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# Quaternary glaciomarine environments west of Committee Bay, central mainland Nunavut[1]

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**Abstract:** Maximum marine transgression limits are identified along the eastern and northern peripheries of the Ellice Hills map area (NTS 56 P), west-central coast of Committee Bay, Nunavut. An age estimate of 9000 to 8600 calendar (cal.) years BP is tentatively assigned to the absolute maximum marine limit (approximately 240–255 m a.s.l.) along this coastline, on the basis of marine features at comparable elevations along the northeast coast of Committee Bay. The lowest marine limit, observed 50 km inland at about 180 m a.s.l., is associated with a later marine highstand. The westward-decreasing trend exhibited by the maximum marine limits is the result of relative sea-level fall during southwestward retreat of Keewatin ice.

Marine fossils commonly form a shell lag atop offshore marine mud or, rarely, are in situ. Relative sea-level fall and progressive ice retreat resulted in a succession of marine communities following initial colonization by ice-proximal species such as *Portlandia arctica*.

**Résumé :** Les limites maximales de la transgression marine ont été repérées le long des bordures est et nord de la région cartographique d'Ellice Hills (SNRC 56P), dans la partie centrale de la côte ouest de la baie Committee, au Nunavut. Par association avec des entités marines situées à des altitudes semblables le long de la côte nord-est de la baie Committee, on attribue de manière tentative un âge de 9 000 à 8 600 ans calibrés BP à la limite marine maximale absolue (environ 240-255 m au-dessus du niveau de la mer) le long de cette côte. La limite marine la plus basse observée à 50 km à l'ouest de la côte et à une altitude d'environ 180 m serait associée à un haut niveau marin plus récent. Par conséquent, la tendance à l'abaissement de la limite marine maximale en direction de l'ouest résulte d'une chute relative du niveau de la mer lors du retrait des glaces du Keewatin vers le sud-ouest.

Des fossiles marins forment couramment un dépôt résiduel de coquillages au-dessus de vases marines extracôtières et, plus rarement, sont observés en place. Suite à une colonisation initiale par des espèces de proximité glaciaire comme *Portlandia arctica*, la chute relative du niveau de la mer et le retrait progressif des glaces ont engendré une succession de communautés marines.

[1] Contribution to the Targeted Geoscience Initiative (TGI) 2000–2003.

## INTRODUCTION

Extensive Quaternary field studies were undertaken near the Prince Albert group rocks (Committee Bay belt), approximately 150 km northwest of Repulse Bay, central mainland Nunavut (Fig. 1). The Quaternary research is a collaboration between the Canada-Nunavut Geoscience Office, the Geological Survey of Canada, and several Canadian universities, and represents only one component of the multidisciplinary Integrated Geoscience Committee Bay Project implemented to increase the exploration potential in the region. Objectives of the 2002 Quaternary field work include: 1) compilation of high-resolution (1:100 000 scale) terrain inventories for the Ellice Hills map area (56 P; Fig. 1); 2) initiation of a reconnaissance-scale drift-prospecting program that utilizes both heavy-mineral (e.g. kimberlite-indicator suite and gold) and till geochemical analyses; 3) interpretation of the glacial history at local and regional scales; and 4) mapping the maximum postglacial limits of marine incursion and associated geomorphic features to advance our understanding of glacio-isostatic rebound and Quaternary glaciomarine environments along the west-central coast of Committee Bay.

This paper presents an overview of glaciomarine-related field research conducted during the 2002 season. Preliminary results from the 2002 glacial-related field investigations (e.g. overview of drift prospecting and ice-movement chronology) from the entire Committee Bay study area are presented in McMartin et al. (2003).

## REGIONAL SETTING

### *Physiography*

The Ellice Hills map area (56 P; Fig. 1) falls within a zone of continuous permafrost (Burgess et al., 2001) north of the Arctic Circle and lies entirely within the Gulf of Boothia Basin. Three primary drainage networks, the Kellet, Atorquait, and Curtis river systems, are found within the map

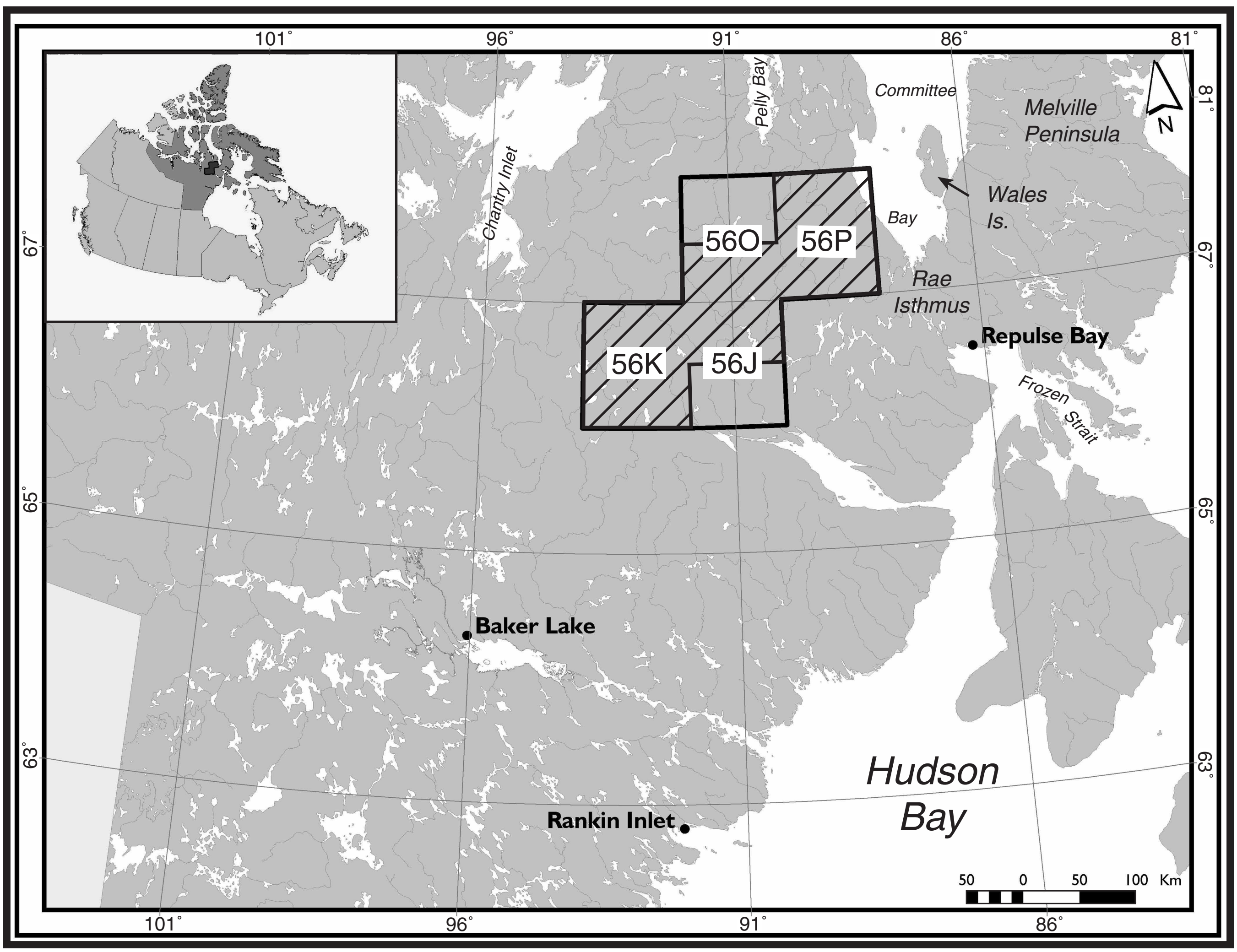


*__Figure 1.__ Study area for the Committee Bay Integrated Geoscience Project. Fieldwork in map area NTS 56 P was completed in 2002.*

area. Elevations range from sea level to about 582 m above sea level (a.s.l.) (Kinngalugjuaq Mountain); topography is characterized by rugged terrain in areas where supracrustal rocks are exposed (southwest central and northeast regions), whereas broad valleys, plains, and rolling to hummocky hills dominate the landscape elsewhere.

