint leur limite d'extension maximale dans la partie centrale de l'île Melville. Seul l'âge de la dernière avancée est connue. La plus ancienne glaciation a recouvert la plus grande étendue. Le secteur méridional de la péninsule de Dundas a été submergé par les glaces jusqu'à 300 m et le Till de Dundas et une importante accumulation de dépôts de contact glaciaire ont été mis en place. Par la suite, un glacier, provenant du détroit de Parry, a empiété sur la région côtière du centre-sud laissant le till de Bolduc. Ce même glacier, venant du sud, a sans doute pénétré dans la partie occidentale du golfe de Liddon empiétant sur la région côtière jusqu'à 100 m et mettant en place le Till de Liddon.*

*Il y a 11 700 ± 100 ans BP, toutes les régions côtières, déprimées par les glaciers occupant le détroit de Parry et peut-être les îles du centre de l'archipel Reine Elizabeth, étaient en voie d'émerger. L'emersion maximale de la côte sud est d'environ 90 m alors que le long des côtes septentrionales un plan d'eau bien marqué est partout présent vers 55 m. Un glacier émanant du détroit de Parry a empiété sur la côte méridionale de la péninsule de Dundas après 10 340 ± 150 BP, mettant en place le Till de Winter Harbour jusqu'à 120 m d'altitude. Ce même glacier s'est définitivement retiré de la région côtière avant 9670 ± 150 BP. Etant donné que l'émersion n'a pas été interrompue de façon significative au cours de cet épisode glaciaire, il est probable que la glace flottait sur le bras de mer. Des glaciers locaux ont vraisemblablement existé, à un moment non déterminé, sur les hautes terres au nord de la péninsule de Dundas.*


## INTRODUCTION

### *Purpose*

This report completes a project designed to study the Quaternary geology of central Melville Island including Dundas Peninsula (Fig. 1). It contains descriptions of surficial materials together with an outline of the Quaternary history with particular emphasis on late Quaternary glacial and marine events. Dundas Peninsula is of particular interest since continental ice sheets reached their maximum limits in this area on several occasions. A particularly important reason for examining south-central Melville Island is the projected routing (at the time of writing) of one or more natural gas transportation systems through it. Nonetheless, this study is not designed to provide geotechnical information for any one project, but rather to provide information relevant to engineering, land management, or environmental impact studies, as well as regional Quaternary studies.

### *Previous Quaternary studies*

Little work has been reported on the Quaternary deposits in the map area, although speculative comments on the age and extent of past glacial events are scattered throughout the literature (e.g., Craig and Fyles, 1960). The earliest field description of Quaternary deposits is by McMillan (1910); however, Henoch (1964) conducted the first systematic study, including measurements on, and radiometric dating of, raised marine shorelines. The most extensive discussion of the Quaternary to date is incorporated in Tozer and Thorsteinsson's (1964) description of the geology of the western Queen Elizabeth Islands; they also outline the history of exploration of the area. Fyles (1967) provides a preliminary account of late Quaternary landforms on the south coast of Dundas Peninsula, in which the Winter Harbour moraine is described and named. Much of the above information, plus other unpublished data, is summarized on the Glacial Map of

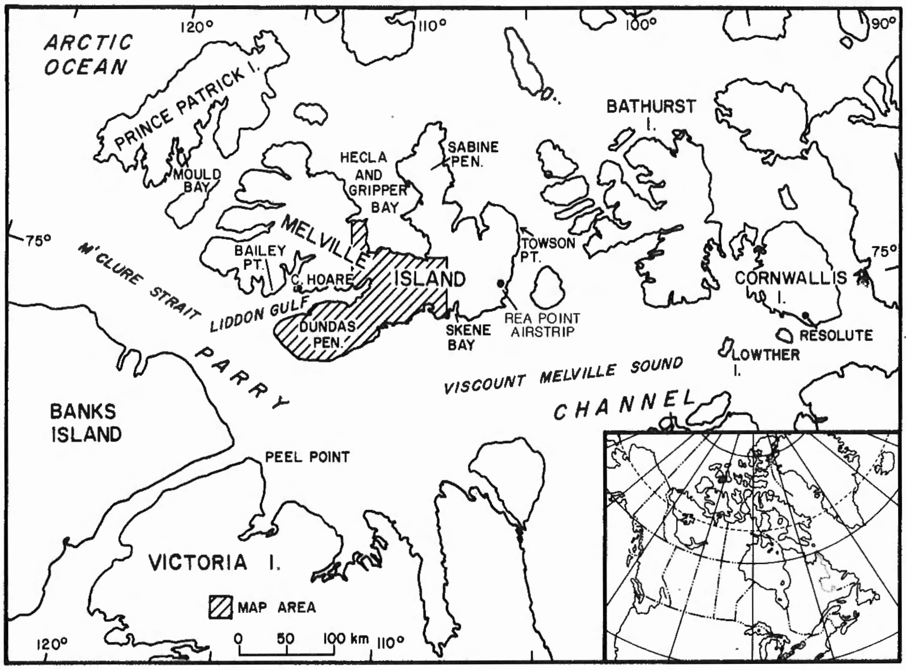



*Figure 1*

*Location map showing study area (shaded).*

Canada (Prest et al., 1967). Hamelin and Jacobsen (1964) described some modern geomorphological processes in the Winter Harbour area. Finally, a geotechnical evaluation, summarized in Stangl et al. (1982), of a proposed pipeline route on the eastern margin of the map area provides much detail on soil properties, ground temperatures and ice conditions, and active geomorphological processes. Although their study concentrates on a narrow corridor, many of these results and conclusions apply to a much wider area.

No Quaternary studies are complete for Melville Island west of the map area, whereas materials to the east and northeast have been described by Barnett et al. (1975, 1977) in an integrated, multidisciplinary mapping scheme (landforms, vegetation, wildlife). Geomorphological work by Barnett and coastal studies by McLaren were combined (McLaren and Barnett, 1978) in a discussion of late Quaternary geological events of eastern Melville Island, with emphasis on Holocene sea level changes.

### *Procedure*

The pattern of fieldwork is summarized in Figure 2. In the summer of 1964, Fyles made a number of observations within the map area during the course of a reconnaissance survey of Quaternary deposits of the western Queen Elizabeth Islands; transport was by Piper Super-Cub aircraft. Fyles returned to southern Melville Island in late July and early August of 1966, when, using two tracked vehicles for transport and accommodation, he investigated the Winter Harbour moraine belt and marine deposits predating and postdating the till between Winter Harbour and Cape Providence.

Ground control for a surficial geology map was obtained in July and August 1980 by Hodgson and Vincent, while Edlund (1982, in press) studied vegetation. Mapping was completed from 1:60 000 panchromatic airphotos. Transport to each of five camps was provided by Twin-Otter aircraft. From these camps, transport within a radius of 20 km was by Honda all-terrain cycles (tricycles), while a Bell 206B helicopter provided five days of traversing over the study area. Good sections through Quaternary deposits are disappointingly scarce, even in thick late Quaternary glacial, marine, and fluvial deposits on the southeast and northwest margins of Dundas Peninsula.

Most elevations mentioned in the text were measured with a surveying altimeter (Wallis and Tiernan, Type FA-181) using high water as the sea level datum. Some heights in the vicinity of Winter Harbour were measured by levelling in 1966.


### *Acknowledgments*

G.M. Haselton and J.G. Korostil were geological assistants to Fyles during the 1966 field season. We received invaluable logistical support from John Jamieson (pilot, Bradley Air Services, 1964) and Polar Continental Shelf Project, which supplied Nodwell tracked vehicles in 1966 and all aircraft support in 1980. Dr. J. England suggested numerous improvements in the course of critically reading the manuscript, while on sabbatical leave with the Division from the University of Alberta.


## PHYSICAL CONTROLS ON SURFICIAL MATERIALS

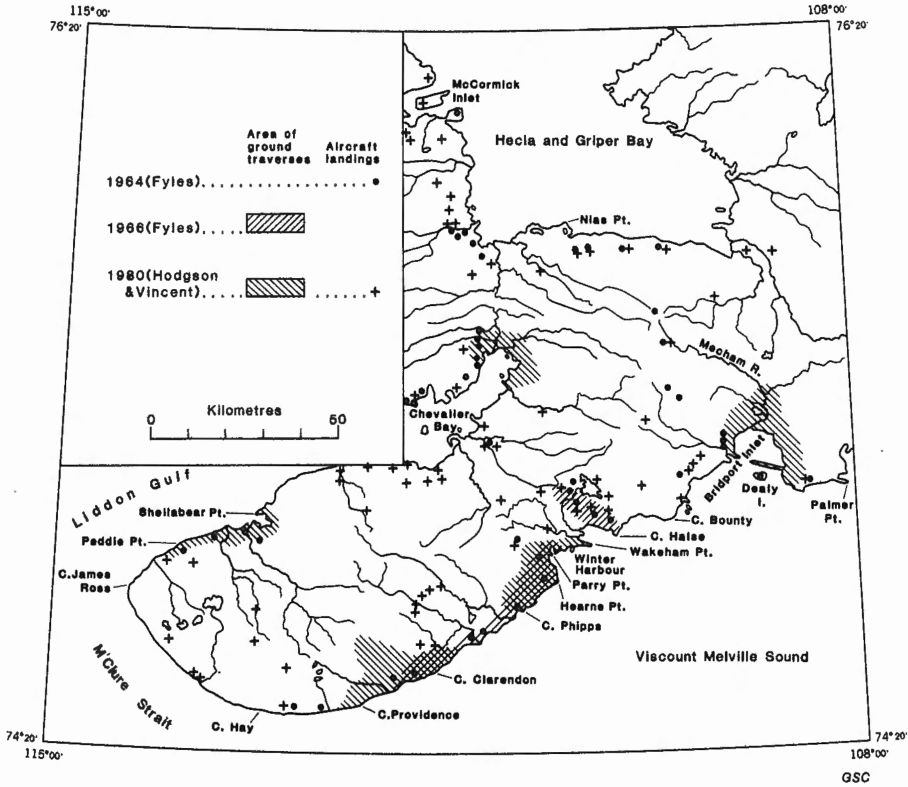
### *Pre-Quaternary Geology*

A grasp of the bedrock lithology of Melville Island is essential, as weathered rock (in situ or colluviated) is the surficial material over most of the map area. The geological framework of the area was first outlined by Tozer and Thorsteinsson (1964), while a more detailed discussion of Devonian units was given by Embry and Klovan (1976).

The surface rock in the map area (Fig. 3) is part of a Middle-Upper Devonian clastic wedge deposited in the Franklinian Geosyncline. Depositional environments included marine continental slopes (Cape de Bray Formation), deltaic marine shelves (Weatherall Formation), braided streams (Hecla Bay Formation), and meandering streams (Griper Bay Formation) – hence the large range of grain sizes and sorting present in the weathered surface materials. The dominant lithologies are well to poorly lithified quartz sandstones, siltstones, or silty shales. Subsequent deformation produced

***Figure 2***

*Central Melville Island: pattern of fieldwork.*



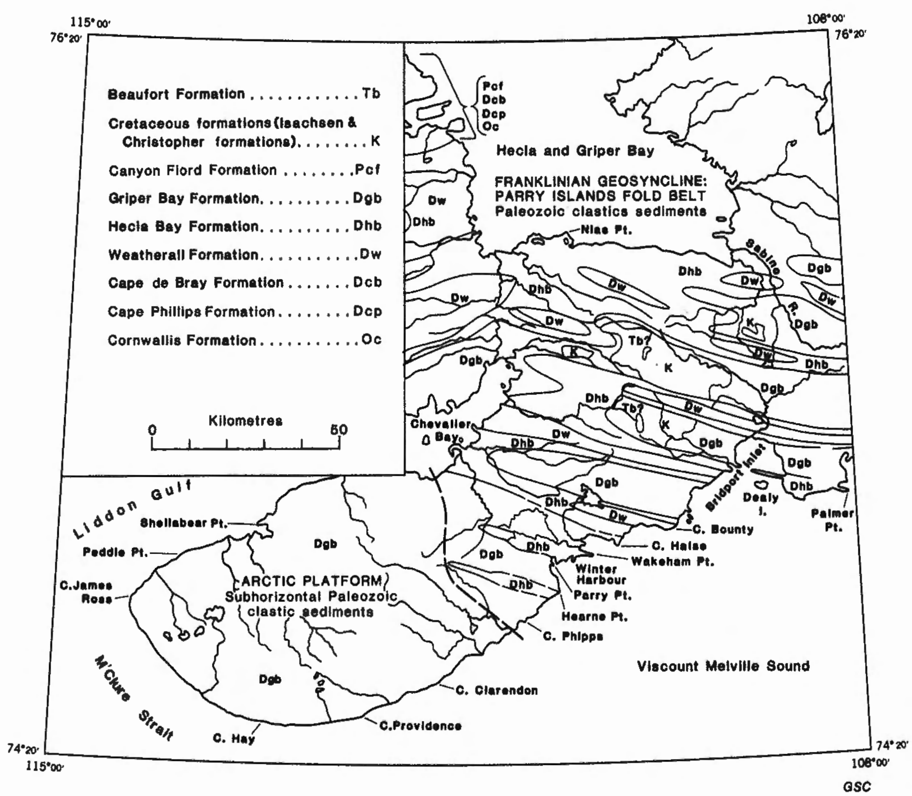




***Figure 3***

*Geological provinces and formations (after Tozer and Thorsteinsson, 1964), central Melville Island.*

WNW-ESE trending folds (the Parry Islands Fold Belt of the Franklinian Geosyncline) over most of the map area except for southwest Dundas Peninsula where strata remain subhorizontal (the Arctic Platform).

These Paleozoic rocks were eroded to a subhorizontal surface and covered by soft sandstone and shale of Cretaceous age which remains in isolated outliers. The pre-Cretaceous peneplains were deformed in the late Cretaceous to mid Tertiary Eurekan Deformation; however Tozer and Thorsteinsson (1964, p. 31) noted widespread remnants of Tertiary or younger peneplains. Rifting along the margin of M'Clure Strait, most likely during the Eurekan Deformation (Kerr, 1980) is probably responsible for the linear trend of the cliffed shorelines of southwest and north Dundas Peninsula. Unconsolidated gravelly sand deposits, which contain rare fragments of wood, commonly overlie Cretaceous rock and are scattered over southern Melville Island; they may represent remnants of the mid to late Tertiary Beaufort Formation (Fyles, 1965).

