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GEOLOGICAL SURVEY OF CANADA — COMMISSION GÉOLOGIQUE DU CANADA

DESCRIPTIVE NOTES

INTRODUCTION

An examination of the Ellice Hills map sheet (NTS 56 P) surficial geology was undertaken in conjunction with reconnaissance drift prospecting and Quaternary-related research. These endeavours complement the work completed in previous years southwest of Committee Bay, Nunavut (NTS 56 K, 56 J north, and 56-O south), and serve as the final mapping effort for the Committee Bay Project *sensu stricto*.

Unique to the Committee Bay Project, the Ellice Hills map sheet area exhibits approximately 50 km of Committee Bay's west-central coastline (Fig. 1), the southern two-thirds of which are confined by topographic relief reaching ~280 m asl. Those areas in close proximity to the present-day coastline are characterized by tidal flats, post-glacial near shore sediments and partially-filled valleys containing horizontally to sub-horizontally stratified marine silt and clay. The remaining areas of this map exhibit till sheets and veneers in the highlands, extensive glaciofluvial deposits are concentrated in topographic lows (Giangioppi et al., 2003).

For the purposes of this GSC Open File, when the author refers to "study area", it refers to the entire Committee Bay Project study area that includes NTS sheets 56 K, J (north), -O (south), and P; when necessary, individual maps will be referred to either by name (e.g., Ellice Hills, Walker Lake sheets etc.) or by NTS map number (e.g., NTS 56 P or NTS 56 J north etc.). The following discussion will focus on details within the Ellice Map sheet area, but reference will be made to other maps within the study area when discussing regional interpretations.

PHYSIOGRAPHY

The Ellice Hills map sheet area falls within a zone of continuous permafrost (Burgess et al., 2001). Three primary drainage networks are found within NTS 56 P: Kellett, Atorquait, and Curtis river systems. Elevations in this region range from sea level up to ~582 m above sea level (asl) at Kinngalugjuaq Mountain. Rugged terrain characterizes the topography in areas where supracrustal rocks outcrop (southwest central and northeast regions), whereas broad valleys, plains, and rolling to hummocky terrain dominate the landscape in the remaining area.

GLACIOMARINE-RELATED GEOLOGY ALONG THE WEST COAST OF COMMITTEE BAY

Five marine-related features dominate the coastal surficial geology within the Ellice Hills map area: glaciomarine deltas (Fig. 2), wave-washed zones (Fig. 3), near shore sand and silt deposits (Fig. 3), reworked ice-pushed beach ridges (Fig. 4A) and thick offshore marine silt and clay sediments (Fig. 5A, B).

The distribution of these features indicates that post-glacial marine transgression was extensive in the northern and extreme eastern portions of the map area. Some of these marine features were found up to ca. 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 ca. 255 m asl (Table 1, site 3). Together, these features (described in Giangioppi et al., 2003) allow marine limits at 180 m, 220 m, and 240 m (locally 255 m) to be approximated (Fig. 1A, B; Table 1).

RELATIVE SEA-LEVEL CHANGE

Wood and shells associated with the above mentioned marine features have yielded ages ranging from 5.19 ± 0.07 ^{14}C ka BP (GSC-6695) to 8.87 ± 0.120 ^{14}C ka BP (TO-10684) after reservoir correction -630 was applied to the marine fauna (Dyke et al., 2005); details of these samples and others collected for glaciomarine interpretations are provided in Tables 1 and 2 respectively. Plotting the suite of ages against their respective elevations yields a reasonable isostatic half-life response; however, several factors had to be considered and some assumptions made for plotting the graph (Fig. 6):

- The highest marine limit was recorded at two deltas within 56 P. Ages of these deltas were inferred based on shell dates from offshore marine muds (site 9) associated with the 250 m delta (site 20).
- Shells with well-constrained environmental living conditions were given priority over those with less well-known or more diverse living conditions (e.g., *Mya truncata* was given priority over *Portlandia arctica*; see Giangioppi et al., 2003, Table 2).
- In situ samples were given priority over surface lag collections.
- Ages obtained from a single species were given priority over those ages obtained through multi-species samples.
- Driftwood sample should fall on the curve, whereas marine fossils should fall on or below the curve (within error) assuming no reworking or post-depositional mobilization.
- Vertical uncertainties represent the known range of water depth in which the respective molluscs live-assuming that the elevation at which they were collected represents either their in situ living depth or remobilization from higher elevations to the sampling site elevation.

Based on the criteria above, various half-life curves were plotted against the western Committee Bay data: 1,900 years, 1,700 years, and 1,500 years (Fig. 6). Of these three curves, only the 1,700-years curve intersected the data points or the uncertainty bars of all data (with two exceptions–see below) and hence is interpreted to represent the best visual fit to the western Committee Bay data (Fig. 6).

There are two sets of shells that do not support any of the proposed curves in Figure 6. The *Clinocardium cilliatum* shells from Site 9, which fall well below the curve, and for which the error bars do not intersect any of the proposed curves are interpreted to be re-mobilized. These shells were collected from the surface of the marine muds where a plethora of different species were observed (Table 1, site 9). Therefore, it is likely that this variety of shell species represents a number of different depositional environments and that the lithostratigraphic units in which they would have been originally deposited have been eroded away. The resulting observed concentrated shell-lag is interpreted to represent a stratum of condensed biostratigraphy that currently rests at much lower stratigraphic elevation than the original horizon(s). The second set in question is the *Portlandia arctica* shells from Site 6. These shells are located much farther south (Fig. 1) and are associated with deltas at a slightly lower elevation (sites 1 and 2) relative to deltas farther north (sites 3 and 20). Therefore, the shells from site 6 are likely related to an earlier marine incursion for which we have not observed any directly associated marine geomorphic features other than the sediments from which they were collected. Hence, when designing the plot of half-life response curves in Figure 6, the delta level illustrated therein at 250 m is based on the delta at Site 20, which is associated with well-constrained shell ages located at Site 9.

TERRESTRIAL QUATERNARY RECORD OF THE COMMITTEE BAY REGION

Glacial events from the last glacial maximum (LGM) to the latest deglacial phases east of Committee Bay are summarized in detail by Dredge (1990, 2001, 2002) and therefore are not reiterated herein. However, much less has been reported on the sequence of glacial events southwest of Committee Bay; the following discussion and interpretations will focus on the events as observed within the Ellice Hills map area, as they relate to evidence and interpretations from the entire Committee Bay Project study area.

PRE-LGM

There is limited evidence (number = 2) to suggest pre-LGM ice movement along the west coast of Committee Bay was to the south. From crosscutting relationships, glacial geomorphic characteristics, and comparisons with ice-movement interpretations at sites south of the study area (e.g., McMartin and Henderson (1999) near Rankin Inlet), Little (2001) speculated that a southwestward ice movement within NTS 56 K could be associated with early Wisconsinan ice build-up and advance (cf. Marine Isotope Stage 4) or possibly even the penultimate glaciation (MIS 6). The presence of suggested southward flow inferred from a roche moutonnée and a polished, north-facing facet of a tri-facetted bedrock surface in Ellice Hills (Site 22, 23, Table 3) support the notion of pre-LGM southward ice movement (Fig. 7). These data also support the model by Kleman et al. (2002) who tested an ice-spreading centre for the Central Arctic Ice Sheet north of the Committee Bay field area (see their Fig. 3b); the age associated with this spreading centre is ca. 73ka (cf. pre-LGM age association of Little, 2001).