The northeast corner of the Ellice Hills map area (56 P/9, 16) includes approximately 50 km of the west-central Committee Bay coastline. The southern part of this coast is confined by relatively high topography (up to about 280 m a.s.l.) and characterized by tidal flats, postglacial nearshore sediments, and valleys partly filled with horizontally to subhorizontally stratified marine silt and clay. The northern and northwestern regions of the map area exhibit a subdued topography with low rolling hills and river valleys partly filled with postglacial marine sediments.

### *Bedrock geology*

The bedrock geology within the map area consists of supracrustal rocks of the Prince Albert group and Archean–Proterozoic intrusive rocks northeast of the Amer shear zone (*see* Skulski et al., 2003). Exposed bedrock makes up approximately 60% of the study area and includes two belts of northeast-trending supracrustal rocks, i.e. the Committee Bay belt and the Ellice Hills strand to the north. Forming the Committee Bay belt are supracrustal rocks of the Prince Albert group dominated by semipelite and psammite with lesser iron-formation, quartzite, komatiite, komatiitic basalt, and intermediate felsic metavolcanic rocks (*see* Skulski et al., 2003). These are intruded by plutons of granodiorite, tonalite, monzogranite, quartz diorite, diorite, gabbro, and peridotite. To the north, the Prince Albert group supracrustal rocks of the Ellice Hills strand are dominated by metavolcanic rocks including komatiite, komatiitic basalt, and basalt; these are interbedded with semipelite, psammite, and iron-formation. Scattered remnants of supracrustal rocks west and north of the greenstone belt are at higher metamorphic grades and include paragneiss and derived peraluminous granitic rocks (*see* Skulski et al., 2003). South and east of the Committee Bay belt are plutonic rocks consisting primarily of K-feldspar, augen-megacrystic biotite granodiorite cut by variably foliated biotite±fluorite monzogranite (*see* Skulski et al., 2003). Supracrustal rocks of the Prince Albert group are highly prospective for a number of commodities including gold, nickel, copper, platinum-group elements, and iron; regionally the area has a potential for diamonds.

Sources of carbonate rocks, important to discussions presented herein, are limited in the Committee Bay and Melville Peninsula regions. The main localities include highly deformed Proterozoic marble outcrops less than 5 km southwest of site 2 (H. Sandeman, pers. comm., 2002) and Paleozoic limestone and dolostone outcrops north of the study area (southeastern NTS 57 A), on Wales Island, and along the northeast coast of Melville Peninsula (Wheeler et al., 1997).

## PREVIOUS WORK

Quaternary research in or near the Committee Bay Project study area has led to numerous theories regarding the glacial history of the Keewatin region, including (but not limited to) the following: ice-divide locations, ice-movement chronologies, and general glacial records of ice advance and retreat based on the distribution of surficial materials (e.g. Wright, 1967; Dyke and Prest, 1987; Dyke and Dredge, 1989; Little, 2001; Little et al., 2002). For a more detailed summary *see* McMartin et al. (2002). In addition, limited data have been gathered on glaciomarine environments in regions adjacent to the Committee Bay Project area, and specifically within the Ellice Hills 1:250 000 scale map area (NTS 56 P).

Craig (1961) described marine silt and clay deposits up to approximately 90 m thick south of Pelly Bay (approximately long. 90°W) and zones of postglacial marine submergence from Pelly Bay to Queen Maud Gulf (approximately long. 102°W). He observed the elevation of the maximum marine limit to be lower in the western half of his study area than in the northeastern quarter (about 154 m a.s.l. versus about 213 m a.s.l., respectively). An age of 8370 ± 200 BP (I-GSC-179) or approximately 8480 ± 290 cal. years BP (all calendar-year corrections herein are made using Stuiver and Braziunas (1993) and Stuiver et al. (1998)) was determined for marine bivalves taken from fine-grained marine sediments (about 165 m a.s.l.) southwest of Pelly Bay. Farther east, an age of 8620 ± 140 BP (GSC-288) or 8840 ± 240 cal. years BP (Stuiver and Braziunas, 1993; Stuiver et al., 1998) was obtained from *Mya truncata* shells lying on the surface of marine sediments at approximately 190 m a.s.l. along the southwest coast of Committee Bay (Craig, 1965). Together, these data suggest that a deglaciated area of the paleo-Gulf of Boothia and paleo-Committee Bay underwent marine transgression prior to ca. 8800 cal. years BP (based on Craig, 1965).

Dredge (1990, 1995) identified and described marine features and proposed a postglacial marine limit for the west side of Melville Peninsula, along the northeast coast of Committee Bay. She concluded that the marine limit is uniformly high near that coastline with a maximum limit of marine submergence at Barnston Point (235 m a.s.l.). Marine-limit elevations and radiocarbon ages from northern Melville Peninsula suggest rapid deglaciation of the northern Committee Bay area between ca. 9000 and 8600 cal. years BP.

Near the Hurd Plateau on the east side of Rae Isthmus, approximately 140 km southeast of the study area, Dredge (2002) observed the maximum marine limit to range between approximately 170 m and 180 m a.s.l. Although samples suitable for radiocarbon dating were rare from this area, the oldest marine shells collected at 100 m a.s.l. yielded an age of 6920 ± 100 BP (GSC 5132) or 7145 ± 170 cal. years BP (Stuiver and Braziunas, 1993; Stuiver et al., 1998). From this age and dates published by Craig (1965) from areas north of Repulse Bay, the estimated deglaciation and associated development of glaciomarine features within the southern Committee Bay and Repulse Bay regions occurred prior to ca. 7000 cal. years BP (Dredge, 2002).

## METHODS

The altitude of various marine features was obtained by comparing data from at least two of the following: hand-held GPS (~100 m accuracy, but often elevations read from GPS agreed to within 5 m of other methods), electronic altimeter (1 m precision), analog altimeter (5 m precision), and NTS 1:50 000 scale maps (5 m vertical, 25 m horizontal accuracy). When the field devices provided conflicting results, a default value obtained from the NTS map was used. Altimeters were recalibrated daily and when circumstances allowed, calibrations with sea level or other benchmarks were made within minutes of taking the site-elevation reading.

Shells were collected from lag deposits on the surface of marine mud, colluvium, or as in situ specimens excavated from cleaned vertical surfaces in a section profile. In these last cases, stratigraphic descriptions of units were recorded prior to shell acquisition. Sampled shells were stored in plastic containers and were identified, measured, and cleaned before being photographed and sent to laboratories for radiocarbon dating.