The Mesozoic and Cenozoic rocks, which can contain crystalline and carbonate clasts of more southerly provenance, probably once covered much of the map area; it is thus difficult to distinguish thin patches of residual weathered rock from glacial deposits.

## Physiography

Two criteria can be used to describe the gross physiography of southern Melville Island. First, the 100 m contour outlines three upland areas and a major north-south lowland (Fig. 4). Second, the attitude of Paleozoic rocks can be subdivided into (1) subhorizontal rocks of the Arctic Platform and (2) deformed rocks of the Parry Islands Fold Belt, including both tightly folded and slightly folded rocks.

Lithology has not been a factor in shaping the gross physiography, despite significant differences in competency of Paleozoic rocks. The bevelled surfaces (of Mesozoic and Cenozoic age), now at both high and low elevations, still dominate the landscape. Differential erosion probably dates only from the time of stripping of Tertiary sediments.

*Dundas Peninsula Upland.* This dissected plateau locally exceeds 300 m a.s.l. (even at coastal margins) and is bounded by rift scarps along the coasts, whereas to the east elevations decline. Notwithstanding the flat strata, scarpland is present and a variety of lithologies is exposed owing to fluvial dissection.

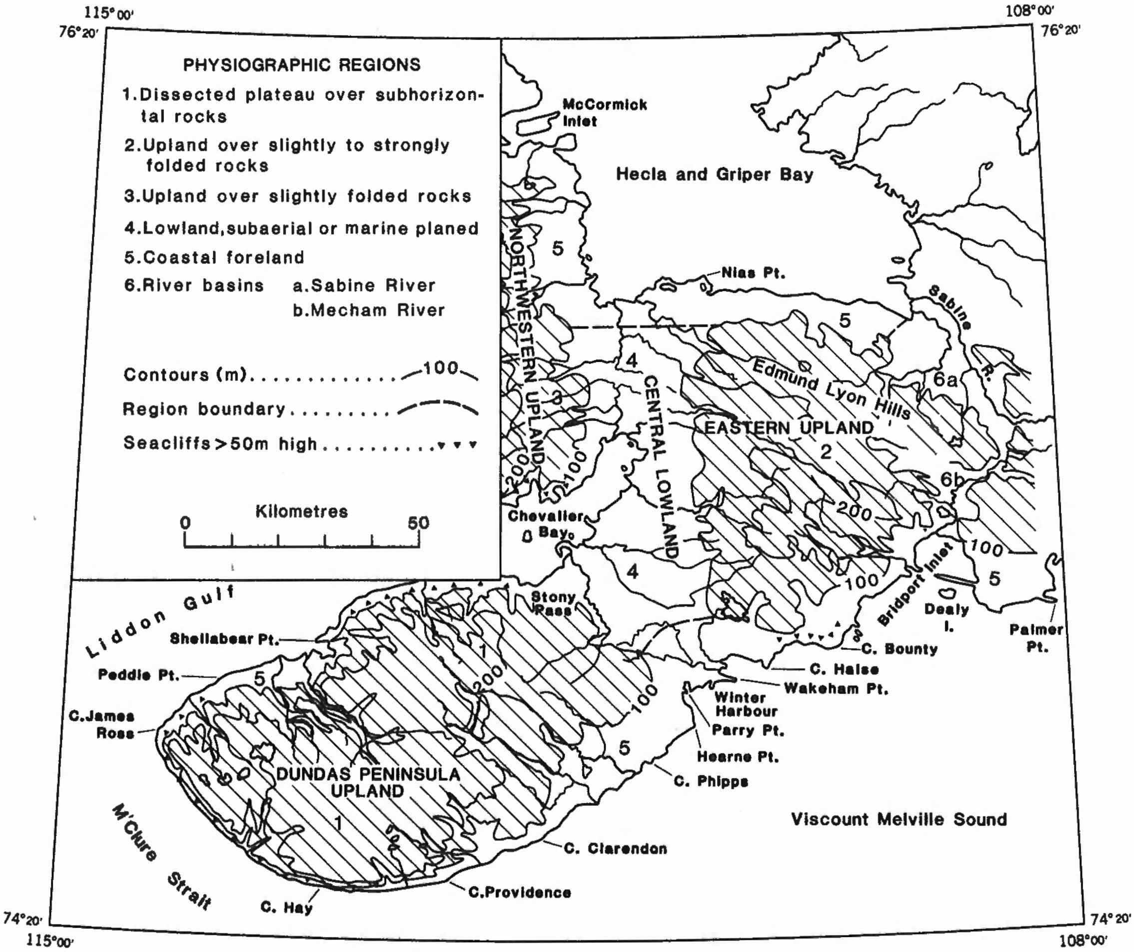



***Figure 4.*** *Topography and physiographic regions, central Melville Island. Uplands above 100 m elevation are shaded.*

*Eastern Upland.* The upland rises to 250 m at the island watershed, and is largely underlain by moderately to tightly folded resistant and recessive Paleozoic strata (Fig. 5). Structure controls the numerous minor and scattered major escarpments (up to 40 km long, 100 m high); however extensive areas of bevelled surface are locally overlain by flat-lying Cretaceous strata. The southern half of this upland is more dissected and rugged than the northern.

*Northwestern Upland.* At the western margin of the map area (Fig. 4), elevations are commonly 250 m and continue to rise westwards. Deformation of underlying Paleozoic strata is less pronounced than under the eastern upland, and most topographic relief results from dissection by rivers rising in the west.

*Central Lowland.* The corridor of low-lying terrain running north-south from southwest Hecla and Griper Bay to Liddon Gulf and Winter Harbour is underlain by subaerial or marine planed rock, though some scarpland and fluvially dissected terrain is present. Planed areas are commonly poorly drained, regardless of rock type.

Two secondary units are the rolling to uniformly inclined forelands adjacent to the coasts of Hecla and Griper Bay and southeast Dundas Peninsula (unit 5, Fig. 4), and the basins of the Sabine and Mecham river systems (unit 6, Fig. 4).

### Climate

The only climatic data from Melville Island is a seven year record (Maxwell, 1980) from Rae Point, on the east coast of Melville Island, 150 km northeast of Winter Harbour. The mean annual temperature for Rae Point is -17.9°C, whereas the mean temperature for the warmest month, July, is 3.9°C; these values are similar to long term data from Resolute and Mould Bay, which lie at similar latitudes (Fig. 1).

Annual precipitation decreases westwards between Resolute and Mould Bay, and the data from Rea Point fit this trend; all three stations experience a midsummer rainfall peak and an early autumn snowfall peak due to greater open water at these times of year. The highest 24 hour rainfall recorded at any of the three stations is 50 mm (i.e., half of the mean annual total).

All High Arctic weather stations are close to sea level, and temperatures at higher elevations are significantly cooler; for example, the 1964-72 July atmospheric freezing level for Resolute and Mould Bay lies 1150 m a.s.l. (Bradley, 1973). The actual glaciation level is 600 to 700 m in the highland of western Melville Island, where a number of small ice caps exist. Perennial snowbanks occur in some deeply incised valleys in the plateau of western Dundas Peninsula. Permafrost is continuous under all land areas, attaining 535 m thickness at Winter Harbour, and 522 m under west central Dundas Peninsula (Taylor and Judge, 1974, p. 12). Active layer depths rarely exceed 1 m and are commonly less than 60 cm.

### Vegetation

Vegetation, including the relationship between plant communities and surficial material, is described by Edlund (1982, in press). In summary, plant communities in the map area consist of associations typical of the Canadian High Arctic: sedge and grass meadows, dwarf shrub (**Dryas** and **Salix**), and purple saxifrage tundra and barrens occur on glacial deposits, whereas sedge and grass meadows, dwarf willow tundra, **Luzula** steppe, and herb barrens occur on materials derived from the local noncalcareous bedrock. The most diverse vegetation occurs along the southern coast of Dundas Peninsula and at the mouth of Liddon Gulf. Diversity and per cent cover of these communities diminish with elevation and to some extent latitude. Continuous cover is restricted to lower elevations particularly to lower slopes and valley bottoms.

## SURFACE MATERIALS

### Pre-Quaternary

Rock, mainly disintegrated by mechanical weathering processes, is the dominant surficial material in the map area. Sandstone and siltstone are widespread, whereas shale is relatively restricted in outcrop. The most common weathering product is quartzose fine sand and silt, whereas coarse sand, gravel and rubble (i.e. angular fragments), and clay are subordinate.

Rock units are described first in stratigraphic order, including their unweathered and weathered character, and then are grouped by dominant size of weathered clasts. Both systems are shown on Map 1583A. The bedrock geology is taken chiefly from Tozer and Thorsteinsson (1964) and Embry and Klovan (1976).

*Cornwallis Group (Oc)**

This minor unit in the map area, exposed only at McCormick Inlet, is composed of resistant carbonate and recessive shale beds which weather to numerous minor scarps covered by rubble, silt, and some clay.

*Cape Phillips Formation (Dcp)*

The siliceous shale (much chert) and minor thin limestone beds are exposed only on the south side of McCormick Inlet and have been washed during the late Quaternary marine transgression. The unit is recessive and low in relief; weathered material is fine grained, and drainage is commonly poor.

*Cape de Bray Formation (Dcb)*

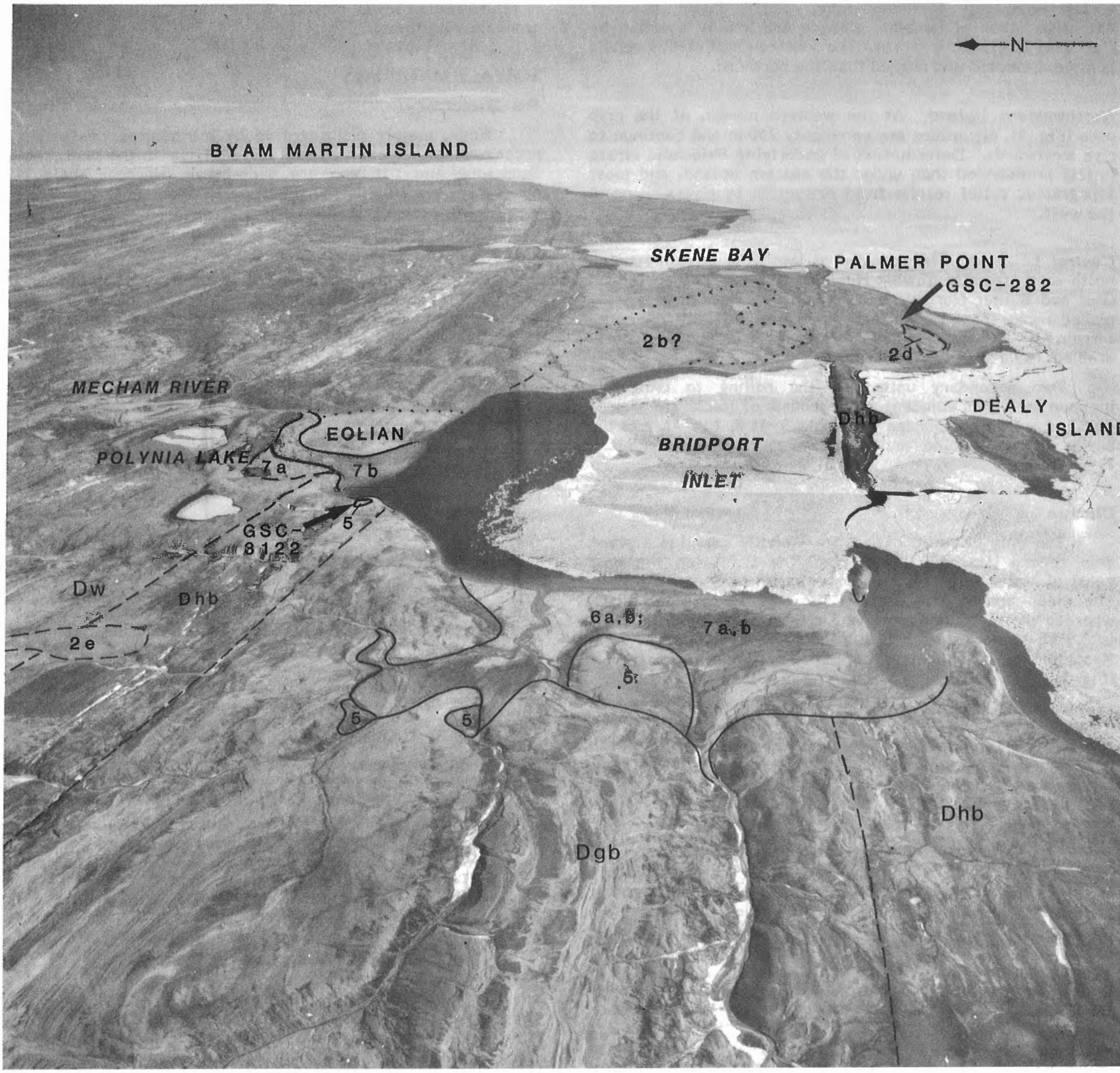
The noncalcareous micaceous shale with minor interbedded siltstone and sandstone only outcrops immediately south of McCormick Inlet. The unit largely weathers to silt or clayey silt having subdued topography. The northern part has been marine washed and is discontinuously overlain by marine, deltaic, and fluvial deposits.

*Weatherall Formation (Dw)*

This formation outcrops widely north of the Arctic Platform on axes of anticlinal folds. The repetitive cycles of fine grained (dominantly quartz) sandstone, siltstone, and shale make a clear close-striped pattern where they intersect a low relief surface. Unweathered to moderately weathered outcrop is rare. Weathered material is commonly fine sand and silt, and minor clay or gravel. A scattered veneer of granule- to cobble-sized clasts, chiefly sandstone, siltstone, or chert, but including some carbonate and crystalline rocks, is present on the northwest upland.

Terrain is level to rolling, and moderately well to poorly drained, on the central lowland north of Liddon Gulf and on parts of the eastern upland east of the gulf. Elsewhere, fluvial dissection provides moderate relief. This formation is generally less resistant to weathering than the adjacent Hecla Bay Formation. Mass movement is active on moderate or steep slopes, chiefly as solifluction but including some detachment slides and bimodal flows.

