COASTAL SURVEYS, JONES SOUND, DISTRICT OF FRANKLIN

Project 820043

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Abstract

In 1983, low-altitude video tapes were made of the coast of Jones Sound; launch surveys were completed off five tidewater glaciers along the northeast coast of Devon Island. Large submarine glacial deposits off northeast Devon Island suggest that some of the valley glaciers once stood 2 to 7 km offshore for a considerable time before rapidly retreating to near their present position. Today, the proglacial tidewater environments in bays resemble those of the slowly retreating shallow-water glaciers in Glacier Bay, Alaska. Most of the Devon Island tidewater glaciers are grounded and are fringed by an ice-proximal shelf. Ice-front thickness is commonly 55 to 76 m but at the face of larger glaciers, it exceeds 100 m. Sediment gravity flows, observed across the ice-proximal shelf foreslope, are an important agent in the transfer and deposition of sediment in the proglacial basins.

Résumé

En 1983, des rubans vidéos ont été pris à faible altitude le long de la côte du détroit de Jones; on a également effectué des relevés à bord de chaloupes au large de cinq glaciers en eau tidale le long de la côte nord-est de l'île de Devon. De vastes dépôts glaciaires sous-marins situés au large de la partie nord-est de l'île de Devon semblent indiquer que certains glaciers de vallée se sont jadis avancés jusqu'à 2 ou 7 km au large pendant une période assez longue avant de reculer rapidement jusqu'aux environs de leur position actuelle. A l'époque actuelle, les milieux d'eau tidale proglaciaire dans les baies resemblent à ceux des glaciers au mouvement de recul lent trouvés dans les eaux peu profondes de la baie des Glaciers (Alaska). La plupart des glaciers en eau tidale reposent sur le fond et sont entourés par une plate-forme gisant à proximité des glaces. L'épaisseur de la glace atteint généralement 55 à 76 m, mais au front des plus gros glaciers, elle dépasse 100 m. Les coulées de sédiments par gravité, dont on a noté la présence à travers l'avant-pente de la plate-forme gisant à proximité des glaces, constituent un agent important dans le transfert et la mise en place des sédiments dans les bassins proglaciaires.

Introduction

A coastal geology survey of Jones Sound was initiated in August 1983 as part of a larger marine geology-geophysics and hydrographic survey of the seabed of Jones Sound (MacLean et al., 1984). During the first phase of the coastal program aerial oblique, colour video tapes were made of the coastline. During the second phase, selected representative coastal environments were visited using a launch or helicopter deployed from **CSS Baffin**, our base of operations. However, extensive fog and coastal sea ice restricted our shore work to one site on Coburg Island and three others on southern Ellesmere Island (Fig. 3.1). At each of the shore stations, a bench mark was established and a beach profile was surveyed with sediment samples collected along it. In addition, the thickness of active layer, the effects of sea ice-shoreline interaction, and the character of raised beaches were noted. Launch surveys were limited to the tidewater glacier environment of northeast Devon Island. Only the aerial photographic program and observations of several tidewater glacier environments off northeast Devon Island are discussed in this report.

Coastal video photography

On 13 and 14 August 1983, a videotape of 935 km of coastline along Jones Sound including Coburg Island (Fig. 3.1) was made using a fixed-wing aircraft. An additional 200 km of coastline was photographed on 9 September, along North Kent Island and Colin Archer Peninsula, Devon Island using a helicopter. Coastal fog obscured the northern Devon Island coast between Sverdrup Inlet and Brae Bay. The videotapes were shot from aircraft flying less than a kilometre offshore at an elevation of 150 to 180 m. A Sony DXC-1800K colour video camera and VO-4800 video cassette recorder were used with 20 minute, 3/4" Sony U-matic Type S tapes. Commentary on the physical shore-zone character and coastal sea-ice conditions was added simultaneously to the tapes. The average length of coast covered per tape was 72 km. Videotapes provide a valuable reference for a multitude of users. We use them primarily to describe the coast, to locate specific coastal or shore-ice features and to identify shoreline changes since the last air photo coverage in the late 1950s. Detailed coastal geology maps can also be produced from this data base.