## GLACIOMARINE FEATURES ALONG THE WEST COAST OF COMMITTEE BAY

The main marine features identified within the study area include glaciomarine deltas, wave-washed zones, nearshore sand and silt deposits, reworked ice-pushed beach ridges, and thick offshore marine silt and clay. Their distribution indicates that postglacial marine invasion was extensive in the northern and extreme eastern portions of the map area (Fig. 2a). Some marine features were found up to approximately 50 km inland from the present-day Committee Bay coastline. The highest marine feature identified is a glaciomarine deltaic deposit located less than 8 km from the coast at an elevation of about 255 m a.s.l. (Table 1, site 3).

### *Deltaic features*

Five deltaic features (sites 1 to 4, 20; Fig 2a) were observed within the map area. Four of these are located within 25 km of the present-day Committee Bay coastline at elevations ranging from 240 m to 255 m a.s.l. (Fig. 3a, b; Table 1). Only one delta (site 4) is located approximately 50 km from the coast at about 177 m a.s.l. All these features exhibited flat-topped areas that may represent primary depositional surfaces or be the result of planation during marine regression (e.g. Dredge, 1990). However, in three cases (sites 3, 4, and 20), the deltaic features are closely associated with eskers and portions of the delta are pitted, likely due to melt out of buried ice blocks.

### *Marine-washed zones*

Washed zones are commonly observed below the local marine limit (e.g. Dredge, 1990). Within the map area, they are typically characterized by an abrupt change from till veneer (<1 m thick) to bare washed rock, or from sandy silt till to wave-washed, loose, sandy till. In both cases, bedrock or till surfaces have undergone marine wave action, which eroded unconsolidated deposits to bedrock or winnowed the fine-grained fraction of the till matrix. Within the study area, these zones are most extensive in the northern regions of the map area and, in some cases, clear associations with raised beaches and nearshore sediments were observed.

### *Nearshore sediments*

Nearshore sediments include those marine sediments deposited in foreshore (beach) and shoreface environments. The foreshore environment occupies the zone above the low-tide limit whereas the shoreface is defined as the zone between the low-tide limit and fair-weather wave base (Walker and Plint, 1992). Within the study area, nearshore facies are characterized by interstratified silt and fine sand (lower shoreface) to massive, coarse, pebbly sand (foreshore).

#### Sites 5 and 19

A series of gravel ridges wrapping around topographic highs are found in the southeastern corner of map area NTS 57 A. They occur at progressively lower elevations from approximately 15 km inland to less than 1 km from the west-central coast of Committee Bay (sites 5 and 19; Fig. 2a, b). They range in height from 15 cm to 1 m (increasing landward) and are composed exclusively of matrix-free, angular, Paleozoic carbonate clasts. At site 5 (117 m a.s.l.), the average clast a-axis is approximately 30 cm long whereas at site 19 (52 m a.s.l.), it is approximately 2 cm long (*see* Dredge, 2002, Fig. 34).

Given the coarse, angular, monolithological nature of the deposit, these ridges are interpreted to be derived from a local bedrock source (Wheeler et al., 1997); their genesis is attributed to frost shattering and seasonal pushing of sea ice up the beach during storm events, thereby forming concentrically descending ice-pushed beach ridges as relative sea level dropped over time. At site 19, a tree trunk approximately 4.5 m long and 30 cm in diameter was found buried approximately 20 cm beneath the surface (Fig. 4a, b); a conventional radiocarbon age is pending.

#### Sites 7, 8, and 14

A composite (i.e. comprised of three sites), coarsening-upward, marine regression sequence (Fig. 2a, 5) is found less than 2 km from the present-day coastline at 94 m a.s.l. The basal approximately 10 m comprise horizontally to subhorizontally stratified, fossiliferous marine silt and clay. This is overlain by a 5 m thick unit of interstratified silt and sand with rare pebbly horizons. A 1 m thick cap of massive pebbly sand with a beach-ridge surface morphology overlies the sequence.

The series of berms characterizing the uppermost surface of the nearshore sediments are interpreted to be receding paleo-water-level positions associated with relative sea-level

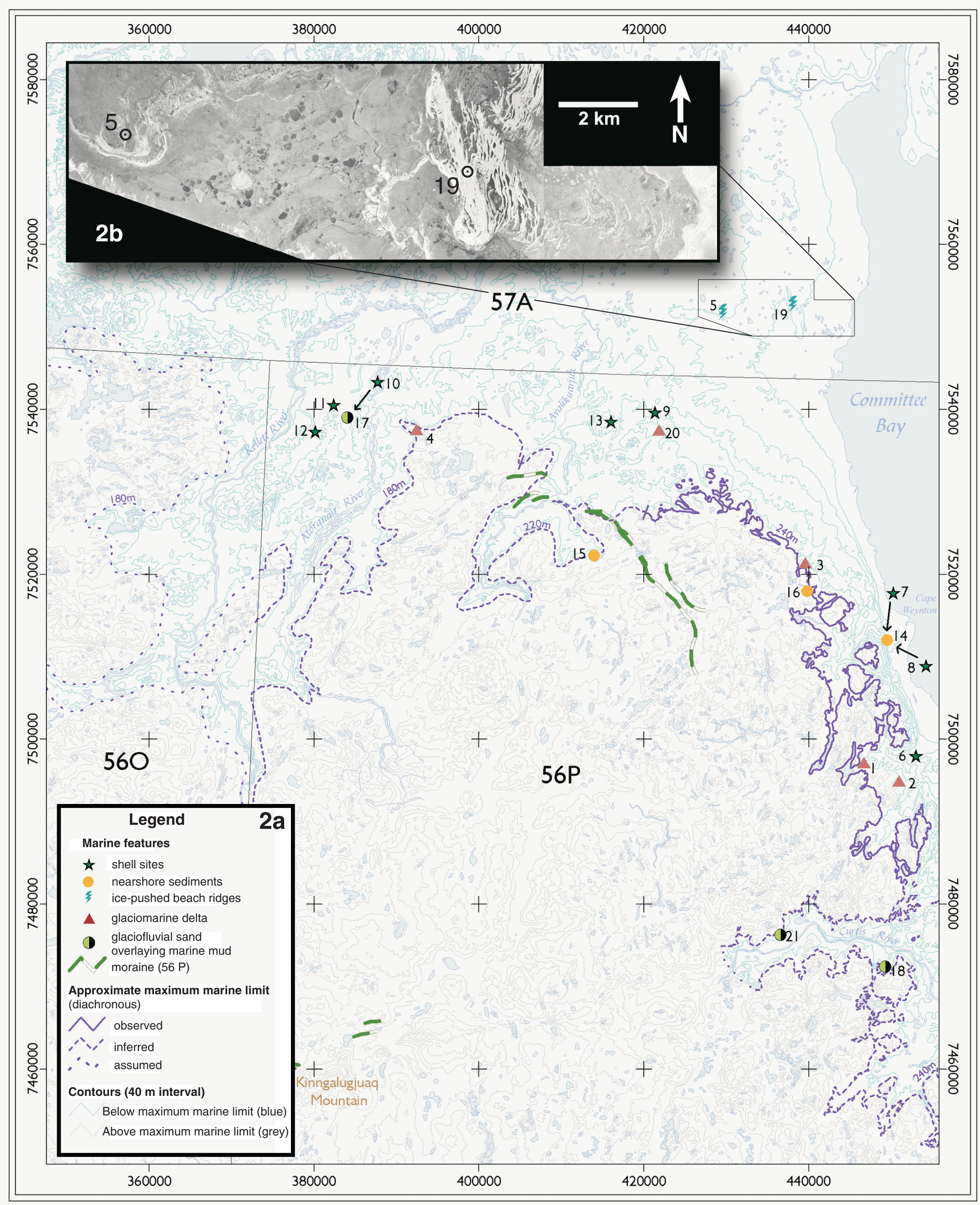


***Figure 2. a**) Site location map with estimated, predictive, westward-decreasing maximum marine-transgression limits (approximately 240 m, 220 m, and 180 m a.s.l., respectively) and primary marine features. **b**) Airphoto of ice-pushed beach ridges and sites 5 (117 m a.s.l.) and 19 (52 m a.s.l.).*