*Unit on Map 1583A




| | | | |
|---|---|---|---|
| *Dw:* | *Weatherall Formation* | *5:* | *late Pleistocene deltaic deposits* |
| *Dhb:* | *Hecla Bay Formation* | *6a,b:* | *Holocene marine deposits* |
| *Dgb:* | *Griper Bay Formation* | *7a,b:* | *fluvial deposits* |
| *2b:* | *Bolduc Till* | *GSC-282 shells:* | *9670 ± 150 BP, 37 m* |
| *2d:* | *Winter Harbour Till* | *GSC-3122 shells:* | *10 200 ± 100 BP, 45 m* |
| *2e:* | *undifferentiated drift* | | |

——— - - - - - ·····  *Geological boundary (defined, approximate, assumed/transitional)*

***Figure 5.*** *Bridport Inlet, Melville Island. View east, showing weathered outcrop of folded Devonian bedrock, late Pleistocene deltas at 46-51 m a.s.l., eolian-veneered bedrock, and till units. NAPL T417R-128.*

The Viscount Melville Sound coastline is generally backed by cliffs, though at the slope foot a modern gravel and sand beach berm is common, and in places raised beaches occur. Inshore slopes are low on Hecla and Griper Bay, and nearshore waters are shallow. The modern shore character varies according to available material and exposure, and includes low sand beach berms, featureless fine grained paralic sediments, and sand or silt active deltas.

*Hecla Bay Formation (Dhb)*

Hecla Bay Formation is the most resistant unit in the map area and is exposed on the flanks of folds and as gently inclined strata northwest of Liddon Gulf. It is composed of fine grained quartzose sandstone and minor siltstone and shale. Most of the unit weathers to one of three surface forms: fields of sandstone rubble, boulders to 1 m diameter; mixed rubble and sand with some fines, which produces a striped pattern similar to that on Weatherall Formation; and complete mechanical disintegration to sand. Embry and Klovan (1976, p. 540) suggested that kaolinite content controls the degree of weathering – that 10% or more kaolinite is present in rubble, and less than 2% in unconsolidated sand. An unconsolidated sand facies is dominant in the northeast, whereas a rubble-forming facies dominates in the south and west. The latter dominance is partially a result of the steeper inclination of beds and narrower outcrop width in the south permitting rubble to overrun and mask weaker adjacent beds.

Hecla Bay Formation has developed some rugged relief, however in the northeast and lowland areas Mesozoic and Cenozoic planations (and possibly protection by younger sediments) have commonly maintained it at a level similar to the adjacent Weatherall and Griper Bay formations. In southern parts of the map area, strike-aligned, rubble-covered scarps have developed, and the formation also forms the spine of promontories including Wakeham Point (north of Winter Harbour) and the peninsulas protecting Bridport Inlet (Fig. 5). Drainage is good, except on planed lowland where lakes and ponds are common.

Modern and raised marine shorelines on Viscount Melville Sound are composed of gravel, or gravel and sand berms, but rubble can be exposed above highwater and in the intertidal zone, particularly where the backshore is steep. On Hecla and Griper Bay, the shoreline is commonly a low sand berm, though topographic highs in the lowland zone south of the bay are covered with rubble partially reworked into flights of berms.

*Griper Bay Formation (Dgb)*

This formation outcrops over most of Dundas Peninsula and a substantial area in the centre and east of the map area. Embry and Klovan (1976) raised this unit to subgroup status and divided it into the older Beverley Inlet Formation and the younger Parry Islands Formation; the latter was itself divided into three members. Although some of Embry and Klovan's units form recognizable terrain units on the eastern margin of the map area, we were unable to extend these boundaries throughout the map area and therefore retain Tozer and Thorsteinsson's (1964) definition of the Griper Bay Formation.

The formation is exposed over the whole of the Arctic Platform in western Dundas Peninsula, and in the axes of synclines in the southern part of the Parry Islands Fold Belt. It is composed of alternating shale, siltstone, and sandstone units and although recessive shale and siltstone dominate in section, the subhorizontal bedding of western Dundas Peninsula permits the more resistant sandstone to develop into a capping, covering more than half of this area. Unweathered outcrops are rare; sandstone disintegrates into rubble, sand, and silt, the finer units to shale and siltstone fragments and sandy clayey silt. However, where beds are inclined, resulting in a closely spaced striped pattern (Fig. 5) similar to that on the Weatherall Formation and parts of the Hecla Bay Formation, division into simple coarse or fine grained units is not possible at the scale of mapping, and a third, mixed, category is needed.

Topography varies more than might be expected in a relatively uniform succession of beds. A major influence is the faulted margin of western Dundas Peninsula, where cliffs are commonly 200 to 300 m high. The interior plateau is dissected by rivers which breach both resistant capping beds and coastal cliffs. In the southern fold belt, however, the Griper Bay Formation is generally the most recessive and dissected unit.

Much of the coastline is cliffed, and the modern shoreline is either slope-foot rubble or a sand and gravel berm. Coastal slopes are low and nearshore waters shallow in the fold belt, and low sand berms alternate with featureless fine grained marine sediments.

*Canyon Fiord Formation (Pcf)*

This is a minor unit, present only on islands in McCormick Inlet. Poorly consolidated sandstone, limestone, and conglomerate beds weather to rubble over resistant ledges with intervening recessive areas of sand or silt.

*Christopher and Isachsen Formations (K)*

Although of radically different lithologies, these two formations were not mapped separately by Tozer and Thorsteinsson (1964), and we are unable to identify their different weathering products on airphotos. Cretaceous strata discontinuously overlie high-level planed surfaces on the main watersheds in eastern parts of the map area and possibly are present farther west. The total thickness of the formations is rarely more than a few tens of metres; however, because beds are subhorizontal, outcrops can be up to 40 km wide.

The basal bed is the Isachsen Formation, composed of poorly consolidated quartzose sandstone and siltstone interbedded with thin coal and conglomerate beds. It weathers to sand and silt with a discontinuous gravel lag and supports little vegetation. Terrain is flat to gently inclined and only the main branches of the sparse drainage system are incised.

The Christopher Formation is far less extensive than the Isachsen. It is composed of poorly lithified shale and silty shale interbedded with sandstone, and weathers to shale fragments and fines which may have a high clay content. The active layer commonly is poorly drained throughout the summer.

The questionable Cretaceous unit mapped in western Dundas Peninsula is a low relief, light-toned area on the primary watershed. Surface materials vary from sand to silty clay, with numerous sandstone clasts, though dolomite (some clasts striated) was common at one site. No exposures were found except in a sand and gravel knoll which projects above the surface and possibly is a younger deposit. This unit may be residual material from a former Cretaceous cover, or it could alternatively be a Quaternary glacial deposit.

*Beaufort Formation (Tb)*

Unconsolidated, well rounded gravel and sand containing rare twigs of unaltered to slightly compressed wood – which is typical of Beaufort Formation deposits on the Arctic Coastal Plain – are scattered over the east of the map area. The gravel is granule to boulder size and composed of quartzitic sandstone and chert, plus some crystalline, ultrabasic and carbonate lithologies. At the few sites examined, the gravel is commonly underlain by dark silty clay, similar to weathered Christopher Formation.

### Weathered Bedrock Units

Four lithological units are identified and arbitrarily labelled A to D. The units may include all, or only part, of a lithostratigraphic formation.

*Fine Grained (A)*

Recessive fine grained rock units weather to fine sand, silt, or clay, plus siltstone, shale, or sandstone clasts. Included are the Cape Phillips and Cape de Bray formations, parts of the Griper Bay Formation, and the Christopher Formation.

*Mixed (B)*

This unit includes both resistant and recessive interbedded sandstone, siltstone, and shale, which weathers to rubble (angular to subround gravel-sized fragments), sand, silt, or clay, inseparable at the scale of mapping. Most of the Weatherall and Canyon Fiord formations, much of the Griper Bay Formation in the fold belt, and part of the Hecla Bay Formation are included.

*Sand, Gravelly Sand (C)*

Sand or silty sand, plus lag gravel or rubble, are derived from poorly consolidated sandstone constituting the sandy (northeast) facies of the Hecla Bay Formation, and the Isachsen and Beaufort formations.

*Rubble (D)*

The most resistant of the sandstone and siltstone units break down to rubble in the matrix of sand, silt, or clayey silt, although some unweathered to moderately weathered outcrop remains. Much of the southern and western exposures of the Hecla Bay Formation, and the Griper Bay Formation in western Dundas Peninsula, are included.

### Marine Modified Rock

All coastal areas and much of the central north-south lowland were submerged during one or more late Quaternary marine transgressions. Maximum sea level was at least 55 m above present on the margins of Hecla and Griper Bay and along Liddon Gulf. Events adjacent to Viscount Melville Sound, however, were more complex; emergence from a relative sea level of at least 82 m, and probably greater than 90 m, was interrupted by deposition of the Winter Harbour Till.

Parts of the formerly submerged areas are indistinguishable from weathered rock at much higher elevations – either because no marine reworking or deposition occurred or because marine deposits were later eroded. Nevertheless much of the submerged zone bears a discontinuous veneer of fine to coarse grained littoral and offshore sediments, and small areas of deltaic sediment. Planed areas in the lowland corridor are extensive and particularly poorly drained (numerous ponds survive the summer) and are therefore identified separately on Map 1583A.

### Quaternary Deposits

#### Ice-contact Deposits (1)

A belt 75 km long and up to 10 km wide, containing numerous kame-like hills of sand and gravel, extends between the high (300 m) cliff tops of southern Dundas Peninsula and the uplands south of Liddon Gulf (Fig. 6, 7). Summit elevations decline from 300 m a.s.l. in the south to 250 m in the north. The surface, and possibly the uppermost 1-3 m of this hummocky terrain, is gravel (Fig. 8) similar to Beaufort Formation but containing much soft local sandstone and crystalline, ultrabasic, and carbonate erratics. Surface gravel is commonly poorly graded (skewed towards fines) and it contains unidentified mollusc fragments and striated pebbles. It also lacks the wood fragments typical of the Beaufort Formation. Rare exposures show the bulk of underlying sediment to be massive to stratified, well graded sand or silty sand plus some gravel strata, and to be at least 15 m and possibly 30 m thick locally. An exposure at the coastal cliff top near Cape Hay, at the southern extremity of Dundas Peninsula (Fig. 6), shows this gravel and sand underlain by up to 2 m of till in which striated dolomite pebbles were found. The Table Hills, northwest of Winter Harbour, are also assigned to the ice-contact unit, on the basis of composition, and thus are not described as till, as in Tozer and Thorsteinsson (1964, p. 33).

Although discrete areas of sand and gravel are shown on Map 1583A, much of the granular material is in small gravelly knolls; the intervening gravelly sand or fines are either till, colluvium, or weathered rock. This gravel unit is considered to have been laid down at or near the margin of a disintegrating ice sheet – probably the ice sheet responsible for depositing Dundas Till, which is described below.

#### Morainal Deposits

Four till units are identified on the basis of their areal distribution, morphostratigraphy, and lithology. These are named here, in order of decreasing age, the Dundas, Bolduc, Liddon, and Winter Harbour tills. The relative ages of Dundas, Bolduc, and Winter Harbour tills (but not Liddon Till) are established, together with an absolute age for Winter Harbour Till.

*Dundas Till (2a)*

The black clayey to sandy, and commonly bouldery diamicton (Fig. 9a) covering extensive areas of the interfluves between the belt of previously described ice-contact deposits, and the northern limit of Bolduc and Winter Harbour tills (Fig. 7, 10) is defined here as Dundas Till. Clasts are dominantly sandstone; but granite, ultrabasic, and striated carbonate clasts also occur. The limit of Dundas Till and part of the ice-contact belt are shown on the Glacial Map of Canada (Prest et al., 1967).

*Bolduc Till (2b)*

Bolduc Till is defined here as a sandy to clayey silt containing clasts dominantly of sandstone, siltstone, and chert, but also including numerous ultrabasic, granite, and carbonate granules to boulders (Fig. 9). This till has a patchy distribution on the distal side of the Winter Harbour till limit (Fig. 10). The till is commonly greater than 2 m thick, though the base of the unit was never clearly observed. The till is overlain in places by marine or deltaic sediment of late Pleistocene age or older.