Tidewater glacier coastal environment, northeast Devon Island

It is estimated that 30 per cent of the shoreline between Brae Bay and Raper Point on Devon Island, is lined by tidewater glaciers (Fig. 3.2). They descend to the coast from the ice cap that covers most of eastern Devon Island through steep sided valleys cut mainly in Precambrian gneisses (Frisch, 1983). Bold talus-banked rock cliffs of 300 to over 480 m elevation make up the coastline between the valley glaciers (Fig. 3.3). For the most part, these coastal slopes are too steep to permit the accumulation of much unconsolidated sediment and the formation of depositional shore features. Beach development is restricted to a low

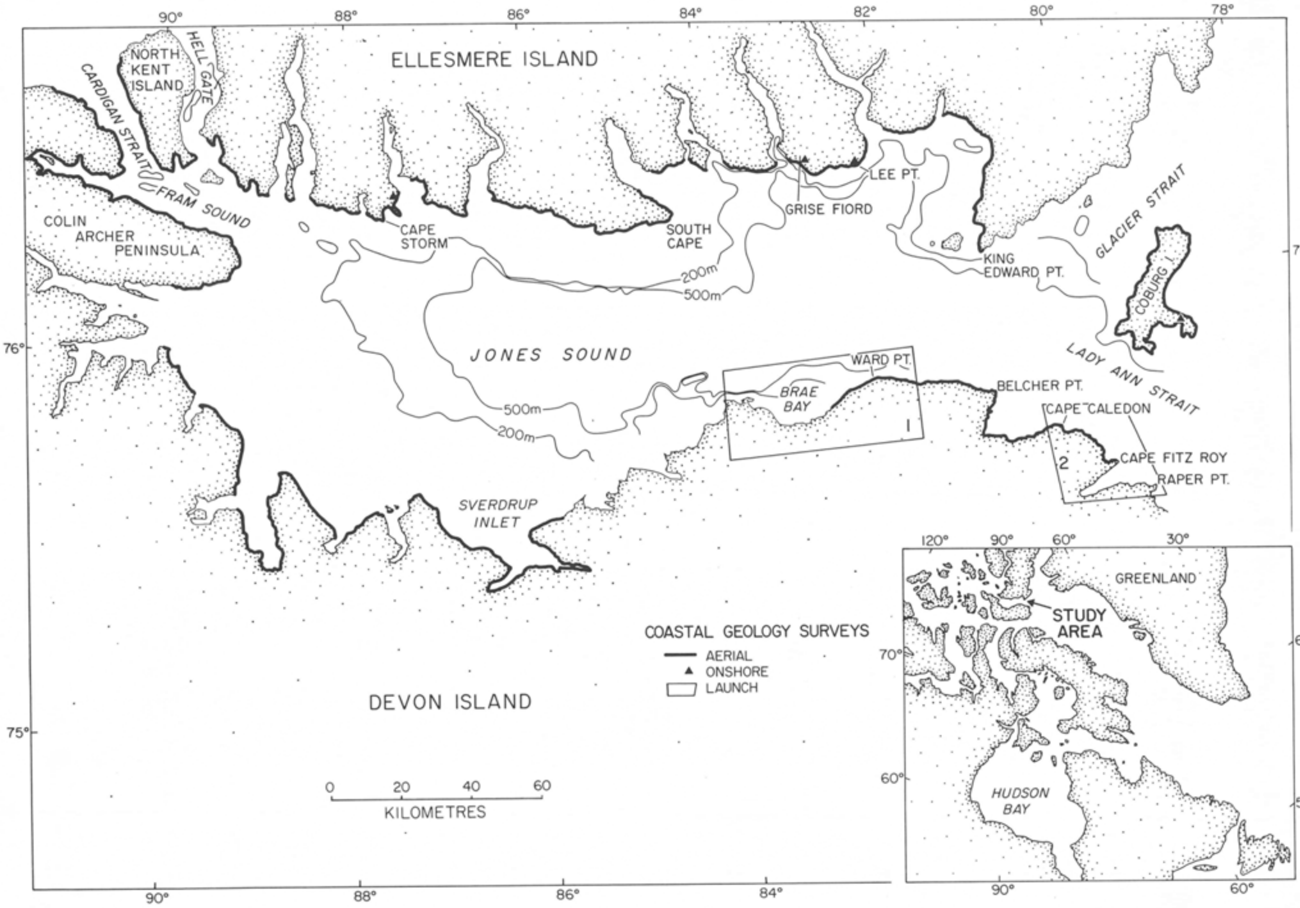

Figure 3.1. *Index map of 1983 coastal geology surveys in Jones Sound. Detailed charts of launch surveys along northeast Devon Island are presented in Figure 3.4.*

Figure 3.2. *Tidewater glaciers, such as Sverdrup Glacier shown here, descend to the coast from the east Devon Island ice cap through steep sided valleys. This view of the eastern face of Sverdrup Glacier illustrates its low, crevassed ice front and the termination of survey line A_3-A_4 (Fig. 3.4a).*

coastal platform west of Ward Point where waves have reworked glacial outwash sediment and other colluvial deposits into discontinuous beach ridges.

There is no published hydrographic or marine geologic information for the pro-tidewater glacier settings of northeast Devon Island. In an attempt to gain a better understanding of these environments, launch surveys were carried out on 16 and 19 August 1983 off five tidewater glaciers and off one non-tidewater glacier (Fig. 3.4a, b). The objective of the survey was to obtain information on bottom morphology and sediment characteristics so that preliminary conclusions could be drawn about recent glacier activity, i.e. retreat or advance, and modern proglacial sedimentation processes. Samples of the top centimetre of bottom sediment were collected for C. Schafer, Paleoecology Section, Atlantic Geoscience Centre, to provide data for the development of a comprehensive foraminiferal assemblage model for ice margin environments.