**Table 1.** Site list for marine features observed within the NTS 56 P map area.

| Sites | Easting | Northing | Elevation (m) | Marine features | Remarks |
|---|---|---|---|---|---|
| 1 | 446740 | 7497146 | 240 | Glaciomarine delta | |
| 2 | 450999 | 7494868 | 240 | Glaciomarine delta | |
| 3 | 439640 | 7521372 | 255 | Glaciomarine delta | Ice-contact esker and glaciomarine delta |
| 4 | 392453 | 7537523 | 177 | Glaciomarine delta | Ice-contact esker and glaciomarine delta |
| 5 | 429606 | 7551817 | 117 | Ice-pushed beach ridges | Beach ridges composed of local monolithic clasts of limestone |
| 6 | 453038 | 7497972 | 90 | Marine silt and clay; in situ shell | *Portlandia arctica* |
| 7 | 449528 | 7512019 | 90 | Marine silt and clay; shell lag/colluvium | *Hiatella arctica* |
| 7 | 449528 | 7512019 | 90 | Marine silt and clay; shell lag/colluvium | *Macoma calcarea* |
| 7 | 449528 | 7512019 | 90 | Marine silt and clay; shell lag/colluvium | *Mya truncata* |
| 8 | 449597 | 7511836 | 76 | Marine silt and clay; shell lag/colluvium | *Hiatella arctica* |
| 8 | 449597 | 7511836 | 76 | Marine silt and clay; shell lag/colluvium | *Macoma calcarea* |
| 8 | 449597 | 7511836 | 76 | Marine silt and clay; shell lag/colluvium | Species not identified |
| 8 | 449597 | 7511836 | 75 | Marine silt and clay; in situ shell | *Mya truncata* |
| 9 | 421394 | 7539656 | 152 | Marine silt and clay; shell lag/colluvium | *Clinocardium ciliatum* |
| 9 | 421394 | 7539656 | 152 | Marine silt and clay; shell lag/colluvium | *Hiatella arctica* |
| 9 | 421394 | 7539656 | 152 | Marine silt and clay; shell lag/colluvium | *Balanus cretanus* |
| 9 | 421394 | 7539656 | 152 | Marine silt and clay; shell lag/colluvium | Species not identified |
| 9 | 421394 | 7539656 | 152 | Marine silt and clay; shell lag/colluvium | *Macoma calcarea* |
| 9 | 421394 | 7539656 | 152 | Marine silt and clay; shell lag/colluvium | *Mya truncata* |
| 9 | 421394 | 7539656 | 156 | Marine silt and clay; shell lag/colluvium | Casts and moulds of various shell species |
| 9 | 421394 | 7539656 | 156* | Marine silt and clay; in situ shell | *Portlandia arctica* |
| 9 | 421394 | 7539656 | 156** | Marine silt and clay; in situ | Skins of shells and organic matter |
| 9 | 421394 | 7539656 | 156*** | Marine silt and clay; shell lag/colluvium | *Hiatella arctica* and *Mya truncata* |
| 10 | 384061 | 7539043 | 106 | Marine silt and clay; shell lag/colluvium | *Portlandia arctica* |
| 10 | 384061 | 7539043 | 106 | Marine silt and clay; shell lag/colluvium | *Macoma calcarea* |
| 10 | 384061 | 7539043 | 106 | Marine silt and clay; shell lag/colluvium | *Mya truncata* |
| 11 | 382418 | 7540572 | 116 | Marine silt and clay; shell lag/colluvium | *Serripes groenlandicus* |
| 11 | 382418 | 7540572 | 116 | Marine silt and clay; shell lag/colluvium | *Mya pseudoarenaria* |
| 11 | 382418 | 7540572 | 116 | Marine silt and clay; shell lag/colluvium | Species not identified |
| 11 | 382418 | 7540572 | 116 | Marine silt and clay; shell lag/colluvium | *Portlandia arctica* |
| 12 | 380179 | 7537315 | 83 | Marine silt and clay; shell lag/colluvium | *Mya truncata* |
| 12 | 380179 | 7537315 | 83 | Marine silt and clay; shell lag/colluvium | *Portlandia arctica* |
| 12 | 380179 | 7537315 | 83 | Marine silt and clay; shell lag/colluvium | *Hiatella arctica* |
| 12 | 380179 | 7537315 | 84 | Marine silt and clay; shell lag/colluvium | *Macoma calcarea* |
| 13 | 416016 | 7538531 | 170 | Marine silt and clay; shell lag/colluvium | *Mya truncata* |
| 14 | 449528 | 7512019 | 82 | Nearshore sediments | Six metres of nearshore sand overlaying marine silt and clay |
| 15 | 413939 | 7522252 | 225 | Nearshore sediments | Raised beaches and nearshore silt |
| 16 | 439832 | 7517969 | 247 | Nearshore sediments | Small pocket beaches and nearshore silt in closed basin |
| 17 | 384081 | 7538967 | 125 | Glaciofluvial sand overlaying marine mud | Sand overlaying marine mud west of Atorquai River |
| 18 | 449320 | 7472360 | 188 | Glaciofluvial sand overlaying marine mud | South of Curtis River |
| 19 | 438077 | 7552784 | 52 | Ice-pushed beach ridges | Tree found in one of the ice-pushed ridges |
| 20 | 421865 | 7537460 | 250 | Glaciomarine delta | Ice-contact esker and glaciomarine delta |
| 21 | 436623 | 7476214 | 196 | Glaciofluvial sand overlaying marine mud | North of Curtis River |

*Articulated individual found approx. 50 cm below the surface (155.5 m a.s.l.).
**Skins of shells and organic matter found approx. 50 cm below the surface (155.5 m a.s.l.) at the same section as 156A
***Shells found below 60 cm (approx. 155 m a.s.l.) in permafrost at the same section as 156A

fall. The berm crests are subdued, with wavelengths much greater than amplitude (<1 m), suggesting that the marine regression was rapid.

Two nearshore sand samples were collected for optical luminescence dating, one approximately 75 cm below the surface to constrain the age of a late phase of marine regression, and another from the first sandy stratum above the marine silt (about 570 cm below the surface) to constrain an earlier phase of marine regression.