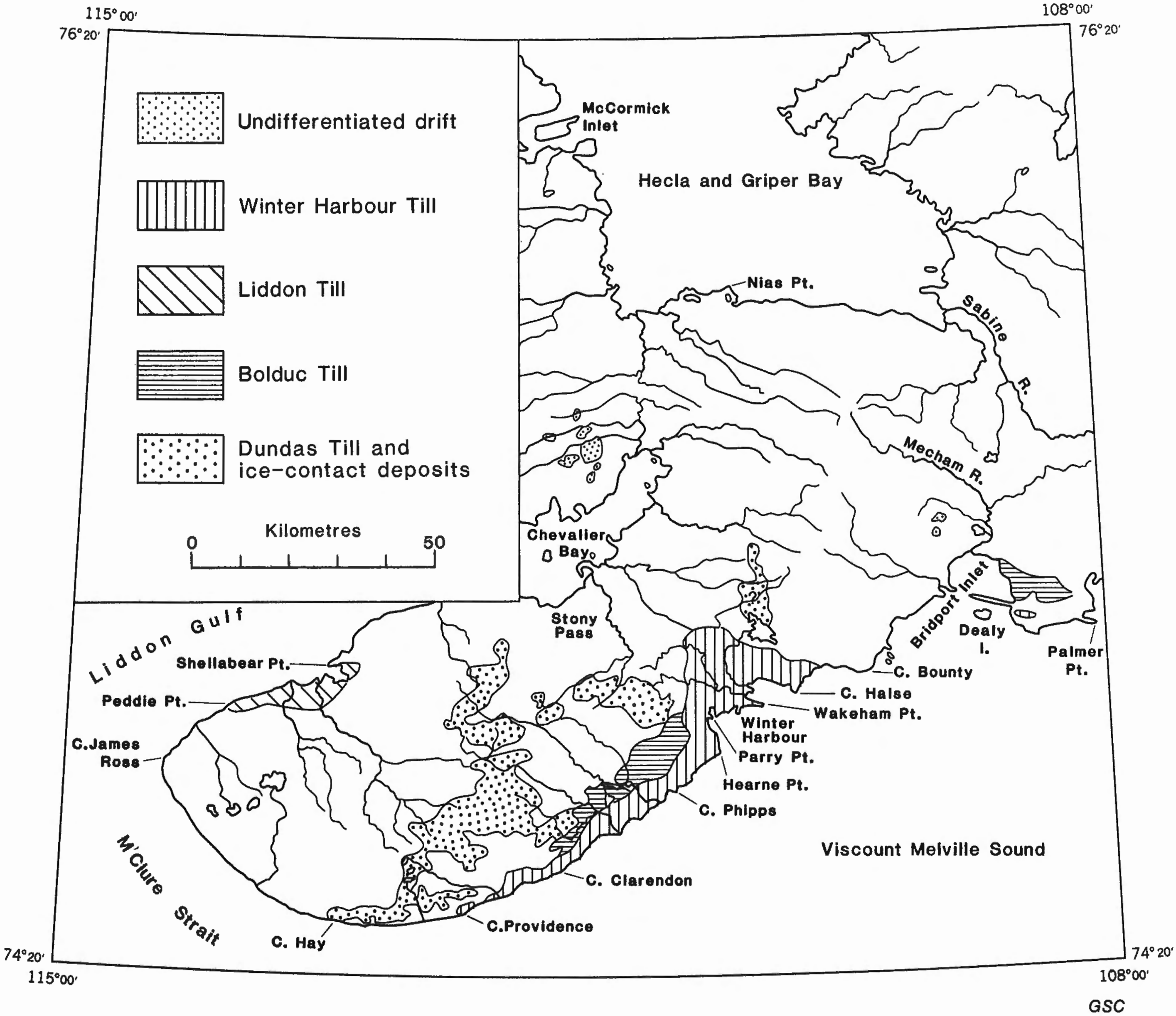
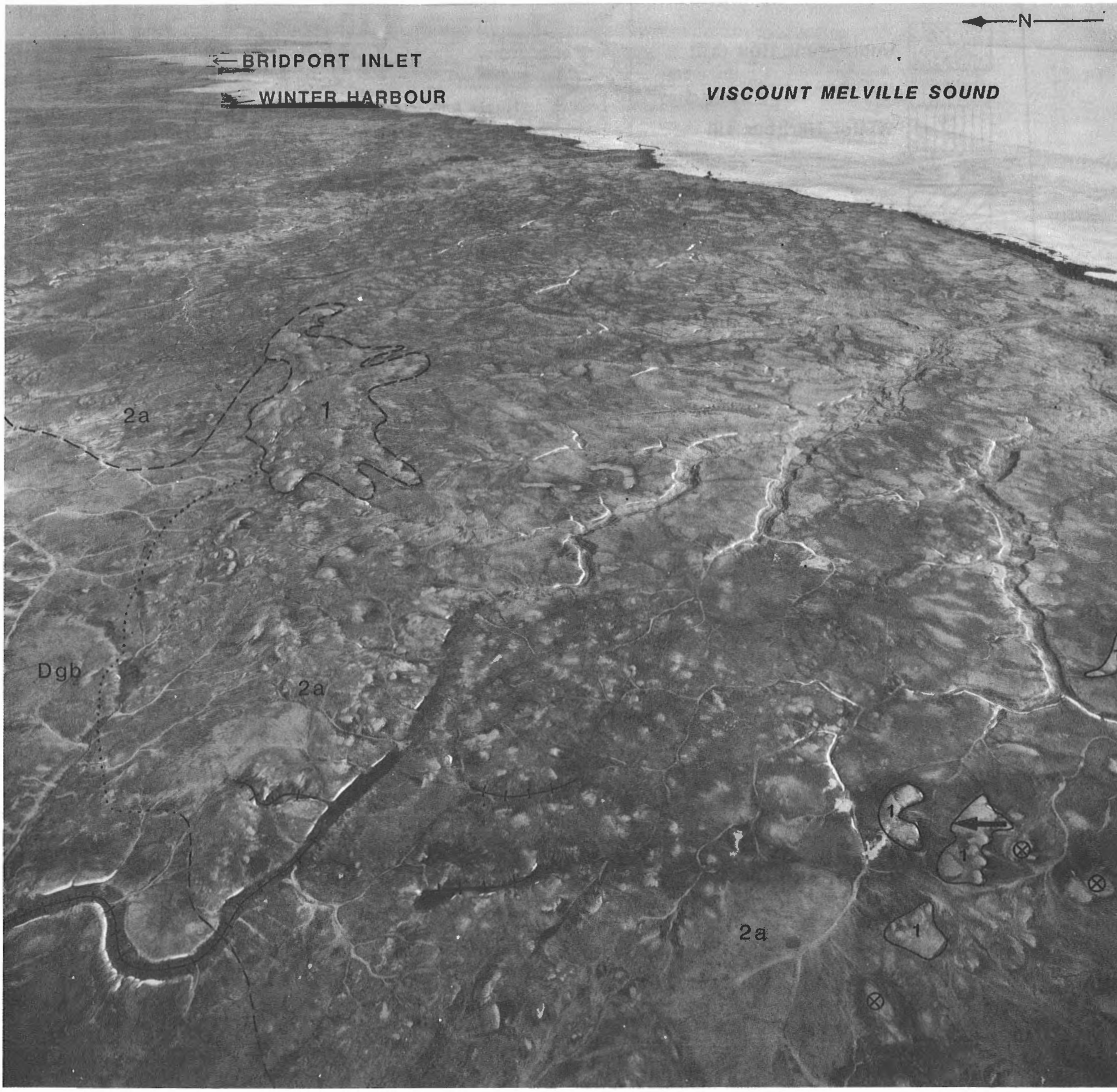



***Figure 6.*** *Quaternary till units, central Melville Island.*

Overlap by marine deposits or incorporation of older marine sediments in the till matrix may explain its prominent light tone on airphotos; Fyles (1967) described this unit as the 'pale till'. Fyles suggested that the subdued relief of the 'pale till' indicated that it was markedly older than the Winter Harbour Till (which is of similar composition); however, it is not otherwise noticeably more weathered. Where Bolduc Till crosscuts Dundas Till there is a recognizable discontinuity in weathering. Bolduc Till has a faint north-northwest grain, does not rise above 100 m a.s.l., and is present in a belt up to 9 km wide from inland of Cape Clarendon to inland of Winter Harbour. Till cover is not continuous, though it is not known whether bedrock inliers result from discontinuous till deposition or from later exposure due to erosion of till.

*Liddon Till (2c)*

Liddon Till is defined here as a silty sand to clayey silt diamicton extending up to 5 km inland from the coast of outer Liddon Gulf, between Shellabear Point and Peddie Point (Fig. 6). Clasts within the till are dominantly sandstone, siltstone, and chert, and local concentrations of ultrabasic, granite, and striated carbonate clasts also occur. These latter exotic rocks are more common near the coast, suggesting ice movement either on shore or parallel to the coast, or possibly deposition from icebergs during a marine inundation. Liddon Till is commonly at least 2 m thick overlying rock, though the lower contact is rarely exposed. Within 1 to 2 km of the coast, the till is directly overlain by late Pleistocene-Holocene marine and deltaic deposits up to 56 m a.s.l.




| | | | |
|---|---|---|---|
| Dgb: | weathered Griper Bay Formation | 2a: | Dundas Till |
| 1: | ice-contact deposits | ⊗: | Gravel Knoll |

————-----•••• *Geological boundary (definite, approximate, assumed/transitional)*

***Figure 7.*** *Central and southeast Dundas Peninsula, Melville Island. View east, showing margin of Dundas Till and associated ice-contact deposits and drainage channels. Arrow indicates view in Figure 18. NAPL T416R-8.*

*Figure 8*

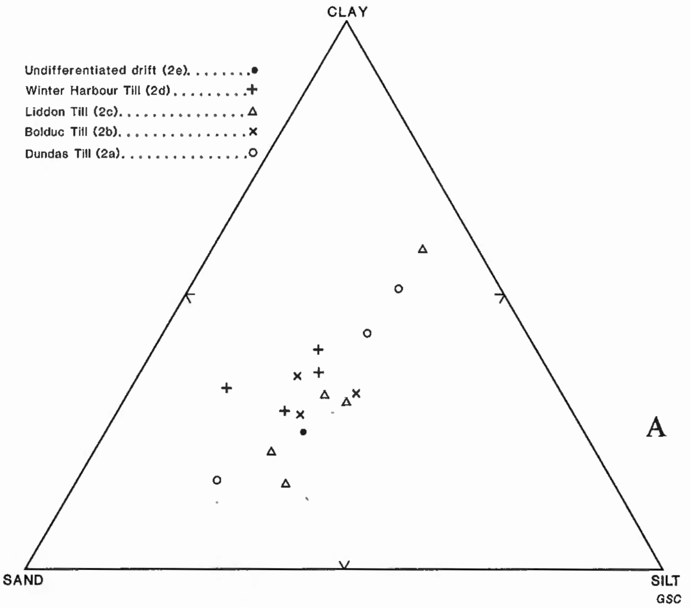
*Ice-contact deposits associated with Dundas Till, central Dundas Peninsula (direction of view is shown in lower right of Figure 7). GSC 203501-C*

Maximum elevation of this till is about 100 m a.s.l.; marginal drainage channels occur to at least 110 m and drain westwards, though the original direction of ice movement is not known. Morphological differences between coastal and inland margins of this till possibly indicate more than one glacial event or perhaps just changes in mode of deposition during glacial recession. The most obvious features are the massive (till-cored?) ridges adjacent to and paralleling the coast, and a hummocky till belt at 60 m a.s.l. Scalloped rock cliffs above the till limit south and east of Shellabear Point (Fig. 4) may be cirques.

*Winter Harbour Till (2d)*

Winter Harbour Till is defined here as carbonate-rich sand, clay, and silt (Fig. 9), containing granule to boulder-sized clasts (Parry's Rock, Winter Harbour, is greater than 4 m square) of dominantly sandstone, siltstone, and chert. Numerous ultrabasic, granitic, and striated carbonate rocks are present. The deposit is continuous for 80 km along the southeast coast of Dundas Peninsula (Fig. 6, 10) from 10 km east of Cape Providence, to 10 km northeast of Cape Halse. This morainic belt was first described by Fyles (1967), who informally referred to it as the Winter Harbour moraine, and suggested that it marked a segment of the northwest margin of the Laurentide Ice Sheet. Its maximum elevation is 120 m a.s.l., and the greatest inland extent is 15 km, north of Winter Harbour, though 5 km is more common. Till is thin, generally only 1-2 m thick, and it lacks surface form except for parts of the inland margin where a single gravelly sand ridge occurs which may be of glaciofluvial or ice push origin (Fig. 11). Underlying deposits are either weathered rock or a varying thickness of late Pleistocene marine or deltaic silty sand or sand, which, in turn, is underlain by silty clay. The seaward margin of the till has been reworked by former Holocene sea levels and is commonly overlain by nearshore and beach sediments.

Patches of till extend 10 km west of the main deposit, at least as far as Cape Providence (Fig. 6), although continuity is broken by rock cliffs. Cliffs also close off the east end of the belt. Farther east, patches of this till, rich in crystalline clasts, occur as far east as Bridport Inlet. Between Bridport Inlet and Skene Bay (Fig. 1), much of the peninsula below 90 m a.s.l. is overlain by thin till with similar composition to Bolduc and Winter Harbour tills (Fig. 5). No major deltaic sediments are associated with Winter Harbour Till.



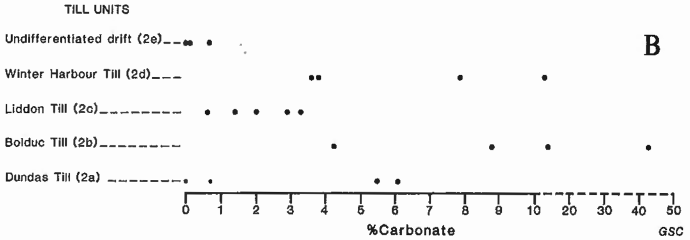
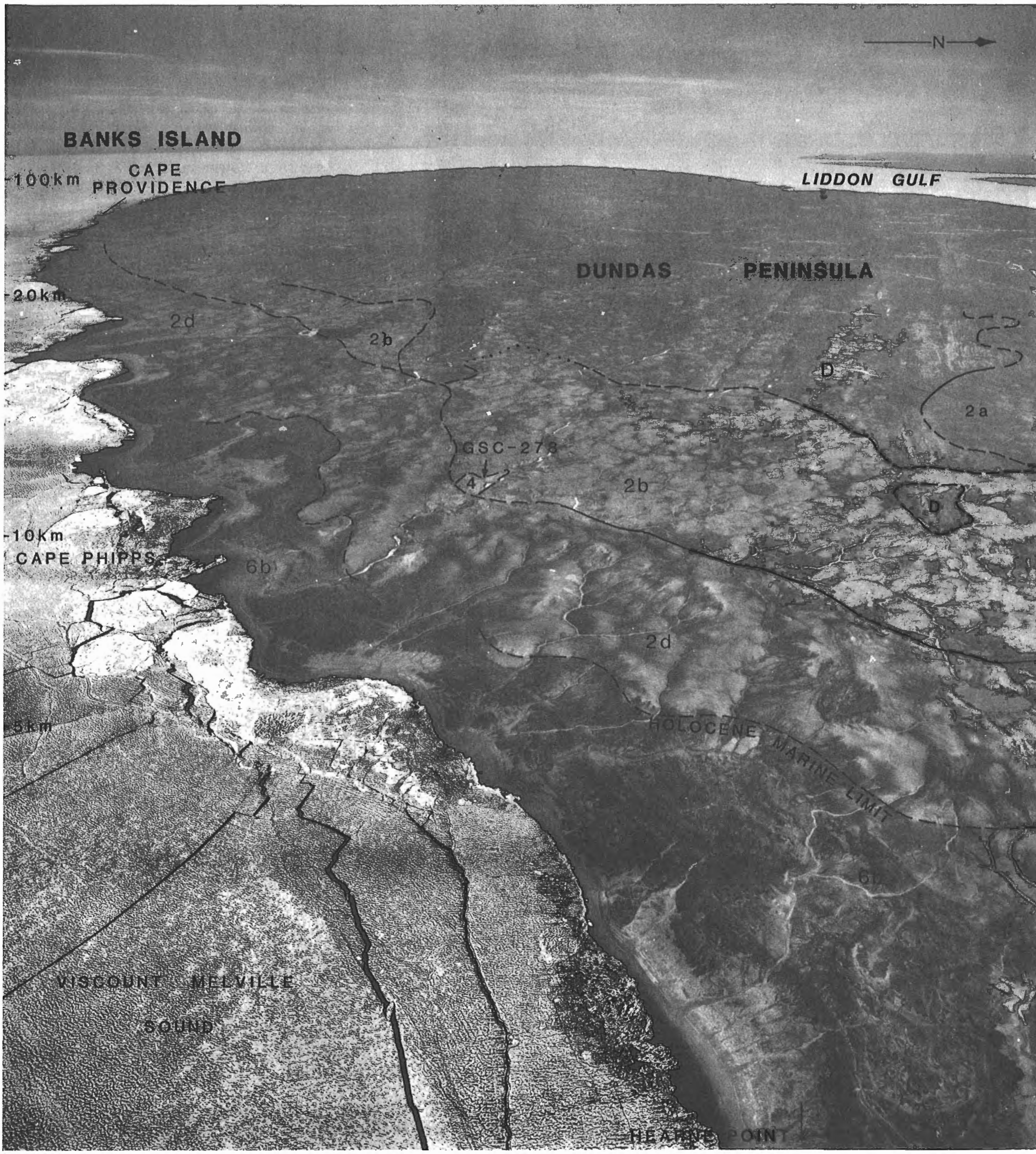




**Figure 9.** *A. Grain size distribution of till. B. Per cent $CaCO_3$ equivalent of till matrix by LECO 1R12 Carbon determinator method.*




*D:* *Devonian rock and weathered rock*
*2a:* *Dundas Till*
*2b:* *Bolduc Till*
*2d:* *Winter Harbour Till*
*4:* *late Pleistocene marine deposits*
*6b:* *Holocene raised beaches*
*GSC-278 shells:* *10 340 ± 150 BP, 55 m.*

——— - - - - - - ···· *Geological boundary (definite, approximate, assumed/transitional)*

***Figure 10.*** *South coast of Dundas Peninsula, Melville Island. View west from Hearne Point (south of Winter Harbour) showing Holocene marine limit, Winter Harbour Till, late Pleistocene marine deposits, and Bolduc Till. NAPL T417R-118.*


*Figure 11*

*Margin of Winter Harbour Till, west of Cape Clarendon, showing the terminal moraine rising to 120 m a.s.l., and a drainage channel on the proximal side. GSC 203501-F*

*Dgb: Griper Bay Formation;*
*2d: Winter Harbour Till*

Winter Harbour Till is moderately well drained on summits and slopes, and there are few closed depressions to impede drainage. Fluvial processes are dominant; however slides and flows are locally significant, with the failures originating in underlying marine deposits. The modern shoreline is a sand or a gravel and sand beach berm, broken by drainage channels and backed by low beach berms or a flat featureless surface.