LAST GLACIAL MAXIMUM (PHASE 1)

The LGM west of Committee Bay occurred during a distinctive early phase of ice-movement that is consistently northward, not only in the Ellice Hills map area, but also across the entire study area (Little, 2001; Little et al., 2002; Ozyer and Hicock, 2002; Little and Ferbey, 2003; Ferbey and Little, 2003; McMartin et al., 2003a,b; Ozyer, 2004; Utting, 2004a,b). With the exception of the pre-LGM phase noted above, phase 1 ice movement is the only phase that exhibits this level of coherence over an east-west distance of ~350 km. Evidence for this phase of ice movement is expressed by indicators such as striae (bi- and uni-directional), grooves, stoss-lee relationships on bedrock surfaces, sculpted bedrock ridges, and roches moutonnées (see McMartin et al., 2003a, their Appendix 2 for Committee Bay Project ice-movement indicator data). The nature of the majority of indicators associated with this phase of ice movement (e.g., roches moutonnées and bedrock ridges with preserved stoss-lee relationships), in addition to processes required for their formation, and the vector coherence across a vast distance suggests a robust ice sheet with a stable ice divide. Therefore, these conditions are associated with LGM ice movement (Little, 2001; McMartin, 2003a,b; Fig. 9A).

POST-LGM

Early and middle stages of deglaciation

The deglaciation west of Committee Bay can be subdivided into three parts: early, middle, and late stages (phases 2 through 4; Fig. 9B, C, and D respectively), with local variations in ice-movement direction due to the increasing influence of local topography (e.g. Phase 2–3 transition, Figs. 7 and 8). The earliest post-LGM phase (2) is characterized by the formation of paleo-embayments in the vicinity of the present day Committee and Pelly bays. During this "early" stage of deglaciation, ice is drawn east-northeasterly to calving fronts in the vicinity of Committee Bay, as well as to calving fronts in the vicinity of Chantrey Inlet to the northwest of the study area; together, these calving fronts resulted in a divergence of ice movement in the western and eastern regions of the study area (McMartin et al., 2003a,b; Fig. 8; Fig. 9B). The transition between phases 2 and 3 is suggested by increasing influence of topographic control on the ice movement in the northeastern regions of the study area (Fig. 7 and 8) when ice would have thinned considerably but may still have been drawn to calving fronts in Committee Bay. The end of the Phase 2–3 transition is marked by a minor retreat and still stand that is manifested by the formation of a northwest-southeast trending end moraine (north half of NTS 56 P, Fig. 9B). The middle stage of deglaciation (Phase 3) is characterized by renewed retreat of the ice margin southward, away from the aforementioned end moraine with a more northwesterly ice movement direction (south half of NTS 56 P, Fig. 9B). During this phase (3), a second series of major end moraines commonly referred to as the Chantrey Moraine system (Dyke and Prest, 1987), are clearly recognized within 56 P, 56-O (south), and 56 K (north). This moraine system denotes a significant still stand event at ca. 8 ka (Dyke, 2004). The re-orientation of these moraines into a more east-west configuration reflects the absence of calving ice fronts as the ice was no longer being drawn into the paleo-embayments; ultimately, this is of major importance for the dynamics of the Keewatin Ice Divide (KID)—the reduced drawn-down effect of the calving ice margins likely caused major changes to the orientation of the KID and its associated ice-movements. Utting (2004a) assigned ages of the ice movement events based on the regional reconstructions of the ice margin by Dyke (2004), suggesting that phase 2 likely occurred at about 9 ka, and phase 3 at about 8.28 ka. Ages from shells denoting the oldest, highest marine limits (i.e., 240–250 m) within the Committee Bay study area support these interpretations.

GEOCHRONOLOGY OF EARLY DEGLACIAL MORAINE FORMATION WITHIN NTS 56 P

Attempts were made to directly date the deposition of the northeastern-most moraine (Fig. 9B) and the deglaciation of a till veneer (Fig. 9C) north of the Chantrey Moraine system through Chlorine-36 terrestrial cosmogenic nuclide (TCN) dating of single in situ boulders resting on these respective surfaces. Details on each sample are provided in Table 4. Ages obtained from these samples should be considered as statistical equivalents (Gosse, pers. comm., 2004) due to the nature of the bedrock samples (i.e., differing erosion rates: coarse-grained biotite granodiorite versus medium-grained granodiorite), the uncertainties involved (Table 4, footnote #3), and lack of additional control samples at each site (three ages per site is recommend; Gosse, pers. comm., 2003). The uncertainties and apparent discrepancies of the ages (i.e., age reversal considering moraine positions deglacial sequence) presented in Table 4 resulted in a low-precision age correlation of these data (late pre-Holocene to early Holocene). Therefore our regional deglacial reconstructions are based primarily on radiocarbon age associations.

EVIDENCE OF ICE MOVEMENT AND FULL DEGLACIATION: RELATING FINDINGS WITHIN NTS 56 P AND ADJOINING MAPS WITHIN THE COMMITTEE BAY PROJECT STUDY AREA

Continued retreat of the ice sheet within NTS 56 P area left only localized evidence that was difficult to detect. Crosscutting relationships demonstrating post phase 3 ice movement (Fig. 9D) were noted only in 56 J.

Radiocarbon ages from two sites suggest ice had fully retreated from the southwest corner of 56-O by 6060 ± 100 ^{14}C-years BP (6820 ± 330 cal. years BP; GSC-6643; Table 5). At that time sea-level would have been approximately 80 m above the present day shoreline and the estimated post-glacial rate of isostatic uplift (indicated by the west Committee Bay curve, Fig. 6) would have been ~5.6 cm year^{-1}.

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Sites	Easting	Northing	Elevation (m)	Marine features	Remarks
1	446740	7497146	240	Glacio-marine delta	Small delta - Not shown on sheet 1
2	450118	7495304	240	Glacio-marine delta	
3	439755	7521236	255	Glacio-marine delta	Ice-contact esker and glacio-marine delta
4	392453	7537523	177	Glacio-marine delta	Ice-contact esker and glacio-marine delta
5****	429606	7551817	117	Ice-pushed beach ridges	Beach ridges composed of local monolithic clasts limestone
6	453038	7497972	92	Marine silt and clay; *in situ* shell	*Portlandia arctica*; corrected elevation from Giangioppi et al. (2003)
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	152	Marine silt and clay; shell lag/colluvium	Casts and molds 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	6 metres thick of nearshore sand overlaying marine silt and clay
15	413939	7522252	225	Nearshore sediments	Raised beaches and nearshore silts
16	439832	7517969	247	Nearshore sediments	Small pocket beaches and nearshore silts in closed basin
17	384081	7538967	125	Glacio-fluvial sand overlaying marine muds	Sand overlaying marine muds west of Atorquai river
18****	449320	7472360	188	Glacio-fluvial sand overlaying marine muds	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	Glacio-marine delta	Ice-contact esker and glacio-marine delta
21****	436623	7476214	196	Glacio-fluvial sand overlaying marine muds	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.
****Sites that are located only on Figure 1A-B.