The survey launch was equipped with a 30 kHz Elac echosounder, a 500 joule Huntec Hydrosonde 2a sparker system and a Petite Ponar sediment grab sampler. Navigational control was limited to radar fixes on distinct shore features and the face of each glacier investigated. Aerial videotape coverage of the coastline from Brae Bay to Cape Fitz Roy complements the launch surveys which were restricted to Brae Bay and to the coastline between Cape Caledon and Raper Point.

Figure 3.3. *Bold talus-banked rock cliffs with semi-permanent snow patches exist between the tidewater glaciers of northeast Devon Island. Where talus has been removed by waves, the base of the snow patch is commonly exposed as an 'icefoot' feature. This view of the shoreline is between Capes Caledon and Fitz Roy.*

Brae Bay

Sverdrup Glacier at the head of Brae Bay is a comparatively wide tidewater glacier (Fig. 3.5) with a front that rises from a few metres to an estimated vertical face of 20 m above sea level along its western end. The front presently lies in water depths of 35 to 68 m. The shallower depths occur along a narrow (<100 m wide) shelf along the western portion of the glacier front (A_1-A_2 – Fig. 3.6). Despite the fact that Sverdrup Glacier is presently free of supraglacial debris, Brae Bay contains glacial deposits for a distance of over 7 km from the present ice front. These deposits form two small islands which rise an estimated 6 to 8 m above sea level, in the northeastern part of the bay (Fig. 3.4a, 3.5). They reflect a major terminal moraine that ranges from 3 km to in excess of 5 km offshore from the present ice front in that part of the bay (A_3-A_4, Fig. 3.6). A second bank of sediment lying 6 to 7 km offshore on the western survey line (A_1-A_2), may indicate an even earlier ice still-stand position. The two moraines are separated by hummocky topography that resembles ice-melt deposits. The moraines are composed of sand and gravel, and are mantled by a cobble-boulder lag.