### Site 15

In the north-central part of the map area, a nearshore sequence of marine sediments exhibits a well developed raised beach berm and an associated offshore transition zone. It lies adjacent to a glaciofluvial complex located approximately 36 km from the present-day coast. The beach sediments occur at approximately 225 m a.s.l. and form a 1 m high embankment of well sorted, coarse sand with cryogenic involutions. Both grain size and slope (<5°) diminish gradually from the beach sand to the offshore clay farther west.

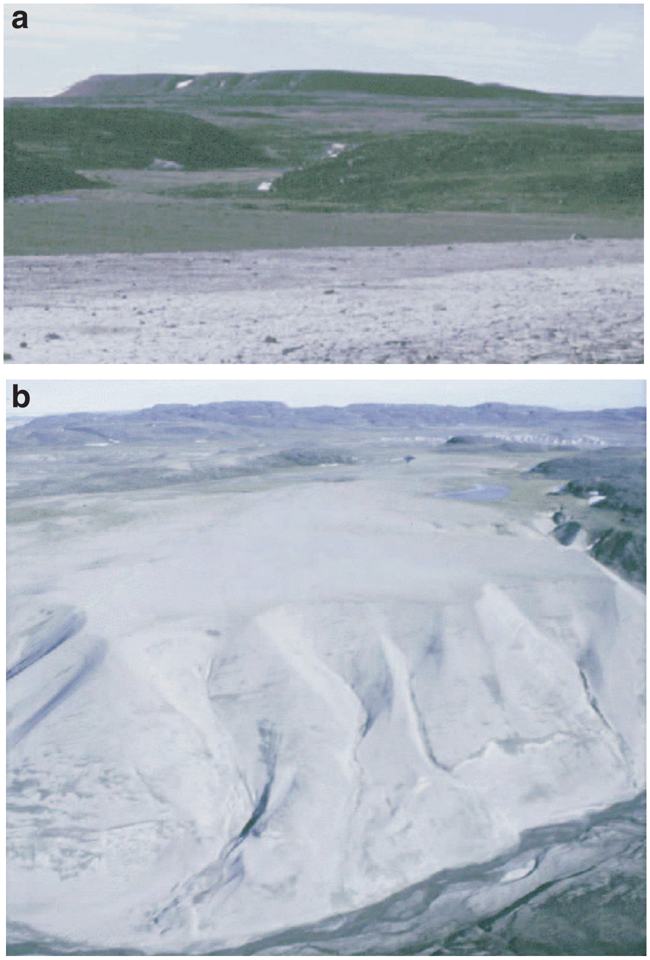

*Figure 3.* **a**) *Ice-contact delta (250 m a.s.l.) at site 20 photographed from offshore marine mud (156 m a.s.l.) at site 9.* **b**) *Large delta (site 2) at the mouth of a glaciofluvial system (240 m a.s.l.).*

*Figure 4.* **a**) *Exhumation of a 4.5 m long tree stump from ice-pushed beach ridges at site 19 (52 m a.s.l.).* **b**) *Close-up of tree stump sampled for* $^{14}C$ *dating.*

**Site 16**

Discontinuous sandy beaches are present approximately 5 km west of the coastline at 247 m a.s.l. They occur 300 m west of and 3 m above cryogenically heaved-up deposits of very well sorted nearshore silt situated within a closed oval basin. The beach deposits are less than 50 cm thick and composed of poorly sorted (due to colluvial and cryogenic processes), very fine to coarse sand overlying a fine to very coarse gravelly sand horizon. The beaches are at the same elevation on both sides of the basin and are bounded at higher elevations by a zone of washed and frost-shattered bedrock (felsenmeer). A till veneer covers the bedrock above the felsenmeer.

### *Horizontally stratified marine mud*

Glaciomarine sediments deposited in offshore environments occur throughout the northern and extreme eastern peripheries of the study area, mainly in broad river valleys and coastal plains. They consist predominantly of rhythmic, horizontally to subhorizontally stratified silt and clay (Fig. 6a) and are locally fossiliferous. Upon closer inspection, both silt and clay beds typically exhibit laminae (e.g. site 6), although rare massive silty clay occurs in some localities (e.g. site 9). Where present, the contact between silt and clay layers is typically well defined. The characteristic erosional morphology

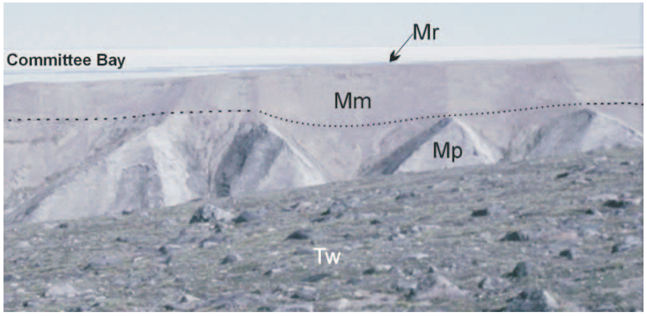


*Figure 5. Nearshore sediments comprising foreshore (Mr) and shoreface (Mm) facies. These overlie deeper water glaciomarine silt and clay strata (Mp). A washed-till surface is in the foreground (Tw).*

of the offshore marine sediments mimics the classic 'badlands topography' (Fig. 6b) and is attributed to extensive post-emergence gully-and-rill erosion (Fig. 6c). The high-latitude Arctic species *Portlandia arctica* was observed in situ within these sediments; other larger and more robust species occur as a lag on the present-day erosional surface of these marine sediments. Species and site depositional environments are described below and in Table 2.

### Site 6

Marine sediments occurring in a valley floor approximately 2 km from the coast at about 90 m a.s.l. have yielded two in situ specimens of *Portlandia arctica* (Fig. 7a) within rhythmically stratified, clay-rich beds. The first, an articulated specimen measuring 0.7 cm across its long axis, was found at 38 cm below the surface; the second, a single valve 1.7 cm across, was found at a depth of 50 cm. Both specimens were lying long axis parallel to bedding planes. In addition to these rare in situ specimens, inarticulated valves of *Hiatella arctica* were collected from the surface of these marine sediments.

Clasts of Paleozoic carbonate rocks were also found on the surface at this site. As there is no known source of Paleozoic carbonate rocks near site 6 and the local till units are noncalcareous, these erratic clasts are interpreted to be dropstones in marine sediments rafted to the site by icebergs in paleo-Committee Bay. They could have been entrained by ice from Paleozoic carbonate sources on Wales Island (Dredge, 2002, Fig. 2, 37) and/or the eastern margin of Melville Peninsula (Dredge, 1995, Fig. 2, 44B, 2000).

### Sites 7, 8, and 14

Southwest of Cape Weynton, a thick deposit of nearshore sand overlies marine silt and clay (Fig. 2a; *see* description in 'Nearshore sediments'). Numerous specimens of *Hiatella arctica* (Fig. 7b), *Mya truncata* (Fig. 7c), and *Macoma calcarea* (Fig. 7d) were collected from the shell and clast lag overlying the marine sediments. A few in situ *Mya truncata* fragments were also collected from marine mud just below the offshore mud-nearshore sand contact.