Table 1. Site list for marine features observed within the NTS 56 P (north) map area (after Giangioppi et al. 2003).

Lab ID	Easting	Northing	Grid Zone	Elevation (m)	Table 1 Site Reference	Carbon-14 Analysis	Media	Species	δ¹³C Uncorrected Age (ka)	δ¹³C Correction	δ¹³C Corrected Age (ka)	Reservoir Corrected Age (A*–0.4ka) (ka)	Reservoir Corrected Age (B**–0.63ka)(ka)
TO-10684	453038	7497972	16	92	6	AMS	Shell	*P. arctica*	9.5 ± 0.12	0	na	9.1	8.87
BU-0202-A	421394	7539656	16	152	9	Standard	Shell	*C. ciliatum*	9.188 ± 0.18	0	na	8.788	8.558
TO-10685	421394	7539656	16	156	9	AMS	Shell	*P. arctica*	9.26 ± 0.07	0	na	8.86	8.63
BU-0208-A	382418	7540572	16	116	11	Standard	Shell	*S. groenlandicus*	7.23 ± 0.17	0	na	6.83	6.6
BU-1661-A	416016	7538531	16	170	13	Standard	Shell	*M. truncata*	8.76 ± 0.06	0	na	8.36	8.13
GSC-6695***	438077	7552784	16	52	19	Standard	Wood	*Picea spp.*	5.22 ± 0.07	-23 ‰	5.19 ± 0.07	na	na

* Reservoir Correction "A" is presented to allow for correction to papers utilizing a reservoir correction of c. –400 years (e.g., Dyke and Peltier, 2000); these shell ages are used in the sea-level curve reconstruction-I to ensure that new values presented herein are comparable to values present in papers utilizing the –400 year reservoir correction.
** Reservoir Correction "B" presents modern reservoir corrections based on Dyke et al. (2005); these shell ages are used in the sea-level curve reconstruction-II to ensure that new values presented herein are comparable to values present in papers utilizing the –630 year reservoir correction.
***Sites that are located only on Figure 1A-B.

Table 2. Radiocarbon ages collected from marine sites within NTS 56 P (north).

Sites	Easting	Northing	Elevation (m)	Terrestrial-related features	Remarks
22	451572	7500809	254	Striae on whalebacks	Possible evidence for southward flow (Figure 7)
23	451545	7500742	247	Modified roche moutonnée with glacial abraision features and facetted outcrop (three surfaces)	Possible evidence for southward flow (Figure 7)
24	441110	7522111	168	Ice-movement indicators associated with site 25 till fabric	See Figure 8
25	441100	7522082	~168*	Basal Till Fabric at ~30m depth	See Figure 8
26**	377847	7468470	355	TCN Sample: 02EL501	See Table 4 for details
27	426065	7512718	398	TCN Sample: 02EL502	See Table 4 for details

*Due to close proximity, elevation at site 25 is estimated to be similar to site 24.
**Sites that are located only on Figure 1A-B.

Table 3. Site list for terrestrial-related data observed within the NTS 56 P (north) map area.

Sample ID	Easting	Northing	Grid Zone	Boulder Lithology	Boulder Dimensions Length (cm)	Width (cm)	Height (cm)	Sample Volume Length (cm)	Width (cm)	Depth (cm)	Age (cal. years BP)	Notes
02EL501**	377847	7468470	16	Medium-grained Granodiorite: +/- hornblende, +/- biotite	227	159	166	20*	9*	7.5*	12.1 ± 2.42	1, 2, 3, 4, 5
02EL502**	426065	7512718	16	Coarse-grained Biotite Granodiorite: +/- hornblende	184	139	106	25	16	7.5	9.9 ± 1.98	1, 2, 3, 4, 6

*Two closely spaced sub-samples of the same volume were combined in order to obtain enough material for sample analyses.
**Locations of samples is depicted in Figure 9.
Reference to Notes:
1. Ages calculated using CHLOE3 (Phillips and Plummer, 1996).
2. Production rate used in age calculation follows from Phillips et al. (1996).
3. No erosion, snow cover or inheritance corrections were considered for the presented age calculations.
4. Future work: other large boulders suitable for TCN age determination and comparison were observed on each of these moraines.
5. Boulder sitting in a thin veneer of till north of the Chantrey Moraine system in south-western NTS 56 P.
6. Boulder resting on the summit of an end moraine trending northwest–southeast in north-eastern NTS 56 P.

Table 4. Terrestrial cosmogenic nuclide (TCN) ages and associated data obtained from boulders resting atop end moraines in NTS 56 P (north).

Lab Number	Easting	Northing	Grid Zone	Material	Age Normalized to (δ¹³C) content	δ¹³C (‰)	Calibrated Age** (cal. years BP)
GSC-6659	439953	7519945	16	peat	2450 ± 90	-26.7	2586 ± 169
GSC-6643*,***	607344	7437874	15	peat	6060 ± 100	-22.7	6820 ± 330
GSC-6644*,***	607344	7437874	15	peat	6010 ± 100	-24.1	6830 ± 160
GSC-6584***	572466	7424567	15	peat	3470 ± 60	-28.1	3814 ± 71

* Samples obtained from different strata at one location.
**Calibrated using Stuiver and Reimer (1993).
***Sites that are located only on Figure 1A-B.

Table 5. Radiocarbon ages obtained from: 1) an actively eroding peat pulsa (GSC-6659); 2) peat beds (GSC-6643 and GSC-6644) located 85 km southwest of site 4 (Fig. 1, Table 1), and; 3) the base of an alluvial over bank deposit sequence in NTS 56 J (GSC-6584). These ages represent minimum ages of deglaciation at each locality. The oldest ages in the southwest corner of NTS 56-O may represent the regional minimum age of deglaciation.