It is evident from the echo sounding survey lines (Fig. 3.6) that the bottom topography varies considerably in areas that are immediately adjacent to the present ice front. Off the western ice front, the narrow ice-proximal shelf is fringed by a 160 m deep basin which has been infilled by a minimum of 10 m of acoustically-transparent sediment. This cover of fine sediment (Sample L101, Fig. 3.6), pinches out upslope on the landward side of the large moraine in water depths of 50 m and disappears completely in water depths shallower than 16 m (Samples L103, 104). In contrast, off the eastern face of Sverdrup Glacier there is no sign of a deep proglacial basin; the bottom topography is very irregular and becomes progressively shallower offshore. Bottom sediment sampled within a kilometre of the eastern ice front (L107-109) is mainly an olive-green silt of variable cohesiveness with traces of sand in samples collected farther offshore.

Along the eastern shore of Brae Bay, the valley glaciers do not reach tidewater. They terminate on a low coastal (rock?) platform that extends a kilometre offshore from the high plateau slope. Today the valley glacier fronts are covered by ablation till and outlined by terminal moraines located just above the present shoreline. For comparative purposes, a survey line was run inshore to one of these non-tidewater glaciers (Fig. 3.4 to 3.6 – Section B_1-B_2). A nearshore platform mantled by glacial debris extends several hundred metres offshore to depths of 6 m. Seaward of this platform, the bottom slopes gradually to 70 m water depth where a ridge, possibly a moraine, exists at about 3.5 km offshore.

Ward Point to Cape Fitz Roy

Tidewater glaciers cover just over 40 per cent of this segment of coastline. Lateral moraines extend farther offshore than the present ice fronts which suggests that most of the glaciers are in a recessional stage. Nevertheless, there is a tidewater glacier west of Cape Caledon that has a floating (?) ice tongue that extends a substantial distance beyond the main ice front and its associated lateral moraines. The only extensive ice-free coastal area is at Belcher Point where the rugged rock shoreline rises to over 200 m.

In 1983, launch surveys were completed off two tidewater glaciers east of Cape Caledon (lines C_1-C_2 and D_1 to D_3 – Fig. 3.4b, 3.7). At the first glacier (line C_1-C_2), the seabed drops sharply across narrow rock ledges to depths greater than 400 m. The only indication of unconsolidated sediment is a ridge (moraine?) at 100-120 m water depth, approximately 500 m from the glacier front. A continuation of the survey line closer inshore was prevented by sea ice.

At the second tidewater glacier (Fig. 3.8), two survey lines (D_1-D_2 – D_3) and three bottom sediment samples were obtained. The ice front, grounded in 20 to 30 m of water, is fringed by a narrow shelf covered by silt and gravel. Shells, sea urchins, starfish and shell fragments are abundant. Off the western portion of the ice front, the seabed drops sharply (line D_1-D_2) from the ice-proximal shelf, whereas off the centre of the glacier (line D_2-D_3) two submarine ridges occur. The seaward ridge has a hummocky topography with hollows that are infilled by at least 2 m of acoustically transparent material. Between the two ridges, at least 10 m of fine sediment has been deposited. A sub or englacial stream flows from the large arch cut in the central face of the glacier (Fig. 3.8) and is thought to be related to the abundant sediment and sea fauna observed off this glacier.

A third glacier was surveyed at the head of the small bight west of Cape Fitz Roy (Fig. 3.4b). Here, a 76 m thick ice front is fringed by an ice-proximal shelf covered by silt and pebbles (line E_1-E_2, Fig. 3.7). The shelf foreslope extends to a depth of 230 m before the bottom rises again at a sill near the entrance to the bight. Although, the composition of the sill could not be determined, sparker records suggest that it is mantled by unconsolidated sediment. At the base of the ice-proximal shelf slope and across the inner part of the bight, the seabed is infilled by a minimum of 3-4 m of overlapping layers of acoustically transparent sediment that resemble slump deposits. The bottom profile across the bight (parallel to the ice face) is a classic u-shape (line E_3-E_4, Fig. 3.7).