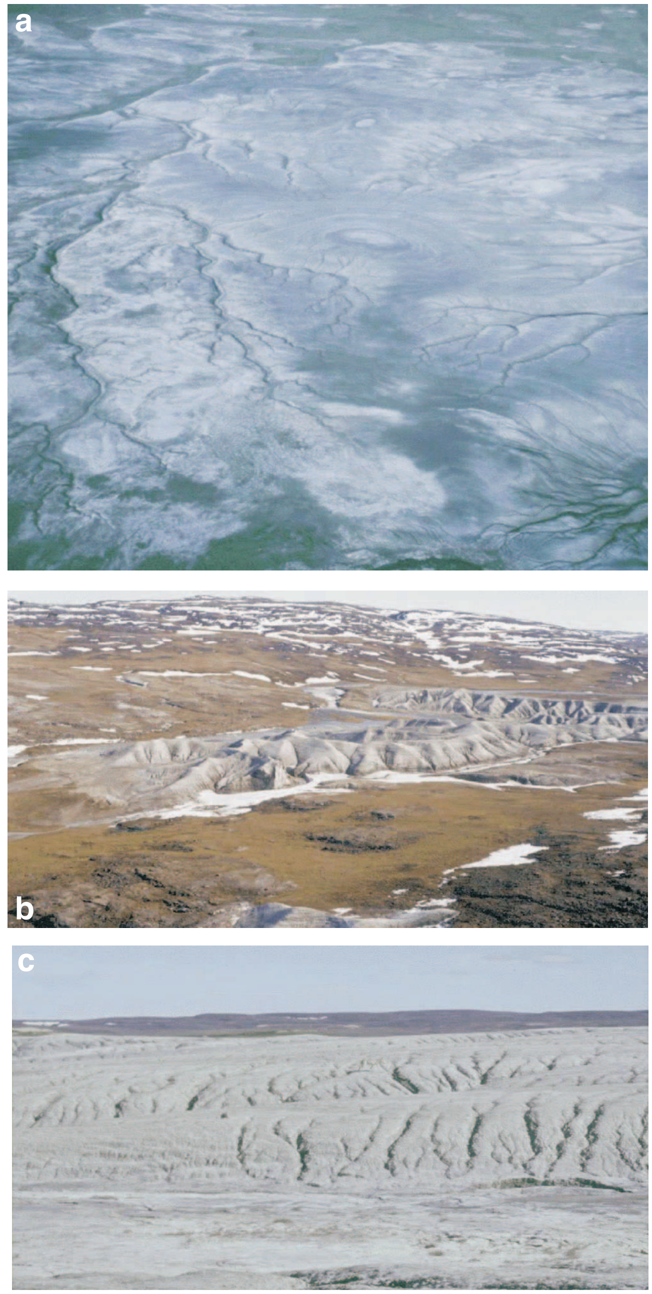


***Figure 6. a**) Oblique airphoto of extensive horizontally stratified marine silt and clay deposits typical of offshore environments. **b**) Oblique airphoto of 'badlands' type topography characteristic of fine-grained offshore marine silt and clay deposits (near site 6). **c**) Example of extensive gully-and-rill systems that are typical in offshore marine silt and clay deposits (east of site 3).*

**Table 2.** List of environments for species observed below the marine limit in map area NTS 56 P (summarized from Wagner, 1970; Hillaire-Marcel, 1980; Lubinsky, 1980; Rodriges, 1980).

| Class | Order | Family | Genus | Species | Environment | Bathymetry | Type of sediment | Salinity (ppt) | Temperature |
|---|---|---|---|---|---|---|---|---|---|
| Bivalvia | Protobranchia | Nuculanidae | *Portlandia* | *arctica* | High-Arctic. Along glacier front | 10–400 m | pebbly clay, sandy clay, clay, silty clay | 15–34 (relatively stenohaline,can tolerate dillution by meltwater) | < or = 0°C |
| Bivalvia | Eulamellibranchia | Saxicavidae | *Hiatella* | *arctica* | Arctic | 0–100 m, avg.15 m | gravel, sand, sandy clay. Epibenthos | 15–34 (stenohaline,tolerant to low salinity; > 8ppt) | 0–12°C. Eurythermal |
| Bivalvia | Eulamellibranchia | Tellinidae | *Macoma* | *calcarea* | Circumboreal distribution | 6–140 m, avg 10–35 m | sandy clay, mud | > 30 (ultrahaline) | close to 0°C |
| Bivalvia | Eulamellibranchia | Myacidae | *Mya* | *truncata undevallensis* | Arctic | In the intertidal and upper sublittoral zone | pebbly clayey sand | > 30 (ultrahaline) | depth dependent |
| Bivalvia | Eulamellibranchia | Myacidae | *Mya* | *pseudoarenaria* | Arctic | n.a. | n.a. | n.a. | n.a. |
| Bivalvia | Veneroida | Cardiidae | *Clinocardium* | *ciliatum* | Panarctic-boreal | Intertidal zone to 30 m. Locally in deeper water | sandy facies | > 30 (ultrahaline) | close to 0°C |
| Crustacea | Balanomorpha | Balanidae | *Balanus* | *cretanus* | Arctic | 5–15 m | require a suitable support. Epibenthos | euryhaline | n.a. |
| Bivalvia | Eulamellibranchia | Cardiidae | *Serripes* | *groenlandicus* | Circumpolar and pan-arctic | Intertidal zone to 30 m. Locally in deeper water | n.a. | > 30 (ultrahaline) | close to 0°C |

n.a.= not available

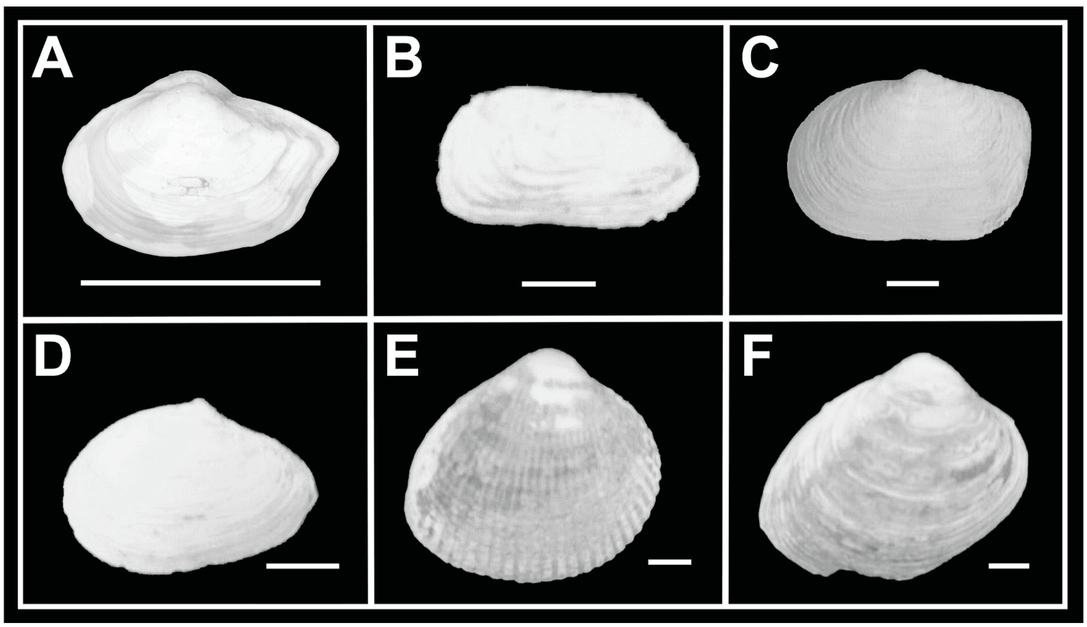


***Figure 7.*** *Examples of species collected from marine sediments (*see *text for a discussion of environmental settings).* ***a)*** Portlandia arctica*;* ***b)*** Hiatella arctica*;* ***c)*** Mya truncata*;* ***d)*** Macoma calcarea*;* ***e)*** Clinocardium ciliatum*;* ***f)*** Serripes groenlandicus.