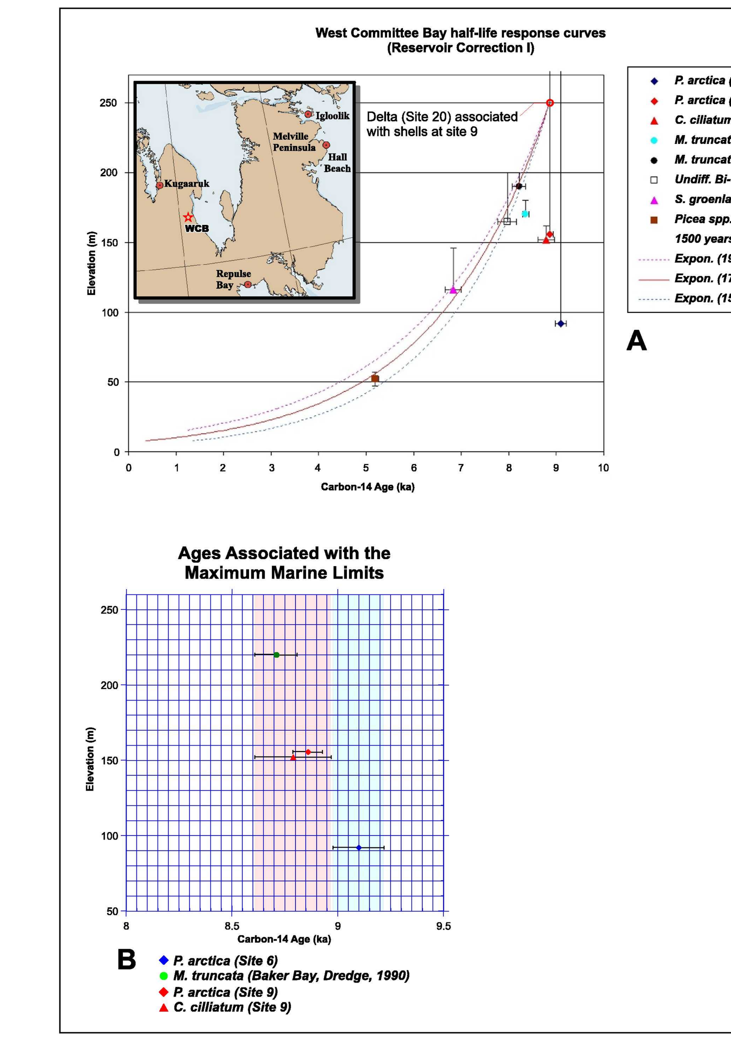

Figure 6. A. Sea level half-life response curve for samples collected along the west coast of Committee Bay. Interpreted sea-level half-life response of 1,700 yrs. **B.** Comparison plot of the oldest radiocarbon ages obtained from the Committee Bay Project study area (i.e., within NTS 56 P) and from Dredge (1990). Three of the samples are statistical equivalents and are associated with delta elevations ranging from 240–255 m, whereas one sample is statistically distinct at 1 sigma uncertainty. This latter sample may suggest that western Committee Bay was the first of these regions to experience deglaciation and marine incursion.

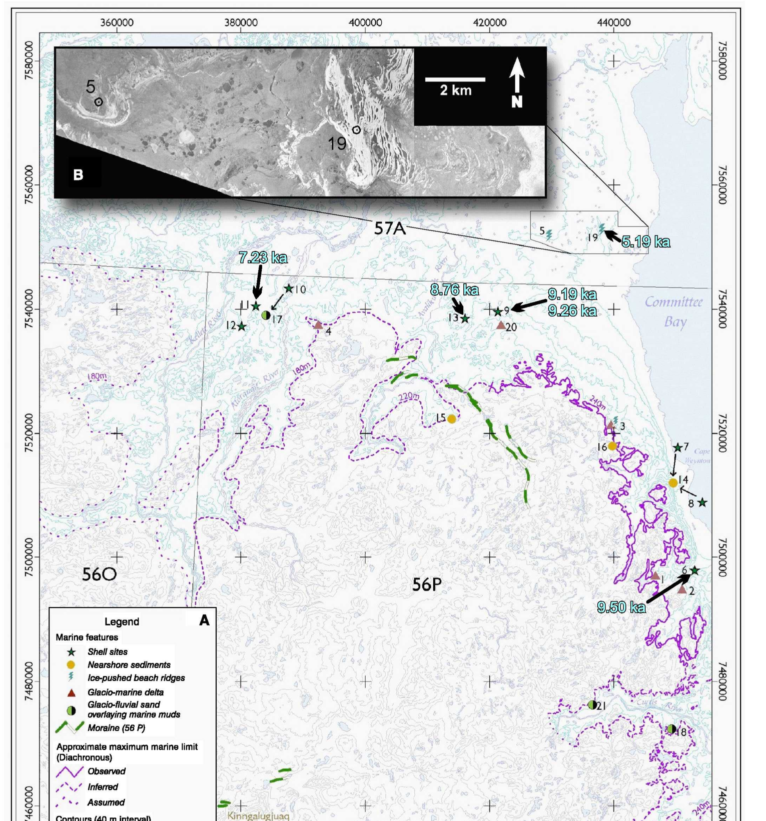

Figure 1. Marine features observed along the southwestern shore of Committee Bay, Nunavut. **A.** Illustrates generalized marine limits at 180 m, 220 m and 240 m with local high marine stands at 255 m and Carbon-14 ages of shell and wood collections (see Table 1 for details). **B.** Raised marine, ice-pushed beaches located just north of NTS 56 P. Modified after Giangioppi et al. (2003). Note: Uncorrected Carbon-14 ages are presented here. For corrected ages see Table 2.

Figure 2. A. Ice-contact delta (surface elevation: 250 m a.s.l.) at site 20 taken from offshore marine muds (elevation: 156 m a.s.l.) at site 9. **B.** Large delta (site 2) at the mouth of a glaciofluvial system; the upper surface of this delta is at an elevation of 240 m a.s.l. (from Giangioppi et al. 2003).

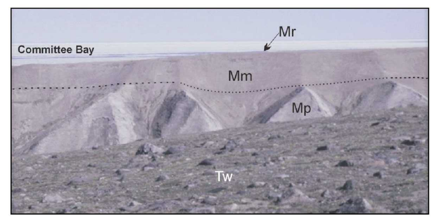

Figure 3. Photo of near shore sediments comprising foreshore (unit Mr) and shoreface (unit Mm) facies. These overlie deeper-water glaciomarine silt and clay strata (unit Mp). A washed-till surface resides in the foreground (unit Tw). Note: Washed tills are grouped under either "Tx" or "Mx" units (the amount of till interpreted to be present in a given unit by the mapper determines the final unit classification–see legend) because tills present within these polygons have been modified by marine processes (from Giangioppi et al. 2003).

Figure 4. A. Exhumation of a 4.5 m-long tree stump from ice-pushed beach ridges at site 19 (elevation: 52 m a.s.l.; see also Figure 1B and Table 1). **B.** Close-up of tree stump sampled for ^{14}C-dating (from Giangioppi et al. 2003).