Cape Fitz Roy to Raper Point

Fourteen valley glaciers, mostly tidewater, descend from the Devon Island ice cap into the unnamed inlet between Cape Fitz Roy and Raper Point (Fig. 3.4b). The largest tidewater glacier fills the head of the inlet. As no published bathymetric information is available for this inlet, a survey line was run along its length (approximately 0.6 km from the north shore) to the head of the inlet.

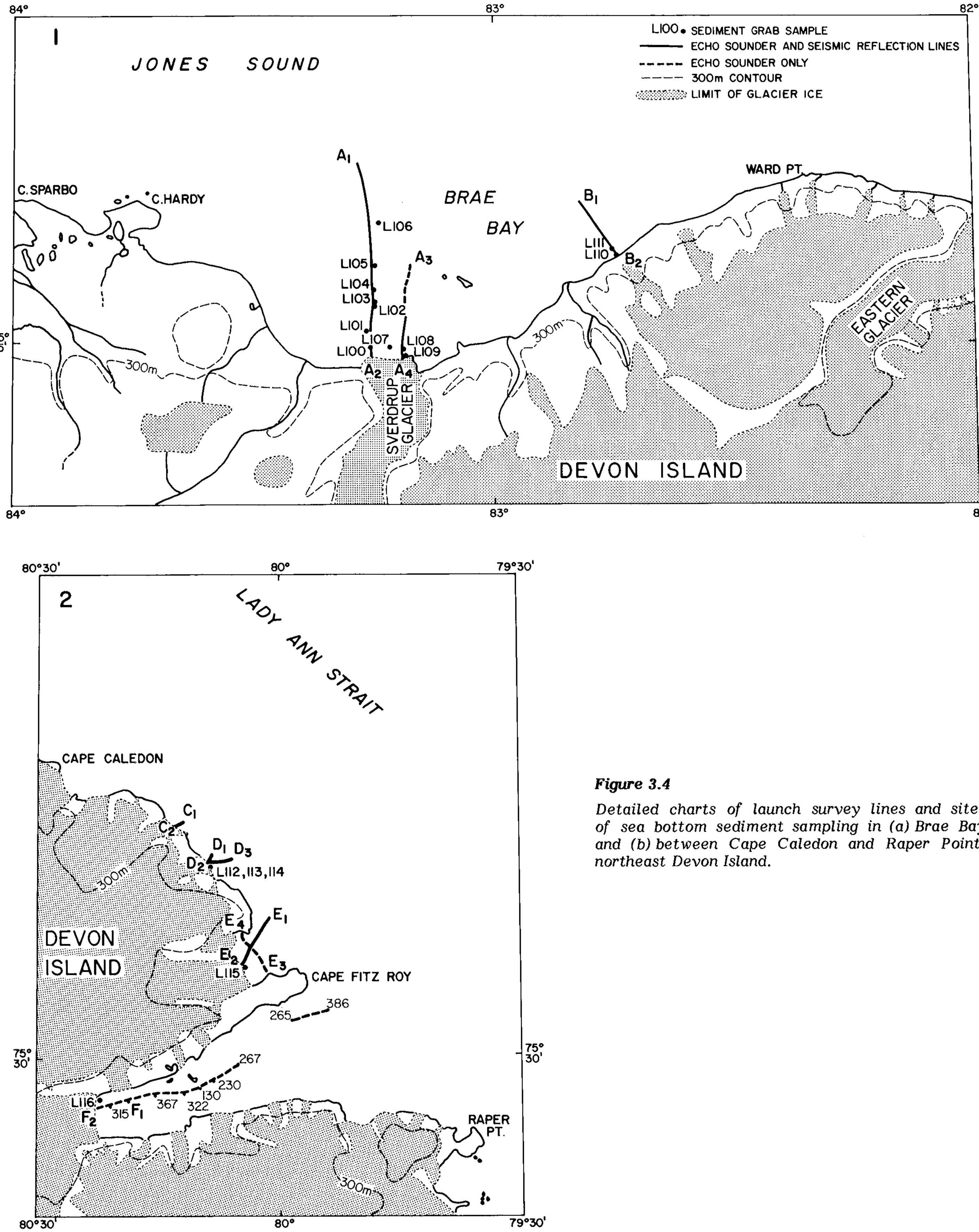

Figure 3.4

Detailed charts of launch survey lines and sites of sea bottom sediment sampling in (a) Brae Bay and (b) between Cape Caledon and Raper Point, northeast Devon Island.