*Undifferentiated Drift (2e)*

Outlying glacial deposits without unifying compositional or morphological characteristics are grouped together as undifferentiated drift (Fig. 6). For example, scattered glacial deposits are present on the upland north of Liddon Gulf. On Dundas Peninsula west and north of the belt of ice-contact deposits, diamictons could conceivably represent the final remnants of formerly more extensive Mesozoic or Tertiary covers (as described under Cretaceous rocks).

### Glaciofluvial Deposits (3)

A few ice marginal or proglacial terraces at 60-70 m a.s.l. abut Winter Harbour Till north of Winter Harbour. Terraces between the till sheet and a Hecla Bay Formation scarp are composed of subangular to round boulders; the westernmost terrace is sand and sandy silt at least 8 m thick.

### Pleistocene Marine Deposits (4)

Marine deposits and associated deltaic deposits from one or more high sea level stands preceding Holocene regression have yielded radiocarbon ages of 10 340 ± 150 to 11 700 ± 100 years B.P. The dates are discussed later in this report.

On the coast of Viscount Melville Sound, marine sediments 1-25 m thick are present at least to 90 m a.s.l. (Fig. 12). Their composition is generally fine sand or silt, though thick deposits coarsen upwards from basal silty clay to sand or gravelly sand. Locally, shell beds to 1 m thick occur. Much of this unit is overlain by Winter Harbour Till, however, small areas of marine sediment do outcrop beyond the distal side of the till as well, overlying Bolduc Till (Fig. 10, unit 4).

The highest raised marine deposits along the shores of Hecla and Griper Bay and Liddon Gulf are about 55 m a.s.l. and commonly form a discontinuous veneer of fine sand, silt, and gravel. Gravel and rubble beach berms at lower elevations developed over Hecla Bay Formation sandstone and may be either of late Pleistocene or of Holocene age. Similarly, the age of thick (to 20 m) sequences of clayey silt and fine sand underlying Holocene regressive deposits is unknown.

Thick, fine grained marine deposits are extensively gullied, and mass movement features, including flows and slides, are common, especially where an overlying veneer of gravelly Winter Harbour Till is present (Fig. 13).

### Pleistocene Deltaic Deposits (5)

Raised marine deltas at 55-60 m a.s.l., associated with late Pleistocene marine deposits discussed above, occur adjacent to Hecla and Griper Bay and Liddon Gulf. The surface composition of most deltas is gravel or rubble, but deltas northwest of the head of Liddon Gulf and on the west side of Bridport Inlet (Fig. 5, unit 5) contain much sand and silt.

### Holocene Marine Deposits (6a, b)

Raised marine deposits which yield radiocarbon dates of 9670 ± 150 BP and younger are common on the southeast coast of Dundas Peninsula (Fig. 10) up to 20 m a.s.l. near Cape Providence, rising to 35 m at Winter Harbour, and to more than 40 m farther east. Deposits are also present on lowland coasts elsewhere in the map area. Although generally occurring within 1 or 2 km of the modern shore, marine sediments sporadically occur farther inland in large river valleys, where marine penetration was greatest. The sandy silt or sand commonly has a planar surface, and total thickness is rarely more than 1 m, over till or rock. Where level, the surface is poorly drained, and ephemeral ponds are common. Silt, fine sand, or clay deposits in river valleys may be as much as 20 m thick.

Raised beach berms are invariably gravel or rubble, or at least gravel veneered, as sand or finer berms are quickly levelled by eolian, fluvial, or mass wasting processes.

Thus raised beaches are limited to sites over till, or coarser rock units such as the Hecla Bay Formation, below elevations described above. Where berms and swales are present, drainage is impeded, hence ponds commonly develop which favour vegetation growth.

A single low sand, gravelly sand, or gravel berm is present along much of the modern shoreline, particularly where the coast has a low gradient in protected embayments, or where debris has accumulated at the foot of steep cliffs on western Dundas Peninsula. Berms are rarely more than 1 m high and 10 m wide, but this profile may be disturbed in late summer where sea ice overrides a berm. Ice pushed ridges are particularly common on gravel beaches bordering arcuate deltas projecting from the coastline. The surface of intertidal zones is commonly sandy silt with minor clay and scattered boulders.

### Fluvial Deposits

*Terraces (7a)*

Terraces adjacent to floodplains or deltas are generally of mappable size only for large rivers. The coarser material dominates the surface layer of terrace deposits, whereas sand or sandy silt is common below the surface. Terrace deposits lying below the uppermost Quaternary sea levels commonly overlie fine grained (locally peaty) deltaic or marine deposits. However, the extensive and thick terrace-delta complex that occurs adjacent to lower Sabine River differs from this pattern; more than 10 m of interbedded sand and silt was observed here in several sections, with no observable fining with depth.

*Active Channel Zones (7b)*

Fluvial deposits of mappable width (100 m) are present at least at the mouths of most rivers, since modern deltas are included in this subunit. Composition varies from clay to boulders, but is generally sand or gravel irrespective of the dominant material in the drainage basin. Peak water discharge is during and immediately subsequent to snowmelt, though secondary peaks may follow (rare) heavy rain.

### Colluvial Deposits (8)

Colluvium is considered here as material transported or altered by mass wasting processes, especially slopewash, rillwash, and solifluction, to such a degree that it markedly differs in composition or structure from its subjacent source material. Although such deposits occur both on and at the foot of slopes, they are rarely extensive enough to be mapped separately from weathered rock. Colluvial deposits are locally rich in peat strata, which has both been incorporated into the colluvium by mass wasting, and developed in situ.

***Figure 12***

*South coast of Dundas Peninsula, midway between capes Clarendon and Providence, showing gullied late Pleistocene marine and deltaic sediments, composed of massive sand and sandy silt over clay, overlain by Winter Harbour Till reworked by marine processes in the Holocene. The arrow indicates the Holocene marine limit. GSC 180619*

***Figure 13***

*Winter Harbour Till overlying fine grained (light toned) late Pleistocene marine deposits, exposed by gullying and flowslides. Shells from the marine deposits at this location (82 m a.s.l.) are 11 400 ± 130 years old (GSC-3111). This site is 5.5 km north of Cape Clarendon, southern Dundas Peninsula. GSC 203501-D*

## Eolian Deposits

Landforms produced by eolian action are rare in the map area, and only identified by a symbol on Map 1583A; however terrain subject to erosion and deposition as a result of the strong prevailing north and west winds can be identified at a few localities, using airphotos. Diagnostic features are light-toned unvegetated areas tailing-off downwind from sand sources. Such features are common on the south and east margins of large rivers that have extensive unvegetated sandy floodplains (unit 7a, e.g., Mecham and Sabine rivers, Fig. 5) and adjacent to sandy shorelines developed on unvegetated Hecla Bay Formation (unit C/Dhb).

# GRANULAR RESOURCES

Most bedrock units in the map area are interbedded fine to coarse grained sediments, poorly to moderately well lithified or cemented. Rippable bedrock is thus widespread, though commonly covered by a rubble, sand, silt, or clayey silt weathered mantle known to be at least 5 m thick in places. The other relatively common material is till, which is generally bouldery sand, silt and clay. Ice contact deposits related to Dundas Till are gravel veneered gravelly sand. Characteristics of all map units are summarized in Table 1.

# QUATERNARY HISTORY

The distribution of the main surficial units is shown on Map 1583A and is discussed in the first part of this report. A second means of reconstructing the Quaternary history is the stratigraphic relationships of these units – however, since deposits are poorly exposed in section, relative ages were only rarely determined. Opportunities for collecting samples for paleoecological, radiometric or other dating methods are even more limited; Table 2 shows all radiocarbon dates from the area known to the authors. Nevertheless, at least three distinct glacial events and two marine events are recognized. Little information exists on subaerial processes, although they dominated landscape shaping.

Poorly consolidated Cretaceous and Tertiary sediments were largely stripped of Paleozoic rock during the late Tertiary and the Quaternary. The dominant erosional process was presumably fluvial erosion, accelerated by tectonic uplift and consequent lowering of (coastal) base levels. Quaternary subaerial deposits, apart from the products of in situ bedrock weathering, are minor in extent.

### *Older Glaciations and Associated Marine Events*

Dundas Peninsula was partially covered by continental ice on at least three occasions (Fig. 6). The oldest recognized and most extensive glacial event, is represented by the belt of ice-contact deposits and Dundas Till. The next most extensive glacial event (also of unknown age) is represented by Bolduc Till and possibly Liddon Till, which overlap only low coastal areas. Finally, at the end of the Pleistocene, ice impinged on the southeast coast of Dundas Peninsula, depositing Winter Harbour Till. Edmund Lyon Hills and the upland north of Liddon Gulf do not bear evidence of a former continental ice cover; however, ice marginal channels indicate that they were covered by local ice at an undetermined time.

## Deposition of Dundas Till

Continental ice moving north and northwest from Viscount Melville Sound covered extensive areas of Dundas Peninsula up to at least 300 m a.s.l., and deposited Dundas Till (Fig. 6). It is not known if this ice advanced farther northwest than the ice-contact deposits which span the peninsula, or if the belt itself marks the limit of all past ice advances. Whatever the case, Dundas Till and the ice-contact deposits mark the unequivocal maximum limit of continental ice on central Melville Island.

## Deposition of Bolduc Till

Distribution and composition (in particular, the large number of granitic erratics) indicate that Bolduc Till was deposited by a distinct continental ice advance moving onshore from Viscount Melville Sound (Fig. 6, 10). To the east and south, this till is completely overlapped by younger Winter Harbour Till. In the west, the deposit pinches out between the coast and higher ground, as occurs with Winter Harbour Till in the same area.

Two collections of marine pelecypods (**Hiatella arctica**) from the Bolduc Till provide ages beyond the range of radiocarbon dating: >33 000 BP (GSC-727, 79 m a.s.l.) and 42 400 ± 1900 BP (GSC-787, 85 m a.s.l.; both dates based on the inner fraction, Table 2). The collections are of fragmented valves; GSC-787 was taken from a slide scar and likely was contained within the till. Both samples may date a marine event postdating till deposition, for which no other information is presently available, or they may be glacially transported from marine deposits older than Bolduc Till. The absolute minimum age for the till is 11 700 ± 100 BP, provided by a date on in situ **Hiatella arctica** valves collected from a transgressive marine sequence overlying the till at 58 m a.s.l. (GSC-3249, Table 2).

A thin (<1 m) diamicton which lies directly on bedrock in an exposure along Bolduc Creek (west of Winter Harbour) is probably Bolduc Till. The nearest surface outcrop of Bolduc Till is 4 km to the west. The diamicton is dominantly derived from local Griper Formation greenish sandstone but includes numerous exotic lithologies. It is overlain by 20 m of unfossiliferous sand and silt, which is capped by Winter Harbour Till.

## Deposition of Liddon Till

Distribution and composition of Liddon Till on northwestern Dundas Peninsula (Fig. 6) indicates that ice moving from Viscount Melville Sound into M'Clure Strait entered Liddon Gulf and overlapped land up to 100 m a.s.l. Liddon Till is bordered by west-draining ice marginal channels, but this probably indicates the form of the wasting ice, not that ice flowed from the east.

The granitic, ultrabasic, and carbonate-rich composition of Liddon Till resembles Bolduc and Winter Harbour tills adjacent to the Viscount Melville Sound coast, which are of Parry Channel or more southerly provenance. The deposition of Liddon Till by west-flowing ice in M'Clure Strait probably postdates the event that formed the Dundas Till sheet and ice-contact belt. If the two events were equivalent in age, the gradient of the ice margin from the 300 m cliff-top at Cape Hay (limit of Dundas Till) to the inland limit of Liddon Till would have been 4 m/km. The low inclination of this theoretical gradient suggests that these two tills are not coeval. Alternatively, the similarities in composition and of maximum elevation between the Bolduc and Liddon tills suggest that they may both have been deposited by a single ice advance which diverged around Dundas Peninsula.