### Site 9

A small deposit of marine mud approximately 30 km from the coast at 156 m a.s.l. yielded abundant diverse shell species. All have been identified from other sites and were present at this site either as a lag on the surface of the marine sediments or as concentrated bedload within streams and gullies draining this site. They include *Hiatella arctica*, *Mya truncata*, *Macoma calcarea*, and *Clinocardium ciliatum* (Fig. 7e). Three species that were only observed at this site were also identified, including *Serripes groenlandicus* (Fig. 7f), *Mya pseudoarenaria*, and *Balanus crenatus* (fragmented). Moreover, in situ articulated specimens of *Portlandia arctica* were collected from clay-rich marine sediments at depths of 50 cm and 60 cm below the surface; accelerated mass spectrometer (AMS) $^{14}C$ ages are pending. Striated amphibolite clasts as well as Paleozoic carbonate rocks were observed as a lag on the surface of these marine sediments.

## DISCUSSION

The recognition of deltas (sites 1, 2, 3, and 20), washed zones, beaches, and nearshore sediments (site 16) at elevations between 240 m and 255 m a.s.l. suggests that a significant marine highstand event occurred along the west-central coast

**Table 3.** Radiocarbon ages collected from peat beds 85 km south of site 4. These ages represent a minimum age of deglaciation in the region.

| Location | | Laboratory | | Age normalized | $\delta^{13}C$ | Calibrated age* |
| --- | --- | --- | --- | --- | --- | --- |
| Latitude | Longitude | number | Material | to ($\delta^{13}C$) content | (‰) | (cal. yrs BP) |
| 67°02′ 21″ | 90°32′ 01″ | GSC-6643 | peat | 6060 ± 100 | -22.7 | 6820 ± 330 |
| | | GSC-6644 | peat | 6010 ± 100 | -24.1 | 6830 ± 160 |

*calibrated using Stuiver et al., 1998

of Committee Bay. Since these are the highest marine features present within the study area, they denote a first-order approximation of the highest maximum marine transgression limit (Fig. 2a); this is corroborated by Dredge (1990, 1995). Therefore, an inferred age range of ca. 9000 to 8600 cal. years BP is associated with initial deglaciation and marine incursion along the west-central coast of Committee Bay.

Because of isostatic uplift, however, the maximum elevation of marine incursion is not constant over time throughout the study area. In the north-central and northeastern portions of map area 56P, this diachronous limit decreases with increasing distance from the coast: the uppermost beach at site 15 (Fig. 2a) denotes a local maximum marine limit of about 220 m whereas the ice-contact deltaic feature at site 4 (Fig. 2a) is at about 177 m a.s.l. This latter feature is *tentatively* interpreted to be penecontemporaneous with an early to mid-Holocene, 170 to 180 m a.s.l. marine limit identified by Dredge (2002) for the western Rae Isthmus region (ca. 7000 cal. years BP). This is based on the aforementioned lower limiting age of early deglaciation (ca. 9000–8600 cal. years BP) and upper limiting deglaciation ages inferred from peat samples located approximately 85 km southwest of site 4 (NTS 56-O/2; Table 3).

Successive marine highstands during the early to mid-Holocene also resulted in the deposition of horizontal to subhorizontal, fine-grained marine strata at offshore positions (sites 6, 9, 10, 11, and 12). *Portlandia arctica* is the only articulated bivalve species found in situ within clay-rich marine sediments and is associated with extremely cold, brackish, ice-proximal water (e.g. Hillaire-Marcel, 1980; Lubinsky, 1980; Gordillo and Aitken, 2001). Moreover, the presence of ice-rafted carbonate clasts from Melville Peninsula (sites 6 and 9) in addition to ice-contact delta formation at sites 3 and 20 suggest that glaciomarine deposition associated with the absolute maximum marine transgression limit (about 240–255 m a.s.l.) occurred along a proximal ice-margin zone during early deglacial conditions.

As ice retreated southwestward (*see* McMartin et al., 2003), subsequent isostatic uplift caused marine regression that resulted in the deposition of nearshore sand over the deep-water marine mud (e.g. sites 7, 8, and 14; Fig. 5). During this phase, successive communities of marine fauna occupied the sites as environmental conditions (e.g. bathymetry, salinity, and temperature) changed with time.

A particular succession of species is identified within the study area. During the early phase of deglaciation, the first species to colonize the ice-proximal marine environments were *Portlandia arctica*, immediately followed by *Hiatella arctica*, *Mya truncata*, and *Macoma calcarea*. As the ice margin retreated inland, waters warmed slightly and increased in salinity. During mid- and late-deglacial phases, species diversity increased through time as other species such as *Serripes groenlandicus* and *Clinocardium ciliatum* were introduced. *Balanus cretanus*, the only crustacean found within the study area, colonized the foreshore environment immediately before the final emergence of the basin. This succession of species is commonly observed in regressive glaciomarine environments and has been recognized by several researchers (e.g. Hillaire-Marcel, 1980; Gordillo and Aitken, 2001).

A succession of erosional phases has also taken place within the study area. From early deglacial phases through to the present day, isostatic uplift has caused the nearshore environment to retreat, resulting in accentuated erosion and the removal of loose nearshore sand and silt. At some sites, typically in the western portion of the map area, isostatic uplift and relative sea-level fall have caused proglaciofluvial channels to cut into marine sediments. This initial intensive erosion of the landscape is attributed to rates of uplift of as much as 10 m/century (Dyke and Dredge, 1989), which caused fluvial and colluvial processes to rapidly erode sediments previously deposited during relatively stable glaciofluvial and glaciomarine highstands (e.g. deltas and horizontally stratified marine mud). The end results of the drastically changing base level and greatly accentuated erosional processes are high, steep embankments and deep cuts into existing deltaic, marine, and glaciofluvial landforms. Decreasing uplift over time attenuated erosion rates and, in some cases, allowed for deposition of proglacial and modern alluvium sand on top of incised glaciomarine mud (e.g. sites 17, 18, and 21); presently, uplift rates of approximately 0.5 m/century (Dyke and Dredge, 1989) result in a relatively modest accentuation of erosion that is gradually modifying the spatial distribution and characteristics of glaciogenic deposits.

## CONCLUSIONS

Early deglaciation of the region resulted in the formation of a marine inlet within the present-day Committee Bay region. This marine incursion allowed the formation of a number of geomorphic features including ice-contact deltas, proglacial deltas, beaches, washed zones, and nearshore sediments. The uppermost limit of these features occurs between 240 m and 255 m a.s.l. and marks the absolute maximum marine transgression limit. Through association with similar marine limits at comparable elevations along the northeast coast of Committee Bay, an early deglacial age estimate of 9000 to 8600 cal. years BP is tentatively associated with this limit.