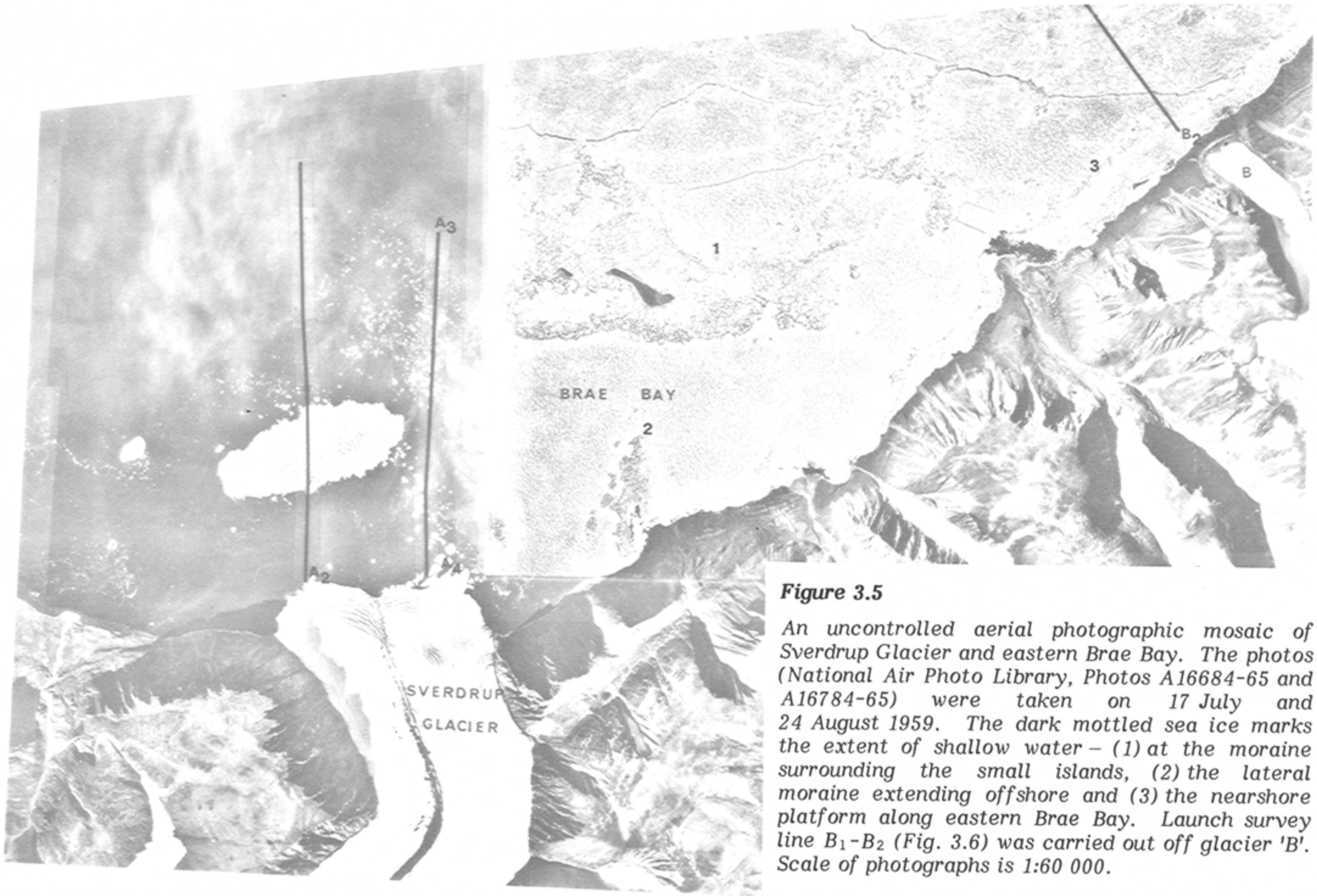

Figure 3.5

An uncontrolled aerial photographic mosaic of Sverdrup Glacier and eastern Brae Bay. The photos (National Air Photo Library, Photos A16684-65 and A16784-65) were taken on 17 July and 24 August 1959. The dark mottled sea ice marks the extent of shallow water – (1) at the moraine surrounding the small islands, (2) the lateral moraine extending offshore and (3) the nearshore platform along