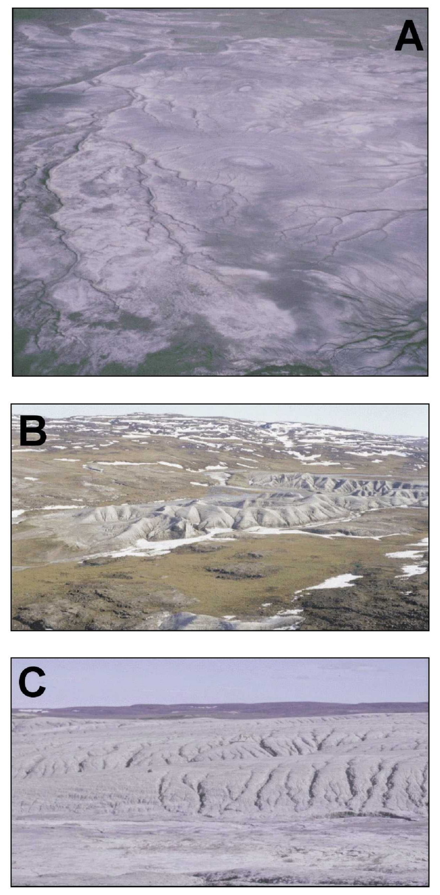

Figure 5. A. Oblique aerial photograph of extensive, horizontally stratified, marine silt and clay deposits typical of offshore environments. **B.** Oblique aerial photograph of "badlands" type topography characteristic of fine-grained offshore marine silt and clay deposits (near site 6). **C.** Extensive gully and rill systems that are typical in offshore marine silt and clay deposits (east of site 3) (from Giangioppi et al. 2003).

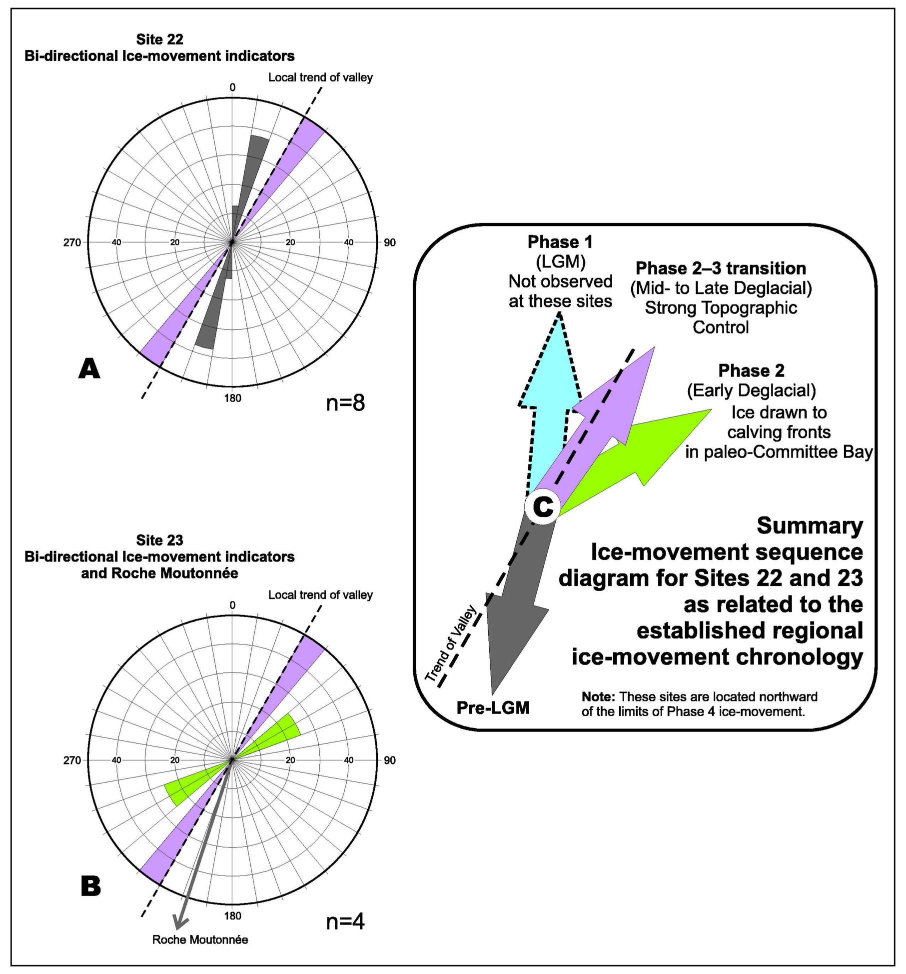

Figure 7. Ice-movement indicators (IMIs) and locally derived interpretations for sites 22 and 23 (Table 3). **A.** Bi-directional data collected from a whale-back feature at site 22. Note the local trend of the valley (210°–30°) that was controlling the ice-movement of thinner, Phase 2–3 transition ice as it retreated from the area. **B.** Bi-directional IMIs from a poly-genetic roche moutonnée. When data from **7A** and **7B** are considered along with the presence of a north-facing polished bedrock facet preserved under a cover of till deposited in the lee of a bedrock high (~50 m SW of site 23), the local ice-movement chronology summarized **7C** results. Relating these local data to the regional ice-movement allows relative age associations to be presented in a regional context (e.g., Fig. 9).