Till similar in composition to Liddon Till was traced outside the map area up to 53 m a.s.l. on Bailey Point (southernmost tip of western Melville Island, Fig. 1). To the east, on the north shore of Liddon Gulf, 10 km east of Cape Hoare (Fig. 1), an east-west ridge rising to 37 m a.s.l. is strewn with striated sandstone clasts overlying fine sand. Till was not observed east of this ridge on the north shore of

**Table 1.** Granular Resources

| | Deposit | Sand | Gravel | Rip-rap | Comments |
|---|---|---|---|---|---|
| 8 | Colluvium | | | | Chiefly sandy fines; locally organic rich |
| 7b | Floodplain | D | D | | Sand or sandy silt, disctontinuous gravel veneer; locally thick gravel |
| 7a | Fluvial terrace | D | D | | As 7b; may contain thick peat, may overlie fines |
| 6b | Raised beach | D | W | | Chiefly gravel |
| 6a | Undifferentiated marine | D | | | Variable sand to clay, minor gravel |
| 5 | Pleistocene delta | D | D | D | Sand, gravel, or rubble; commonly underlain by finer sediment |
| 4 | Pleistocene marine | D | | | Silty clay to gravelly sand; commonly overlain by Winter Harbour Till on south coast |
| 3 | Glaciofluvial | D | D | | Bouldery gravel or silty sand |
| 2a-e | Till | D | D | | Variable silty sand to silty clay matrix; local bouldery gravel, especially at margin of Winter Harbour Till |
| 1 | Ice contact | W | D | | Gravelly sand overlain by bouldery gravel veneer |
| | BEDROCK/RESIDUAL ROCK FORMATIONS | | | | |
| Tb | Beaufort | D | D | | Unconsolidated sand and gravel, some organics |
| K | Cretaceous, undivided | W | | | Isachsen Formation (not separated from the overlying, but less widespread, clayey Christopher Formation) is chiefly sand |
| Pcf | Canyon Fiord | | | D | Poorly consolidated clastic and carbonate rocks; weathers to rubble, sand, and silt; only outcrops at McCormick Inlet |
| Dgb | Griper Bay | | | D | Sandstone and siltstone weathered to rubble widespread in central and western Dundas Peninsula, scattered elsewhere |
| Dhb | Helca Bay | D | D | W | Rubble-forming sandstone widespread; poorly consolidated sandstone or sand common in northeast and east |
| Dw | Weatherall | | D | D | Mixed rubble to fines; discontinuous gravel veneer over northwestern upland |
| Dcb | Cape de Bray | | | | Shale |
| Dcp | Cape Phillips | | | D | Cherty shale and minor limestone rubble |
| Oc | Cornwallis Group | | | D | Carbonate and shale rubble |

D = discontinuous presence in unit
W = widespread in unit

Liddon Gulf, nor east of Shellabear Point on the south shore. Deposition of Liddon Till presumably occurred during the last glacial event which filled M'Clure Strait with ice.

The base of Liddon Till, which is rarely exposed, directly overlies bedrock. Marine sediments, commonly shelly at the base, directly overlie the irregular upper surface of the till to elevations of about 60 m a.s.l. Marine shells (**Hiatella arctica**) from the surface of marine sediments at 56 m were dated at 11 500 ± 260 BP (GSC-3113) and provide a minimum age for the till. **Hiatella arctica** valves at 40 m on the till surface near Bailey Point were dated at 10 600 ± 150 BP (GSC-324).

Evidence of glacial erosion or deposition along the coast between Cape Providence and Peddie Point (Fig. 2) in outer Liddon Gulf was found at only two locations, and thus Liddon Till cannot be correlated with the tills along Viscount Melville Sound. The only evidence of glaciation on this high cliffed coast are plugs of stratified sediment overlain by ultrabasic, granitic, and carbonate-rich till in the mouths of two valleys northwest of Cape Dundas (Map 1583A). These deposits, which rise to less than 50 m a.s.l., probably represent proglacial and ice-contact deposits laid down at the margin of an ice mass flowing into M'Clure Strait (and depositing Liddon Till?).

### Late Pleistocene Marine Transgression

Sediment and landforms marking a late Pleistocene transgression, postdating deposition of Bolduc and Liddon tills, are present on the coasts of Hecla and Griper Bay, Liddon Gulf, and Viscount Melville Sound. The detectable limit of submergence rises from about 55 m in the north and west of the region, to at least 90 m adjacent to Viscount Melville Sound.

In Hecla and Griper Bay, a significant raised water plane, first reported by Henoch (1964, p. 110), is recorded by raised deltas in the subaerial drainage system along the 100 km of coast from McCormick Inlet to the head of Sabine Bay. The elevations of the deltas (the fronts are indistinct), measured by altimeter, are consistently between 53 and 57 m (Map 1583A). The only shell sample from the raised deltas (**Hiatella arctica**) was collected from stratigraphically below a fluvial surface at 49 m and is 10 380 ± 160 year old (GSC-338, Table 2); hence this is a minimum age for the 55 m water plane – which in turn may not mark maximum late Pleistocene submergence. At this time, the isthmus between Hecla and Griper Bay and Liddon Gulf was submerged, bisecting Melville Island, until sea level fell below 40 m.

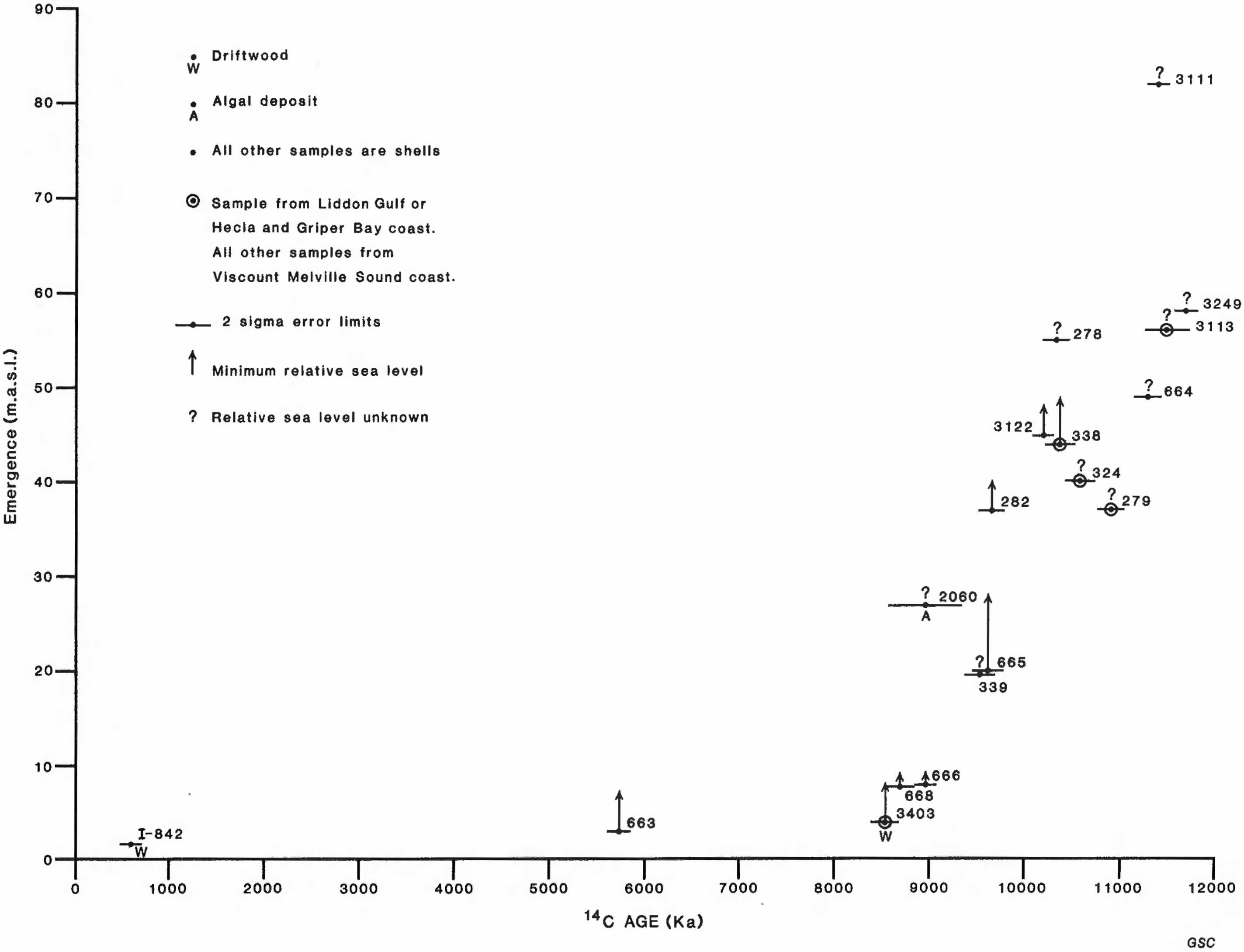



*Figure 14. Late Pleistocene and Holocene emergence data, central Melville Island; samples are described in Table 2, where all numbers are prefixed by GSC-(except I-842).*

**Table 2.** Radiocarbon dates, Central Melville Island

| Date (years BP) | Laboratory No. and Field Sample | Elevation (m) sample | Elevation (m) relative sea level | Material | Location[1] | Geological Environment[2] |
|---|---|---|---|---|---|---|
| 42 400 ± 1900 (inner fraction) 33 800 ± 900 (outer fraction) | GSC-787 FG-66-78a | 85 | - | **Hiatella arctica** fragments | Hill to the north of a large lake 14.5 km west of Cape Phipps and 8 km north of south coast; 74°38.5'N, 111°22'W (78 F). | In slide scar developed in silty "Bolduc" Till. Situated outside the northern limit of Winter Harbour Till. |
| >33 000 | GSC-727 FG-66-58a (site 5-28-7) | 79 | - | **Hiatella arctica** fragments | On a hill, 6 km SW of Parry Point, on the south coast; 74°46.4'N, 110°50'W (78 F). | Surface of "Bolduc" Till. Situated outside the northern limit of Winter Harbour Till. |
| 27 790 ± 480 (inner fraction) 26 770 ± 450 (outer fraction) | GSC-667 FG-66-55a (site 1-27-7) | >61 | - | **Hiatella arctica** fragments | Ridge surface 17.5 km NNW of Parry Point on the south coast; 74°56'N, 110°45.7'W (78 F). | On the surface of the bouldery crest of a terminal moraine, at the limit of extent of the Winter Harbour Till. |
| 11 700 ± 100 | GSC-3249 HCA-80-15/7-4 | 58 | >82? | **Hiatella arctica** | West bank of river, 1.5 km WNW of Cape Clarendon; 74°30.7'N, 111°42.0'W (78 F). | On the surface of marine silt which is overlain, upslope, by a gravel stratum and Winter Harbour Till. |
| 11 500 ± 260 | GSC-3113 HCA-80-7/7-3 | 56 | >56 | **Hiatella arctica** | 13 km WSW of Shellabear Point; 74°49'N, 113°42'W (88 E). | Surface of littoral deposits close to limit of late Pleistocene marine transgression; overlying Liddon Till. |
| 11 400 ± 130 | GSC-3111 HCA-80-15/7-11 | 82 | >82 | **Hiatella arctica** | Section 5.5 km NE of Cape Clarendon; 74°32.7'N, 111°32.5'W (78 F). | At head of flow slide, in silt clearly underlying marine sand, sand and gravel, and Winter Harbour Till. |
| 11 310 ± 150 | GSC-664 FG-66-80a (site 4-4-8) | 49 | >49 | **Hiatella arctica** | On the southern slope of a bedrock hill, 6.5 km NE of Cape Providence, 74°29'N, 112°11'W (88 E). | Horizontally bedded nearshore marine silt and clay within area covered by ice that deposited Winter Harbour Till. |
| 10 920 ± 150 | GSC-279 FG-64-141a (site 8/4C) | 37 | >37 | **Hiatella arctica** | Ridge surface 4.5 km SW of Shellabear Point; 74°50.5'N, 113°24.5°W (88 E). | Marine clay overlying Liddon Till and bedrock. |
| 10 900 ± 160 | GSC-363 FG-64-134c (site 8/2H) | 64 | - | **Hiatella arctica** fragments | On the west side of a stream 4.5 km NW of Cape Phipps and 3.5 km north of the south coast; 74°40.7'N, 110°57.5°W (78 F). | On the surface of Winter Harbour Till near its outer limit of extent. |
| 10 900 ± 150 | GSC-786 FG-66-64a (site 4-30-7) | 79 | - | **Hiatella arctica** fragments | Ridge surface 9 km west of Hearne Point and 8 km north of the south coast; 74°43.4'N, 110°52'W (78 F). | Stony sandy crest of a terminal moraine at the Winter Harbour Till limit. |
| 10 600 ± 150 | GSC-324 (site 8/4H) | 40 | >40 | **Hiatella arctica** | Ridge surface NW of Bailey Point; 75°01'N, 115°10'W (88 E). | On surface of till ridge. Till probably of same age as Liddon Till of NW Dundas Peninsula. |
| 10 380 ± 160 | GSC-338 FG-64-51b (site 7/21I) | 44 | >49 | **Hiatella arctica** | Section in delta 9.5 km SE of Nias Point on Sabine Bay; 75°30.4'N, 110°15'W (78 G). | In fine silty sand of a marine delta, 5 m below delta surface which stands at 49 m. |
| 10 340 ± 150 | GSC-278 FG-64-134b (site 8/2H) | 55 | >55 | **Hiatella arctica** | On the west side of a stream 5.5 km NW of Cape Phipps and 4.5 km north of the south coast; 74°41'N, 110°57.5'W (78 F). | On the surface of nearshore marine sand and silt which likely overlie "Bolduc" Till. Situated outside the limit of Winter Harbour Till. |

| Comments | Collector(s) | References | %Removed by Leaching | Counting Procedure |
|---|---|---|---|---|
| As the fragmented shells were on "Bolduc" Till, they are probably ice transported. Nevertheless they may be from a marine event that postdates "Bolduc" Till. | J.G. Fyles, 1966 | Lowdon and Blake (1968, p. 241) | 20 | one 3-day (inner), two 1-day (outer) counts in 5 L counter |
| As the fragmented shells were on "Bolduc" Till, they were probably ice transported. Nevertheless they may be from a marine event that postdates "Bolduc" Till. | J.G. Fyles, 1966 | Lowdon and Blake (1968, p. 241) | 20 | Two 1-day counts in 5 L counter |
| As shells are fragmented and lie over till, not marine sediments, they are probably ice transported. | J.G. Fyles, 1966 | Fyles (1967), Lowdon and Blake (1968, p. 241) | 20 | one 3-day (inner) two 1-day (outer) counts in 5 L counter |
| Minimum age for marine submergence predating Winter Harbour Till; GSC-3111, 300 years younger, is from a nearby site at 82 m a.s.l., which is thus the minimum elevation of this submergence. | D.A. Hodgson and J-S. Vincent, 1980 | This report | 30 | one 3-day count in 5 L counter |
| Possible marine limit on Liddon Gulf. | D.A. Hodgson and J-S. Vincent, 1980 | This report | 20 | two 1-day counts in 2 L counter |
| Maximum age for 82 m water plane of marine event immediately preceding deposition of Winter Harbour Till. Absolute maximum age for Winter Harbour advance. | D.A. Hodgson and J-S. Vincent, 1980 | This report | 20 | two 1-day counts in 2 L counter |
| The stratigraphic relationship with Winter Harbour Till is not clear, nevertheless shells likely predate the till. | J.G. Fyles, 1966 | Lowdon and Blake (1968, p. 241-242), McLaren and Barnett (1978) | 20 | one 3-day count in 5 L counter |
| | J.G. Fyles, 1964 | Lowdon et al. (1967, p. 192) | 20 | one 4-day count in 2 L counter |
| As the fragmented shells were on Winter Harbour Till, they were probably ice transported. | J.G. Fyles, 1964 | Lowdon et al. (1967, p. 192) | 15 | two 1-day counts in 5 L counter |
| As the fragmented shells were on Winter Harbour Till, they were probably ice transported. | J.G. Fyles, 1966 | Lowdon and Blake (1968, p. 242), McLaren and Barnett (1978) | 50 | one 3-day count in 5 L counter |
| | J.G. Fyles, 1964 | Lowdon et al. (1967, p. 192) | 20 | one 3-day count in 5 L counter |
| Dates a water plane which was at least 49 m and possibly as high as 55 m which is the height of the highest delta remnant. | J.G. Fyles, 1964 | Blake (1972, p. 81) | 30 | two 1-day counts in 5 L counter |
| Provides a probable maximum age for deposition of Winter Harbour Till. | J.G. Fyles, 1964 | Fyles (1967), Lowdon et al. (1967, p. 192), McLaren and Barnett (1978) | 20 | one 3-day count in 5 L counter |