Lower marine limits at about 220 m a.s.l. and about 180 m a.s.l. are associated with later phases of marine regression and southwestward retreat of the ice-sheet margin; the lowest observed limit likely formed during the early to middle Holocene, on the basis of the timing of early regional deglaciation and minimum deglaciation ages (ca. 6800 cal. years BP) obtained from peat located 85 km southwest of that limit.

Offshore sediments containing in situ, ice-proximal marine species (e.g. *Portlandia arctica*) are associated with early deglacial phases. Subsequent isostatic uplift resulted in a shallowing of these environments, depositing sandy substrates and allowing nearshore species such as *Mya truncata*, *Macoma calcarea*, and *Clinocardium ciliatum* to inhabit the sites. Continued uplift resulted in emergence of these sites, some of which were then eroded by meltwater systems that deposited proglacial and modern alluvial sand over marine silt and clay.

During early deglaciation, erosive processes were greatly accentuated in the region as a result of uplift rates of 10 m/century. During this time, mass-wasting processes would have dominated the landscape, producing deep erosional scars. Decreasing isostatic uplift rates attenuated later erosional processes (relative to the early deglacial phase); current estimates of uplift in northern Keewatin are 0.5 m/century.

Future work involves obtaining radiocarbon ages from shells and wood and optical ages from deltas and nearshore sand. These quantitative age estimates will increase our ability to understand the relationships and chronology of events that gave rise to the present-day distribution of glacial and emerged glaciomarine sediments.

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## REFERENCES

**Burgess, M.M., Riseborough, D.W., and Smith, S.L.**

2001: Permafrost and glaciers/icecaps monitoring networks workshop report on the permafrost sessions: a contribution to the development of the Canadian GCOS-Global Climate Observing System-Cryosphere Plan; Geological Survey of Canada, Open File D4017, 49 p.

**Craig, B.G.**

1961: Surficial geology of Northern District of Keewatin Northwest Territories; Geological Survey of Canada, Paper 61-5, 8 p.

1965: Notes on moraines and radiocarbon dates in northwest Baffin Island, Melville Peninsula, and the northeast District of Keewatin; Geological Survey of Canada, Paper 65-20, 7 p.

**Dredge, L.A.**

1990: The Melville Moraine: sea-level change and response to the western margin of the Foxe Ice Dome, Melville Peninsula, Northwest Territories; Canadian Journal of Earth Sciences, v. 27, p. 1215–1224.

1995: Quaternary geology of northern Melville Peninsula, Northwest Territories; Geological Survey of Canada, Bulletin 484, 114 p.

2000: Carbonate dispersal trains, secondary till plumes, and ice streams in the west Foxe Sector, Laurentide Ice Sheet; Boreas, v. 29, p. 144–156.

2002: Quaternary geology of southern Melville Peninsula, Nunavut; Geological Survey of Canada, Bulletin 561, 110 p.

**Dyke, A.S. and Dredge, L.A.**

1989: Quaternary geology of the northwestern Canadian Shield; *in* Chapter 3 of Quaternary Geology of Canada and Greenland, (ed.) R.J. Fulton; Geological Survey of Canada, Geology of Canada, no. 1, p. 189–214 (*also* Geological Society of America, The Geology of North America, v. K-1, p. 189–214).

**Dyke, A.S. and Prest, V.K.**

1987: Paleogeography of northern North America, 18 000–5 000 years ago; Geological Survey of Canada, Map 1703A, scale 1:12 500 000.

**Gordillo, S. and Aitken, A.E.**

2001: Post glacial succession and palaeoecology of Late Quaternary macrofaunal assemblages from the central Canadian Arctic Archipelago; Boreas, v. 30, p. 61–72.

**Hillaire-Marcel, C.**

1980: Les faunes des mers post-glaciaires du Quebec : quelques considérations paléoécologiques; Géographie Physique et Quaternaire, vol. 34, p. 3–59.

**Little, E. C.**

2001: Preliminary results of relative ice-movement chronology of the Laughland Lake map area, Nunavut; Geological Survey of Canada, Current Research 2001-C14.

**Little, E.C., Ferbey, T., McMartin, I., Ozyer, C.A., and Utting, D.J.**

2002: Overview of Quaternary research for the Committee Bay Project, central Nunavut; Geological Survey of Canada, Current Research 2002-C13, 12 p.

**Lubinsky, I.**

1980: Marine bivalve molluscs of the Canadian Central and Eastern Arctic: faunal composition and zoogeography; Canadian Bulletin of Fisheries and Aquatic Sciences, v. 207, 111 p.

**McMartin, I., Little, E.C., Ferbey, T., Ozyer, C.A., and Utting, D.J.**

2002: Drift prospecting across the Committee Bay greenstone belt, central mainland, Nunavut (NTS 56 K, 56 J-north, 56 J-south); Geological Survey of Canada, Open File 4277.

2003: Ice-flow history and drift prospecting in the Committee Bay belt, central Nunavut: results from the Targeted Geoscience Initiative; Geological Survey of Canada, Current Research 2003-C4.

**Rodrigues, C.G.**

1980: Late Quaternary invertebrate faunal associations and chronology of the western Champlain Sea Basin; *in* The Late Quaternary Development of the Champlain Sea Basin, (ed.) N.R. Gadd; Geological Association of Canada, Special Paper 35, p. 155–176.

**Skulski, T., Sandeman, H., Sanborn-Barrie, M., MacHattie, T., Young, M., Carson, C., Berman, R., Brown, J., Rayner, N., Panagapko, D., Byrne, D., and Deyell, C.**

2003: Bedrock geology of the Ellice Hills and new constraints on the regional geology of the Committee Bay area, Nunavut; Geological Survey of Canada, Current Research 2003-C22.

**Stuiver, M. and Braziunas**

1993: Modeling atmospheric $^{14}C$ influences and $^{14}C$ ages of marine samples to 10 000 B.C.; Radiocarbon, v. 35, p. 137–189.

**Stuiver, M., Reimer, P.J., Bard, E., Beck, W.J., Burr, G.S., Hughen, K.A., Kromer, B., McCormac, G., van der Plicht, J., and Spurk, M.**

1998: Intcal98 radiocarbon age calibration, 24 000–0 cal B.P.; Radiocarbon, v. 40, p. 1041–1083.

**Wagner, F.J.E.**

1970: Faunas of the Pleistocene Champlain Sea; Geological Survey of Canada, Bulletin 181, 91 p.

**Walker, R.G. and Plint, A.G.**
1992: Wave- and storm-dominated shallow marine systems; *in* Facies Models: Response to Sea-level Change, (ed.) R.G. Walker and N.P. James; Geological Association of Canada, p. 219–238.

**Wheeler, J.O., Hoffman, P.F., Card, K.D., Davidson, A., Sanford, B.V., Okulitch, A.V., and Roest A.R. (comp.)**
1997: Geological map of Canada; Geological Survey of Canada, Map D1860A, scale 1:3 500 000.

**Wright, G.M.**
1967: Geology of the southeastern barren grounds, parts of the districts of Mackenzie and Keewatin; Geological Survey of Canada, Memoir 350, 91 p.

Geological Survey of Canada Project 000005