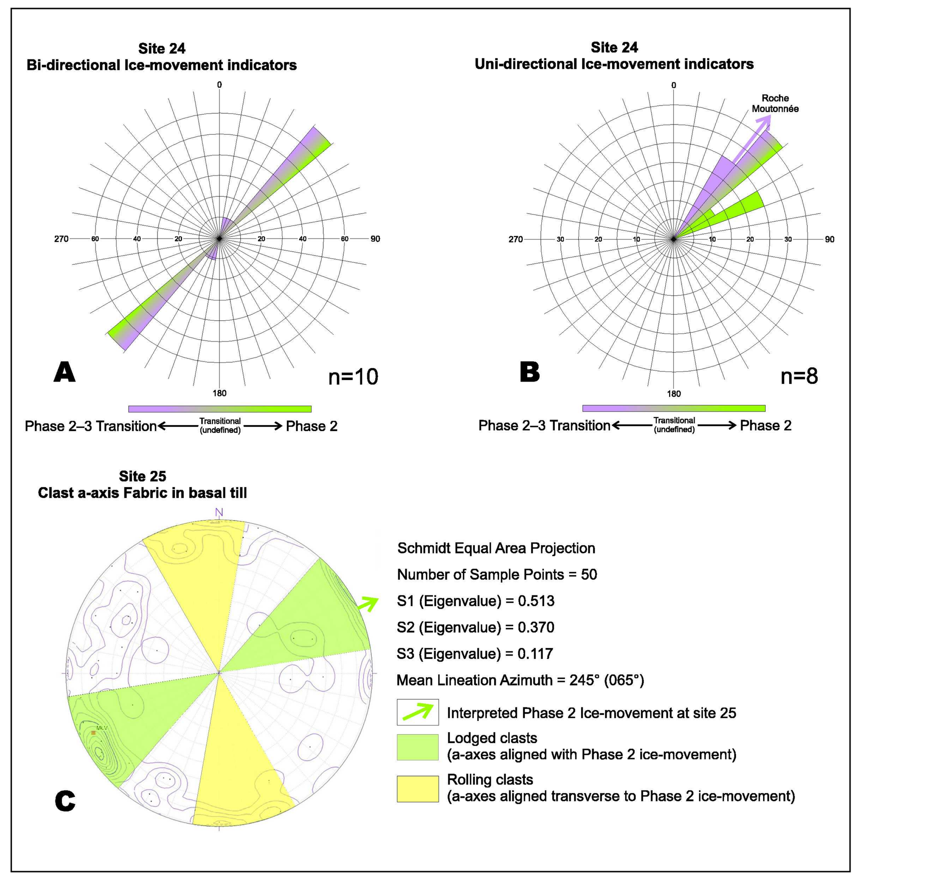

Figure 8. Ice-movement indicators and locally derived interpretations for sites 24 and 25 (Table 3). **A.** Bi-directional data from site 24 suggesting two distinct populations of data: Phase 2–3 transition (mid-deglacial) ranging from 10°–40°, and what is interpreted as the earlier Phase 2 set (based on all data collected at these sites ranging from 40°–50°. **B.** Uni-directional data from site 24 also suggests the following: 1) an IMIs set associated with Phase 2–3 transition (i.e., set < 40°; 2) that comprises ~45% of the data; and, 3) an IMI set ranging from 50°–70° (i.e., Phase 2) and which is crosscut by the Phase 2–3 transition IMI sets. **C.** Clast a-axis fabric demonstrating a lodgment-type till clast orientation obtained from till located beneath 30 m of marine mud. The dominant alignment of clasts a-axes dips moderately to the southwest suggesting a northeasterly ice movement associated with the deposition of this till in Phase 2 as ice was drawn to calving fronts in a paleo-Committee Bay. The component of a-axes transverse to ice-movement is also evident (yellow zone) suggests that there was some subglacial ductile deformation (Hicock et al., 1996). These data support the interpretation that this unit is primarily a lodgement till with a moderate overprint of subglacial ductile deformation that likely developed as till water content increased due to the retreat of the ice margin and associated advance of the paleo-Committee Bay shoreline/grounding line.

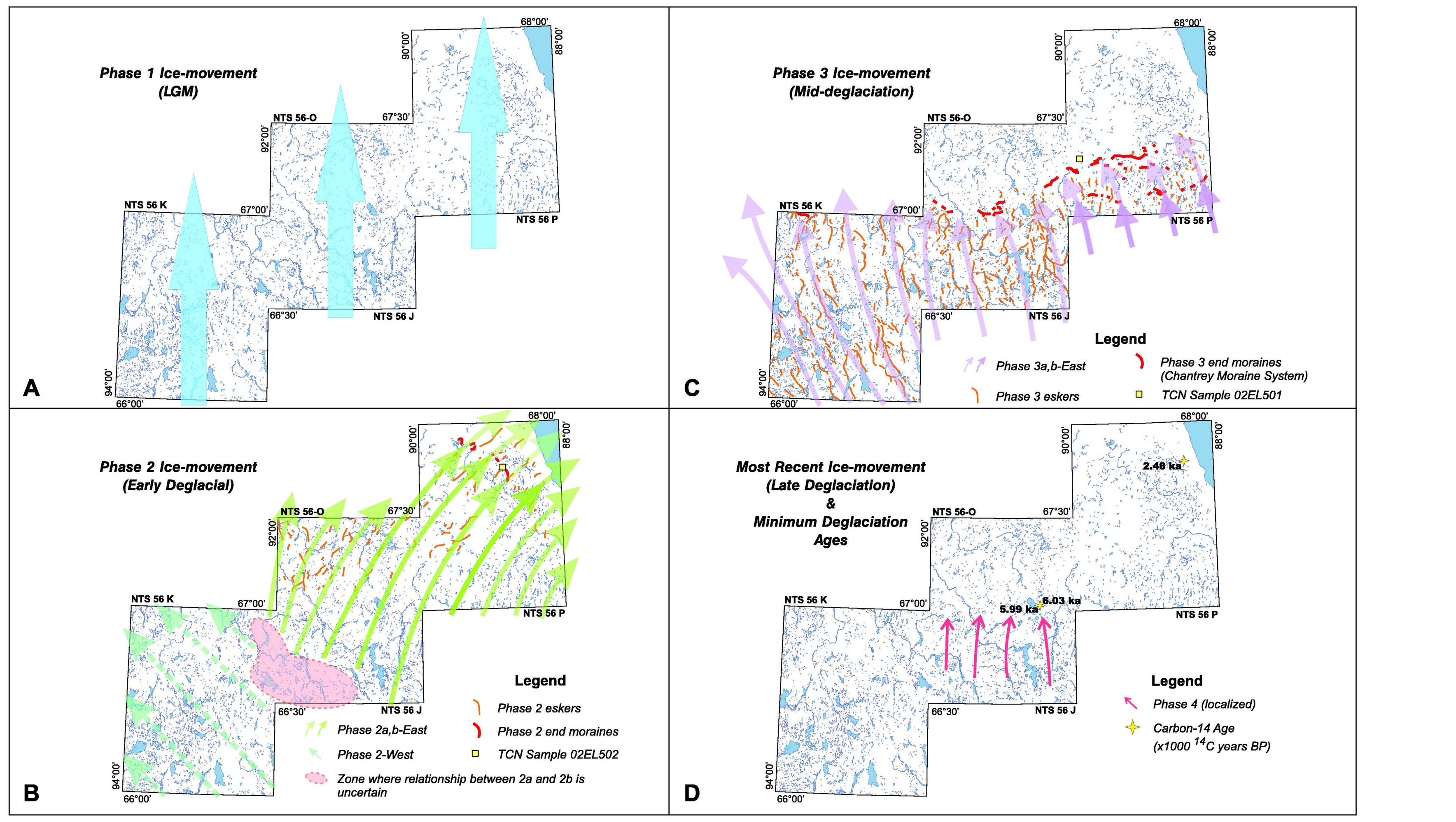

Figure 9. Regionally interpreted ice-movement sequence vectors (schematics) west of Committee Bay (ice-movement indicator data is presented in McMartin et al., 2003a). **9A.** Phase 1 (LGM) ice-movement characterized by ubiquitous northward flow under a robust ice sheet. **9B.** Phase 2 movement during the early deglaciation of the region. Ice is drawn toward calving fronts in the incipient Pelly and Committee bays (see also Fig. 6). A standstill during retreat allowed for the formation of a major end moraine system oriented NW-SE. **9C.** Phase 3 ice-movement characterized by a re-orientation of the ice margin into a generally EW configuration as calving margins are no longer a factor (i.e., ice has pulled away from the paleo-coastlines). During this phase, the Chantrey Moraine system is developed and may be associated with the 8.2–8.0 ka ice divide configuration of Dyke (2004). **9D.** Most recent ice-movement derived from rarely preserved ice-movement indicator data. Radiocarbon ages from peat beds suggest minimum ages of deglaciation; the oldest ages suggest the minimum age for regional, complete deglaciation of the study area.