Table 2 (cont.)

| Date (years BP) | Laboratory No. and Field Sample | Elevation (m) sample | Elevation (m) relative sea level | Material | Location[1] | Geological Environment[2] |
|---|---|---|---|---|---|---|
| 10 200 ± 100 | GSC-3122 HCA-80-21/7-2 | 45 | ≥48 | **Hiatella arctica** | At mouth of river which drains lake 3 km SW of Polynia Lake; at head of Bridport Inlet; 72°04.25'N, 108°50'W (78 G). | On surface of fine sand and silt underlying a coarse gravel delta surface at 48 m. |
| 9670 ± 150 | GSC-282 FG-64-118a (site 7/29A) | 37 | >40 | **Hiatella arctica** | In a gully on the east side of a small lake 11 km west of Palmer Point and 2 km north of the south coast; 74°56.5'N, 108°15'W (78 F). | In stony silt (nearshore marine?) beneath pebbly beach gravel. On the proximal side of Winter Harbour Till limit. |
| 9620 ± 150 | GSC-665 FG-66-55c (site 3-27-7) | 20 | >28? | **Hiatella arctica** | On the west side of a stream 1.5 km NW of Parry Point on the south coast; 74°47.2'N, 110°40.5'W (78 F). | On the eroded surface of silty marine sand underlying deltaic sands (delta surface is at 25 m with apex at 28 m) on the proximal side of Winter Harbour Till limit. |
| 9550 ± 160 | GSC-339 FG-64-132a (site 8/2F) | 20 | >20 | **Hiatella arctica** | On the surface, 4.5 km NNW of Hearne Point and 3.5 km north of the south coast; 74°43.7'N, 110°41'W (78 F). | On silt and sand (nearshore marine?) overlying bedrock. On the proximal side of the Winter Harbour Till limit. |
| 8980 ± 400 | GSC-2060 WH-1971 | 27 | ≥27 | Algal deposit | About 1 km NW of Braithwaite Point on the south coast; 74°47.5'N, 112°32.5'W (78 F). | In raised beach on the proximal side of Winter Harbour Till. |
| 8960 ± 140 | GSC-666 FG-66-70e (site 2-1-8) | 8 | >9 | **Astarte** sp. **Portlandia** sp., **Mya** sp., and **Hiatella arctica** | About 2 km north of Parry Point on the south coast; 74°48'N, 110°38'W (78 F). | In 1-2 m deep gullies in raised beach. |
| 8700 ± 160 | GSC-668 FG-66-70d (site 2-1-8) | 8 | >9 | **Astarte** sp., **Portlandia** sp., and **Hiatella arctica** | About 2 km north of Parry Point on the south coast; 74°48'N, 110°38'W (78 F). | In 1-2 m deep gullies in raised beach. |
| 8530 ± 90 | GSC-3403 HCA-80-30/7-13 | 4 | >8 | Driftwood | River bank 2 km upstream from Hecla and Griper Bay, 19 km WSW of Nias Point; 75°31'N, 111°07'W (78 G). | Driftwood in freshly undercut river bank, 3 m above river level. Bank composed of 4 m highly reduced silty clay marine and deltaic bottomsets, overlain by 3 m sand and gravel foresets and topsets. Bank top 8 m a.s.l. |
| 5750 ± 130 | GSC-663 FG-66-70a (site 1-1-8) | 3 | >7? | **Astarte** sp. | Immediately north of Parry Point near to R.C. Scott's grave; 74°47.5'N, 110°39'W (78 F). | On the surface of fine sands and silts, adjacent to a marine delta which stands at 7 m a.s.l. |
| 2920 ± 60 | GSC-3175 HCA-80-17/7-6c | 66 | | **Salix** sp. | Section on north bank of small stream, at foot of scarp, 6 km NE of Cape Providence; 74°29'N, 112°12'W (88 E). | Willow bush in organic-rich sand, 2 m below surface, at base of colluviated slope. |
| 625 ± 100 | I-842 | 1.6 | | Driftwood | NW shore of bay north of Wakeham Point; 74°50'N, 110°25'W (78 F). | Driftwood collected on raised beach. |

[1] Some coordinates are corrections of previously published descriptions
[2] Some interpretations vary from those published earlier

| Comments | Collector(s) | References | %Removed by Leaching | Counting Procedure |
|---|---|---|---|---|
| Dates a 48 m or higher water plane. Relationship to Winter Harbour Till uncertain (see text). | D.A. Hodgson and J-S. Vincent, 1980 | This report | 20 | one 3-day count in 2 L counter |
| Provides minimum age for deposition of Winter Harbour Till. | J.G. Fyles, 1964 | Lowdon et al. (1967, p. 191) | 20 | one 3-day count in 2 L counter |
| Provides minimum age for deposition of Winter Harbour Till at Winter Harbour. | J.G. Fyles, 1966 | Lowdon and Blake (1968, p. 242) | 20 | two 1-day counts in 5 L counter |
| | J.G. Fyles, 1964 | Fyles (1967), Lowdon et al. (1967, p. 192), McLaren and Barnett (1978) | 30 | two 1-day counts in 2 L counter |
| If the algal deposit has not been ice pushed, this gives a maximum age for contemporary storm water limit. | M. Kuc, 1971 | McLaren and Barnett (1978) | 0 | one 4-day count in 2 L counter |
| | J.G. Fyles, 1966 | This report | 20 | one 4-day count in 5 L counter |
| | J.G. Fyles, 1966 | This report | 20 | one 3-day count in 2 L counter |
| Sea level at time of deposition was higher than top of overlying topset beds (i.e. 8 m). Plant material, fish scales, and variety of molluscs were found in same stratum as log. Log is oldest dated driftwood of finite age from western Arctic Islands. | D.A. Hodgson and J-S. Vincent, 1980 | This report | - | two 1-day counts in 5 L counter |
| | J.G. Fyles, 1966 | This report | 20 | one 3-day count in 5 L counter |
| Organics and colluvium accumulated at an average of 1 mm per year. | D.A. Hodgson and J-S. Vincent, 1980 | This report | - | two 1-day counts in 5 L counter |
| Henoch (1964, p. 113) believed this wood had not been ice pushed; dates the contemporary storm water limit | Henoch, 1962 | Henoch (1964)<br>Trautman (1964, p. 270) | - | N/A |

Several massive raised deltas west of the head of Liddon Gulf are graded to a former sea level at about 55 m a.s.l. – the same water plane that is recorded around Hecla and Griper Bay. Smaller raised deltas at about 55 m a.s.l. are strung down the south shore of the gulf over the 100 km to Peddie Point. Larger valleys in the Chevalier Bay – Stony Pass area (southeast Liddon Gulf) are partially filled with unfossiliferous, finely stratified sand and silt, fining downwards to silt and clay, with a total thickness of >10 m. The uppermost beds of these (deltaic?) deposits are again close to 55 m a.s.l. Similar deposits are present on the lowland west of Shellabear Point, but these rise to at least 73 m a.s.l. However, whereas the highest of the latter deposits are unfossiliferous, marine shells do occur at lower elevations up to 56 m, both on the surface and concentrated in strata at the base of sandy sediments overlying Liddon Till. A surface sample of **Hiatella arctica** collected at 56 m a.s.l. (the highest shells found in Liddon Gulf) dated 11 500 ± 260 BP (GSC-3113) and another sample at 37 m dated at 10 920 ± 150 BP (GSC-279). The high unfossiliferous deposits near Shellabear Point may be lacustrine sediment marginal to ice in Liddon Gulf, or alternatively they may represent sediment deposited into a sea of unknown age that rose higher than the 55 m water plane.

Shells, abundant in places, lie on the washed (Liddon?) till surface of Bailey Point, western Melville Island, up to an elevation of 43 m. A sample of **Hiatella arctica** collected at 40 m a.s.l. dated 10 600 ± 150 BP (GSC-324). Remnants of two massive, bouldery deltas at about 70 m elevation, 12 km east of Peddie Point (southwest Liddon Gulf), may be coeval with the high unfossiliferous deposits. No obvious break occurs in the sequence of marine sediments from 50 m down to modern sea level, and hence the profusion of 10 000 and 11 000 year dates on shells requires that extreme care be taken in selecting material for dating changes in Holocene sea levels. This is especially relevant if both transgressive and regressive marine deposits exist beyond the margin of the last glaciation (which only reached Dundas Peninsula).

Along Viscount Melville Sound, between Winter Harbour and Cape Providence, shells from marine sand, silt and clay, lying directly below Winter Harbour Till, yield 10 000 and 11 000-year shell dates. It is clear that similar sediments, which outcrop widely within the Winter Harbour Till belt, are part of the same unit, but stripped of the till cover. The unit less commonly outcrops on the distal side of the Winter Harbour Till margin, overlying Bolduc Till. The oldest shell sample from this unit was collected at 58 m a.s.l., at a site assumed on the basis of local stratigraphy to have been stripped of Winter Harbour Till; the whole **Hiatella arctica** valves dated 11 700 ± 100 BP (GSC-3249). However, the highest dated shells, from 82 m a.s.l., are younger; these **Hiatella arctica** valves, collected in situ below Winter Harbour Till, dated 11 400 ± 130 BP (GSC-3111, Fig. 14). The highest elevation at which the marine unit was identified is 91 m, where a single, large valve of **Hiatella arctica** (undated) was found, apparently in situ. The origin of the water body into which deltaic sediments 124 m a.s.l. were deposited at the west end of the Winter Harbour Till belt, is unknown.

The irrelation between depth of shell deposition and contemporary sea level is emphasized by another two samples of **Hiatella arctica** from the marine unit: shells from 49 m a.s.l. dated 11 310 ± 150 BP (GSC-664) whereas shells from 55 m dated 10 340 ± 150 BP (GSC-278). The latter sample was collected from a 1 m-thick bed of paired **Hiatella arctica** valves, lying less than 1 km beyond the distal margin of the Winter Harbour Till, near Cape Phipps (Fig. 6, 10).

**Hiatella arctica** valves (10 900 ± 160 BP, GSC-363 and 10 900 ± 150 BP, GSC-786) taken from the surface of the Winter Harbour Till are coeval with the Pleistocene marine sediment; however as the shells were all fragmented, they were more likely transported by glacial ice or redeposited by mass wasting, rather than occurring in situ.

*Summary.* Sediments from a late Pleistocene marine transgression occur on all coasts in the region. On the basis of the available radiocarbon ages of shells, this event has a maximum age of at least 11 700 years and a minimum age of 10 400 years or less (Fig. 14). The sediments directly overlie Bolduc Till and Liddon Till, and underlie Winter Harbour Till. The transgression records a considerable crustal adjustment, the most obvious cause of which was ice occupying Viscount Melville Sound. The local abundance of shells (almost exclusively **Hiatella arctica**) indicates an open marine environment immediately preceding the advance of ice that deposited Winter Harbour Till.

A former water plane at 55 m is recorded on the shores of Hecla and Griper Bay and Liddon Gulf; though there are no radiocarbon dates to show that it is synchronous, it is nonetheless marked by raised deltas which do not occur at other elevations. This water plane was traced 150 km from southwest to northeast and 75 km from southeast to northwest. Although no evidence of the 55 m water plane was found on the shore of Viscount Melville Sound, here submergence occurred to at least 82 m, probably >90 m a.s.l., and possibly to a delta at 124 m. Any previous shorelines along this part of Viscount Melville Sound are overlapped by Winter Harbour Till.

### Deposition of Winter Harbour Till

Winter Harbour Till (Fyles, 1967; Prest et al., 1967) was deposited by ice flowing from Viscount Melville Sound onto the south coast of Dundas Peninsula. It is the most recent till sheet in the map area and has the best defined margin. Till at the margin is commonly thicker than elsewhere, and its surface here stands higher than adjacent Bolduc Till or late Pleistocene marine deposits. This relief is accentuated in places by a single drainage channel paralleling the former ice front. The highest elevations at which till was deposited (Map 1583A) decline from 120 m at Cape Providence to 100 m west of Winter Harbour, and to 68 m at the limit of the embayment north of Winter Harbour. Kame terraces abutting high ground on the north side of the embayment, and a delta probably built into ice-dammed water at the nose of the former ice lobe, are 66 to 68 m a.s.l. Assuming a sea level of about 66 m, then most of the ice was below sea level, with such little freeboard that it was likely floating prior to grounding on the coast. To the east of Bridport Inlet, till that includes numerous granitic and ultrabasic clasts – thus almost certainly Winter Harbour Till – occurs up to 50 m a.s.l.

Ice flow direction at Cape Providence, was west-southwest, paralleling the coast, as indicated by chattermarks and by striae at 255°. North of Winter Harbour, the shape of the embayment indicates northward flow, and this is confirmed by the orientation of rare drumlinoid features. On the summit of Dealy Island (60 m a.s.l.; Fig. 2), striae are aligned at 350°, though ice flow direction was not determined.

*Age of Till.* The only dated material underlying Winter Harbour Till is a sample of **Hiatella arctica** valves 11 400 ± 130 years old (GSC-3111) which occurs at 82 m a.s.l. in marine silt, overlain by marine sand and gravel, beneath 1 m of Winter Harbour Till. This maximum age for the till can be reduced to 10 900 BP if the **Hiatella arctica** fragments of that age (GSC-363, GSC-786) collected on the till were glacially transported, rather than being in situ late Pleistocene marine deposits. By 10 340 ± 150 BP, **Hiatella arctica** valves (GSC-278) were being deposited in marine sediments 55 m a.s.l. near Cape Phipps, at a location now 1 km beyond the till margin. There are three possible age relationships between the Cape Phipps shells and Winter Harbour Till: The shells can be preglacial, and part of the late Pleistocene marine unit already described. Secondly, they can be proglacial; however the narrow belt of water, between the grounded ice sheet and higher ground to the northwest, is an unfavourable environment for accumulation of thick beds of shells. Finally, if they are postglacial, then areas of abundant whole valves also should occur over Winter Harbour Till, at elevations of at least 55 m. As shown above, such deposits have not been found, and as shown below in the discussion of Holocene marine regression, a clear postglacial washing limit occurs on the till at about 35 m a.s.l. in the vicinity of Cape Phipps. Thus, using presently available information, 10 340 BP is likely the earliest date of deposition of Winter Harbour Till.

A minimum age of the till is obtained from the oldest in situ shells underlain by the till, below the proximal washing limit. At Palmer Point (Fig. 5), **Hiatella arctica** valves under beach gravel 40 m a.s.l. dated 9670 ± 150 BP (GSC-282), whereas shells near Parry Point, related to a sea level of at least 28 m, dated 9620 ± 150 BP (GSC-665).

There is one radiocarbon dated deposit from the shores of Viscount Melville Sound which cannot be adequately explain. **Hiatella arctica** valves collected immediately beneath coarse topset beds of a delta graded to a 48 m sea level, on the west side of Bridport Inlet, dated 10 200 ± 100 BP (GSC-3122; Fig. 5). The delta lies on the north side of a group of deltas graded to a sea level 48 ± 3 m above present (Map 1583A). Using the same analysis applied to the marine deposits at Cape Phipps: First, the group of deltas can predate deposition of Winter Harbour Till (the closest identified outcrop is 15 km to the southeast). Secondly, the deltas can be proglacial deposits; indeed, the largest delta (3 $km^2$) includes much gravel similar in composition to Winter Harbour Till. Although meltwater from ice impinging on the coast northeast of Cape Bounty could reach the deltas via channels crossing divides (Map 1583A), the same glacier might be expected to override the rock bar confining Bridport Inlet and cover the site of the deltas themselves. A floating glacier, however, is less likely to cross the rock bar. Finally, the deltas may be postglacial deposits, although they are 8 m higher than the highest marine feature elsewhere in the vicinity of Bridport Inlet.

*Grounded vs. Floating Glacier.* The provisional emergence curve (Fig. 14) shows no major inflection for the period from 10 340 to 9670 BP, during which it is deduced that a glacier advanced from, and retreated to, Viscount Melville Sound. Isostatic readjustment associated with the advance and retreat of a grounded glacier should induce large sea level changes along the coast. If ice is floating, or at least partially buoyant, however, then the effect on sea level might be slight. It is therefore suggested that Winter Harbour Till was deposited by an ice shelf floating in Viscount Melville Sound (where depths are commonly greater than 500 m) and grounded only on the shore of Melville Island. (This concept is expanded in Hodgson and Vincent, 1984).

### Holocene Marine Regression

Raised beaches are discontinuously present around Hecla and Griper Bay and around Liddon Gulf between the 55 m a.s.l. water plane and present sea level. Datable material clearly in situ was found only at the southwest corner of Hecla and Griper Bay. Here, a driftwood log dated 8540 ± 90 BP (GSC-3403) was collected, together with other plant material, a variety of molluscs, and some fish scales, from bottomset beds beneath 4 m of foresets and topsets. Sea level during deposition of the organic material is unknown, but obviously was higher than the 8 m elevation of the topset bed surface. Evidence of submergence of the present shoreline was not found, hence it is assumed to be either still emerging or stationary on all coasts.

Along Viscount Melville Sound, a clear washing limit of Holocene age is discontinuously present on central and eastern parts of the Winter Harbour Till (Fig. 10). This is the highest reliable evidence of a marine incursion after deposition of the till. On the basis of morphology, the shoreline can be seen to have regressed steadily down from the washing limit. Fyles (1967, p. 8) suggested that this limit rose from 15 to 30 m over the 35 km between Cape Phipps and Winter Harbour, but he also noted that "Levels on a prominent lower beach, about 30 feet above present sea level, revealed no tilt over a distance of several miles". Later measurements of the Holocene washing limit show no tilt over this 35 km of coast: delta surfaces are 34 m a.s.l. at Cape Phipps and 30 m a.s.l. at Winter Harbour, and the highest beaches we measured at Wakeham Point are only 30 m a.s.l. (though Henoch (1964) reported a boulder barricade at 35 m a.s.l. and McMillan (1910) reported a 32 m marine limit).

Nonetheless, to the southwest, between capes Clarendon and Providence, the highest deltas overlying till are 20 m a.s.l., and beach ridges are not present above 6 m a.s.l. In contrast in the east, beaches on the shore east of Dealy Island, towards Palmer Point, rise to at least 40 m a.s.l., and overlie the oldest Holocene marine shells dated along this coast – **Hiatella arctica**, 9670 ± 150 years old (GSC-282).

Five radiocarbon dates on marine shells from a small area immediately west of Winter Harbour provide a provisional emergence curve for this location (Fig. 14; Table 2). The oldest sample (**Hiatella arctica**) dated 9620 ± 150 BP (GSC-665) was collected at 20 m a.s.l. but occurs stratigraphically below a delta surface at 25-28 m a.s.l., which records the minimum contemporary sea level. The other samples also were below deltas or beaches, and hence date sea levels at unknown higher elevations: GSC-339 (9550 ± 160 BP) was collected from 20 m, and GSC-668 (8700 ± 160 BP) and GSC-663 (5750 ± 130 BP) are from lower elevations. Driftwood collected at 1.6 m a.s.l., northeast of Wakeham Point, dated 625 ± 100 BP (I-842) and records a maximum sea level for that time (Henoch, 1964). An algal deposit collected by M. Kuc from a raised beach 27 m a.s.l. dated 8980 ± 400 BP (GSC-2060). This sample is high and young relative to the four oldest Holocene shell dates, unless sea level relative to all four shell collections was 15 to 20 m higher. Therefore the possibility that GSC-2060 was thrust up by ice push (particularly active now at this site) must be considered.

### Local Ice Caps

A pattern of ice marginal channels (Map 1583A) cut into bedrock indicates retreat of local ice onto the western and eastern uplands. The western upland channels are aligned WNW-ESE, and show that the retreat was to an ice centre west of the map area. No direct evidence of the age of these features was found, however one of the massive 55 m deltas at the head of Liddon Gulf occurs at the mouth of a 5 km-long misfit stream occupying one of the drainage channels. If, as discussed previously, the 55 m delta is of late Pleistocene age (ca. 11 000 BP), then ice covered the western Melville Island upland at this time. The relationship of this ice to striae at 065° to 080° at the head of Liddon Gulf, reported by McMillan (1910), is not known.

For the eastern upland, the centre of the ice retreat was the Edmund Lyon Hills; here, no age estimate can yet be made, since drainage channels have not been connected to any specific former relative sea level. However, the existence of such local ice caps is most important to the understanding of local postglacial emergence, paleoclimatic change and the style of glaciation on Melville Island, which presently supports four small ice caps in its western upland.

### *Summary of Quaternary Events*

1. Dundas Till and associated ice-contact deposits mark a minimum limit of the oldest observable continental ice advance on central Melville Island. The absolute age of this event is unknown, and no former relative sea level has been determined to date its recession.

2. Bolduc Till was deposited by a subsequent continental ice advance overlapping the present southeast coast of Dundas Peninsula to 100 m a.s.l. Shell fragments on and possibly within the till surface date >33 000 BP (GSC 727), and either may be glacially transported, or may date an otherwise unidentified overlapping marine event younger than the till. The oldest marine sediments definitely overlapping the till are 11 700 ± 100 years old (GSC-3249).

3. Liddon Till, on the coast of outer Liddon Gulf, was deposited by continental ice entering the gulf from M'Clure Strait. The oldest overlapping sediments are 11 500 ± 260 years old (GSC-3113). This till is probably not as old as Dundas Till, but it may be coeval with Bolduc Till.

4. A late Pleistocene marine transgression with a minimum age of 11 700 ± 100 BP (GSC-3249) overlapped all shores. Along Liddon Gulf and Hecla and Griper Bay, an undated water plane marked by numerous perched deltas occurs at 55 m a.s.l., and this may represent the limit of the submergence ca. 11 000 years ago. The maintenance of this water plane over a wide area indicates possible contemporaneous loading by ice, north of the continental ice margin (which lay along southeast Dundas Peninsula). In Viscount Melville Sound, at Winter Harbour, submergence reached at least 90 m. Subsequent emergence probably resulted from the retreat of continental ice in Viscount Melville Sound – perhaps following a retreat from the Liddon Till limit, though this till may be much older. Alternatively, emergence possibly resulted from a reduction in size of ice caps on Melville Island or other islands north of Parry Channel (Fig. 1).

5. Winter Harbour Till partially overlapped Bolduc Till and late Pleistocene marine sediments on the southeast coast of Dundas Peninsula. Marine sediment 82 m a.s.l., overlain by the till, dated 11 400 ± 130 BP (GSC-3111), whereas marine sediment apparently deposited prior to till deposition at 55 m a.s.l. on the distal side of the till limit dated 10 340 ± 150 BP (GSC-278) and provides a maximum age for Winter Harbour Till. The oldest dated Holocene offlap sediments provide the latest date for deposition of Winter Harbour Till: shells 9670 ± 150 BP (GSC-282), related to a sea level >40 m a.s.l. east of Bridport Inlet, and shells 9620 ± 150 BP (GSC-665) related to a sea level >28 m a.s.l. were collected at Winter Harbour. It is probable that the glacier that deposited Winter Harbour Till floated in Viscount Melville Sound and grounded on the south shore of Melville Island.

6. A washing limit, discontinuously present on eastern and central parts of the Winter Harbour Till, is the highest reliable evidence of a marine incursion after till deposition. The limit is about 35 m a.s.l. in the vicinity of Winter Harbour, and the oldest dated offlap sediments here are 9620 ± 150 years old (GSC-665).

### *Regional Correlations*

Correlations are made provisionally with Quaternary events described in two adjacent areas. South of Parry Channel, for Banks Island (Fig. 1) Vincent (1982, 1983) suggested relative ages of deposits from a number of glacial and interglacial stages. For eastern Melville Island, Henoch (1964) and McLaren and Barnett (1978) limited their reconstructions to the Holocene.

#### Banks Island

On the basis of geographical extent, the Dundas Till of Melville Island is tentatively correlated either with the extensive Bernard, Plateau, and Durham Heights tills deposited during the continental Banks Glaciation on neighbouring Banks Island, or with the less extensive till of the Thomsen Glaciation on central and eastern Banks Island.

Liddon Till was deposited by the last ice entering Liddon Gulf from M'Clure Strait. In the chronology of Banks Island, ice last filled M'Clure Strait in the M'Clure Stade (the penultimate stade) of early Wisconsinan age of the Amundsen Glaciation (the last glaciation).

At Peel Point, on the northwest corner of Victoria Island (Fig. 1), shells 12 600 ± 140 years old (GSC-1707, Lowdon and Blake, 1976, p. 16) at 70 m a.s.l. were probably deposited in the same late Pleistocene sea that is dated 10 000 to close to 12 000 BP on the south shore of Melville Island. The last continental ice to reach Banks Island was the Viscount Melville Lobe, which overran only the extreme northeast tip, in the Russell Stade. Glacially deformed marine sediments from this area, dated 10 600 ± 270 BP (GSC-1437, Lowdon and Blake, 1973, p. 45), possibly provide a maximum age for this advance, which thus is provisionally correlated with ice which deposited Winter Harbour Till.

#### Eastern Melville Island

Till has not been reported along the north shore of Parry Channel, east of Bridport Inlet; however Barnett et al. (1976) commented on the fresh appearance of till containing Laurentide erratics and on north-trending striae on Lowther Island near the centre of Parry Channel (Fig. 1). Barnett et al. suggested that ice from the last continental advance reached Lowther Island, but not Cornwallis Island to the north. Thus Lowther Island till may be coeval with Winter Harbour Till.

Henoch (1964, p. 116) described an unsuccessful attempt to correlate raised shorelines across eastern and central Melville Island, nevertheless, he had sufficient data to construct a 'preliminary uplift curve' for Melville Island. McLaren and Barnett (1978), using many more samples, drew separate emergence curves for the east and south coasts of Melville Island. The south coast curve is in part similar to the provisional emergence curve presented above (Fig. 14). However, as we have found that shells higher and older than the Holocene washing limit along Viscount Melville Sound cannot be related to a specific sea level, the upper portion of McLaren and Barnett's curve (i.e. older than 9600 BP) is unreliable. Indeed, one of the two dates used to construct this curve (10 900 ± 150 BP, GSC-786) was obtained from shells which we suggest are ice transported. The east coast curve is steeper than for the south coast – the oldest and highest date used is 9640 ± 90 BP (GSC-1981), obtained from shells in a delta 98 m a.s.l. at Towson Point (Fig. 1), where the marine limit is 101 m a.s.l. McLaren and Barnett explain the apparently greater and more recent emergence of the east coast as unloading from an ice sheet covering northeast Melville Island. This they consider to be part of the Innuitian Ice Sheet and to be thicker than ice in the marginal zone of continental ice, which lay off the south coast.

Information presented in this report does not deny this hypothesis. We have shown that the Holocene marine limit tilts up to the northeast from 40 m elevation at Winter Harbour (where McLaren and Barnett did not realize that Winter Harbour Till overlies the late Pleistocene marine deposits) to 101 m at Towson Point. Nonetheless, emergence data alone (and that is all that exists) is insufficient evidence to support the presence of an ice sheet, in view of the present state of knowledge of crustal dynamics.

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