LEGEND

Notes regarding compound units: *For those compound units that contain veneers, only two possibilities have been mapped. Where veneers are observed as a minor component forming patches over another map unit, the "/" is used to represent the dominant non-veneer unit (e.g., Tv/R). Where veneers are interpreted to be overlying a unit, the "-" is used to designate ubiquitous veneer cover overlying the primary unit (e.g., Cv-Tb).*

In areas where the surficial units (other than veneers) form complex cover, the area is coloured according to the dominant cover and is labeled in descending order of cover, example Tb/R. The relation of these complex covers are shown with a symbol between the unit letters as follows:
. approximates 50% cover to each unit;
/ approximately 70% to 30%;
// approximately 90% to 10%;
- unit to the left of dash stratigraphically overlies the unit to the right of the dash.

Example: Tb/R represents a cover area with an approximate ratio of 70% Tb and 30% R.

QUATERNARY

POST GLACIAL ENVIRONMENT

O — ***Organic Sediments:*** *Water-saturated organic sediments, commonly underlying peat/moss layers.*

Lp — ***Lacustrine plain:*** *Well stratified clay, silt, and sand. Local relief is less than 1 m (plain) and masks the underlying topography. Thickness ranges from 1 m to 10 m.*

Ld — ***Lacustrine delta:*** *a scarp or face with a low-relief mantle of well to moderately sorted, cross-stratified sand and rounded gravels associated with fluvial deposition into a lacustrine environment.*

LX — ***Lacustrine complex:*** *Lacustrine units too small to be represented at the scale of mapping. Consists primarily of lacustrine units, but may have relatively small pockets of alluvium, colluvium, till, glaciofluvial, glaciolacustrine, glaciomarine, and/or marine sediments.*

ALLUVIUM: *Silt, sand, and gravel deposited by streams either within channels or as overbank deposits. Deposits are usually stratified and moderately to well sorted, with the exception of some alluvial fan deposits.*

Ap — ***Alluvial plain:*** *Predominantly sands and gravels. May be locally overlain by or include lacustrine silt, clay and minor peat and organic silt deposited in abandoned channels and along floodplain margins. Typically forms plains within approximately 1 m of present stream level. Thickness ranges from 1–5 m.*

At — ***Alluvial terrace:*** *Massive to stratified, moderately to well sorted sand and gravel with minor silt. Sediments are of floodplain origin and presently isolated from flooding by stream incision. Thickness ranges from sporadic cover on bedrock to several metres.*

Af — ***Alluvial fan:*** *Gravel and gravelly diamicton, stratified, poorly to moderately sorted. Forms fan-shaped landforms where streams enter larger valleys. Thickness can reach up to 10 m.*

Au — ***Alluvial sub-units:*** *Alluvial unit comprising only alluvial related units such as Av, Ap, At, and/or Af.*

Ax — ***Alluvial complex:*** *Alluvial units too small to be represented at the scale of mapping. Consists primarily of alluvial units but may have relatively small pockets of colluvium, till, glaciolacustrine, glaciofluvial, glaciomarine, and/or marine sediments.*

PERIGLACIAL AND GLACIAL ENVIRONMENT

COLLUVIUM: *Typically less than 1 m thick, but can reach thicknesses up to 2 m; poorly sorted, unconsolidated debris (diamicton) deposited on slopes; derived from bedrock or glacial parent materials.*

Cv — ***Colluvial veneer:*** *Thin (<1 m) or discontinuous sheets of colluviated materials. Hatch-fill is used when colluvial veneer is compounded with another unit.*

Cb — ***Colluvium Blanket:*** *A mantle of colluviated material with a thickness greater than 1 m.*

Ca — ***Colluvium Apron:*** *Stratified diamicton, and poorly sorted sand and gravel. Deposit forms a wedgeshaped, slope-toe complex of relatively small steep debris flows, avalanche-dominated fans, and soliflucted deposits derived from bedrock and glacial debris. Thickness up to 10 m, thinning at head and toe of deposit.*

Ch — ***Landslide Sediments:*** *Diamicton formed of broken rock, soil and glacial deposits. Forms a hummocky or ridged topography with ridges transverse to direction of movement. Thickness is highly variable, but may range up to 10 m (Direction of movement indicated by symbol).*

Cx — ***Colluvial complex:*** *Colluvial units too small to be represented at the scale of mapping. Consists primarily of colluvial units but may have relatively small pockets of alluvium, till, glaciolacustrine, glaciofluvial, glaciomarine, and/or marine sediments.*

HOLOCENE AND LATE PLEISTOCENE (WISCONSINAN) GLACIAL ENVIRONMENT

GROUND MORAINE SEDIMENTS (Till): *Diamicton (granule to boulder size clasts suspended in a poorly sorted clay to sand matrix) deposited directly by glacial ice; redeposition directly from glacial ice is by sediment gravity flow and/or ductile deformation. Contrasting vegetation cover reflecting compositional differences. Thicknesses range from 1 to >20 m.*

Tv — ***Till veneer:*** *Till less than 1 m thick; occurs in patches over rock and is interspersed with rock outcrop; deposits are thin enough to reveal details of underlying rock structure. Hatch-fill is used when till veneer is compounded with another unit.*

Tb — ***Till blanket:*** *Surface morphology conforms to underlying bedrock topography. May exhibit crag-and-tails, flutes, and/or roches moutonnées. Some areas have large frost polygons and stone nets. Thicknesses generally from 1 m to 5 m.*

Tm — ***Rolling till plain:*** *Surface morphology forms gently rolling plains with 1 to 2 m of relief; may exhibit flutes. Generally masks underlying topography. Some areas have large frost polygons and stone nets. Thickness is greater than 5 m.*

Tr — ***Ridged till complex:*** *Surface morphology forms parallel ridges with amplitudes less than 15 m and wavelengths less than 30 m. Orientation is often transverse to palaeoflow directions. Comprised of till and glaciofluvial sediments. Thickness is variable, but is usually less than 15 m.*

Th — ***Hummocky till:*** *Stratified to massive diamicton and interstratified glaciofluvial gravel and sand. Stratification often exhibits syndepositional deformation features caused by slumping or ice meltout. May contain variable amounts of ice-walled glaciofluvial and glaciolacustrine sediments. Forms hummocky surface (kame and kettle topography); in places the unit may exhibit prominent ridges marking major recessional ice margins, or diffuse zones marking boundaries between glacial-ice regimes.*

Tx — ***Till complex:*** *Till units too small to be presented at the scale of mapping. May contain relatively small pockets of alluvium, colluvium, glaciofluvial, glaciolacustrine, glaciomarine, and/or marine sediments.*

PROGLACIAL AND GLACIAL ENVIRONMENT

GLACIOFLUVIAL DEPOSITS: *Well stratified to massive sand, gravel with minor silt and diamicton deposited by streams flowing away from, or in contact with glacial ice. These sediments can range from well to poorly sorted. Strata are commonly deformed due to syndepositional collapse from the meltout of supporting ice.*

Gv — ***Glaciofluvial veneer:*** *Stratified to massive gravel, sand, and silt. May occur in patches or as gravel lag over rock; thickness is typically less than 1 m. Hatch-fill is used when glaciofluvial veneer is compounded with another unit.*

Gt — ***Glaciofluvial terrace (Outwash):*** *a scarp or face with a low-relief mantle of moderately to well sorted, cross-stratified sand and rounded gravels typically elevated above a lower-level glaciofluvial or fluvial deposit.*

Gp — ***Glaciofluvial plain (Outwash):*** *low-relief mantle of moderately to well-sorted, cross-stratified sand and rounded gravels; 1–20 m thick.*

Gh — ***Hummocky glaciofluvial (Ice-contact):*** *Complex arrangement of slopes extending from rounded depressions, to irregular conical mounds and includes esker ridges. Composed primarily of poorly sorted sand and gravel from 5 m to ≥15 m thick.*

Gu — ***Glaciofluvial sub-units:*** *Glaciofluvial deposits - comprising only glaciofluvial related units such as Gv, Gt, Gp, and/or Gh.*

Gx — ***Glaciofluvial complex:*** *Glaciofluvial units too small to be represented at the scale of mapping. Consists primarily of glaciofluvial units, but may have relatively small pockets of alluvium, colluvium, till, and/or glaciolacustrine sediments.*

GLACIOLACUSTRINE DEPOSITS: *Stratified sand, silt, and clay deposited in lakes dammed by glacial ice. Distally deposited glaciolacustrine sediments typically underlie plains or gently rolling terrain. Proximally deposited glaciolacustrine sediments may underlie ridged, hummocky, or pitted terrain caused by subsequent meltout.*

L^{G}p — ***Glaciolacustrine plain:*** *Well stratified clay, silt, and sand. Local relief is less than 1 m (plain) and masks the underlying topography. Thickness ranges from 1 m to >20 m.*

L^{G}d — ***Glaciolacustrine delta:*** *a scarp or face with a low-relief mantle of moderately to well sorted, cross-stratified sand and rounded gravels associated with glaciofluvial deposition into a glaciolacustrine environment.*

L^{G}x — ***Glaciolacustrine complex:*** *Glaciolacustrine units too small to be represented at the scale of mapping. Consists primarily of glaciolacustrine units, but may have relatively small pockets of alluvium, colluvium, till, glaciofluvial, glaciomarine, and/or marine sediments.*

MARINE/GLACIOMARINE ENVIRONMENT

MARINE-RELATED DEPOSITS: *Sediments deposited from suspension in a marine or glaciomarine environment by submarine gravity flows, and those sediments that accumulate in the littoral zone.*

Mv — ***Marine veneer:*** *Stratified to massive gravel, sand, silt, clay with thicknesses less than 1 m; may occur as patches over rock. Hatch-fill is used when marine veneer is compounded with another unit.*

Mp — ***Offshore marine:*** *Rhythmically stratified silt, silty-clay, and clay. Usually forms thick sequences that exhibit extensive gullying; locally fossiliferous. Thickness ranges from 1 to >20 m.*

Mm — ***Nearshore marine:*** *Well sorted, massive or rhythmically stratified silt to fine and/or medium sand. Usually forms thin sheets to gullied blankets that fill topographic lows. Thickness typically less than 5 m, but may reach 10 m.*

Mr — ***Littoral sediments:*** *Sand and gravel generally well sorted material that locally includes pockets of washed till. Usually forms flights of beach ridges (raised beaches), bars, spits, terraces and ice-pushed ridges. This include low sandy-gravel ridges that also denote former beaches; commonly strewn with boulder lags. Derived from reworking of upland surficial deposits; occurs commonly on the slopes of topographic highs. Thickness ranges from 1–5 m.*

Mt — ***Marine tidal flats:*** *Silty sand to silt and clay, moderately sorted material locally containing pockets of nearshore silts and sands; commonly strewn with a boulder lag. Thickness ranges from 1–10 m. In cases where the mapper was able to differentiate between modern- and paleo-environments, superscripted "M" and "P" (respectively) following a unit label were used to identify this relationship.*

Md — ***Marine delta:*** *a scarp or face with a low-relief mantle of cross-stratified sand and rounded gravels associated with fluvial deposition into a marine environment. In cases where the mapper was able to differentiate between modern- and paleo-environments, superscripted "M" and "P" (respectively) following a unit label were used to identify this relationship.*

M^{G}d — ***Glaciomarine delta:*** *a scarp or face with a low-relief mantle of cross-stratified sand and rounded gravels associated with glaciofluvial deposition into a glaciomarine environment.*

M^{G}x — ***Glaciomarine complex:*** *Glaciomarine units are too small to be represented at the scale of mapping. Consists primarily of glaciomarine units, but may have relatively small pockets of alluvium, colluvium, till, glaciofluvial, glaciolacustrine, and/or marine sediments.*

Mu — ***Marine sub-units:*** *Marine deposits - comprising only marine related units such as Mv, Mp, Mm, Mr, Mt, and/or Md.*

Mx — ***Marine complex:*** *Marine units too small to be represented at the scale of mapping. Consists primarily of marine units, but may have relatively small pockets of alluvial, colluvial, till, glaciofluvial, glaciolacustrine, and/or glaciomarine sediments.*

Pre-Quaternary Units

ROCK: *Bare, coherent outcrop of various lithologies; locally glacially polished and striated or sculpted by glaciofluvial processes.*

R — ***Bedrock undifferentiated:*** *Cross-reference with Committee Bay Project, bedrock component.*

Rf — ***Bedrock Felsenmeer:*** *Frost-heaved, angular blocks of bedrock (cross-reference with Committee Bay Project bedrock component). Tend to be rare units because they are only identifiable from field observations.*

Geological boundary (defined, approximate, assumed)
Limit of fieldwork
Crag-and-tail
Fluting
Kame
Esker (flow direction known, unknown)
Beach
Meltwater channel, flow direction unknown (large, small)
Escarpment
Moraine ridge
Ice contact
Wasting
Marine feature with site number — 7
Terrestrial-related feature with site number — 22
Terrestrial cosmogenic nuclide (TCN) age — 02EL502
Radiocarbon date — Date / Material; Lab no / Elevation (m)

Author: E.C. Little

Geology by E.C. Little, 2003, M. Giangioppi, D. Utting, T. Ferbey, and C. Ozyer

Geological compilation by E.C. Little, 2004, 2005

Co-ordinated through the auspices of the Committee Bay TGI Project

Digital compilation by C. Gilbert, J. Taylor, and J. Beaulieu

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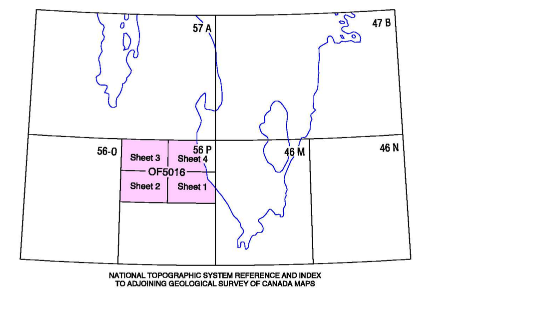

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