eastern Brae Bay. Launch survey line B_1*-*B_2 *(Fig. 3.6) was carried out off glacier 'B'. Scale of photographs is 1:60 000.*

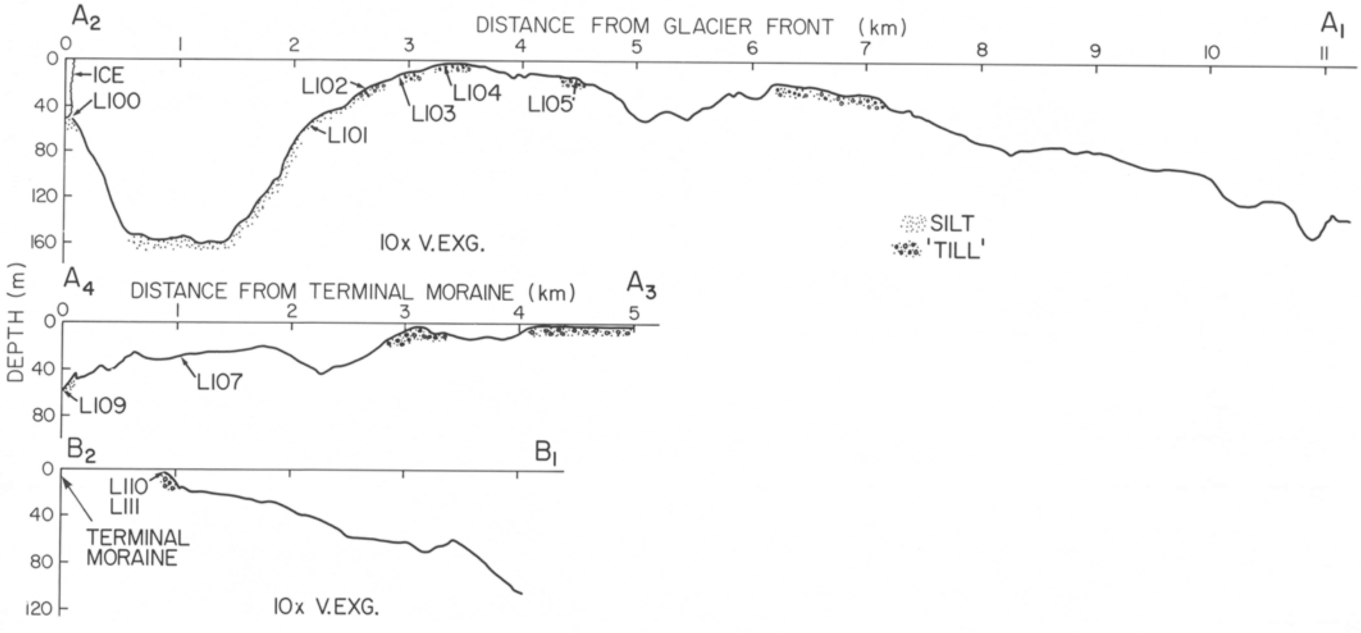

Figure 3.6. *Cross-sectional profiles of the nearshore bottom off Sverdrup Glacier (*A_1*-*A_2 *– western face and* A_3*-*A_4 *– eastern face) and off a smaller non-tidewater glacier (*B_1*-*B_2*) located along eastern Brae Bay. See Figure 3.4a for the location of survey lines.*

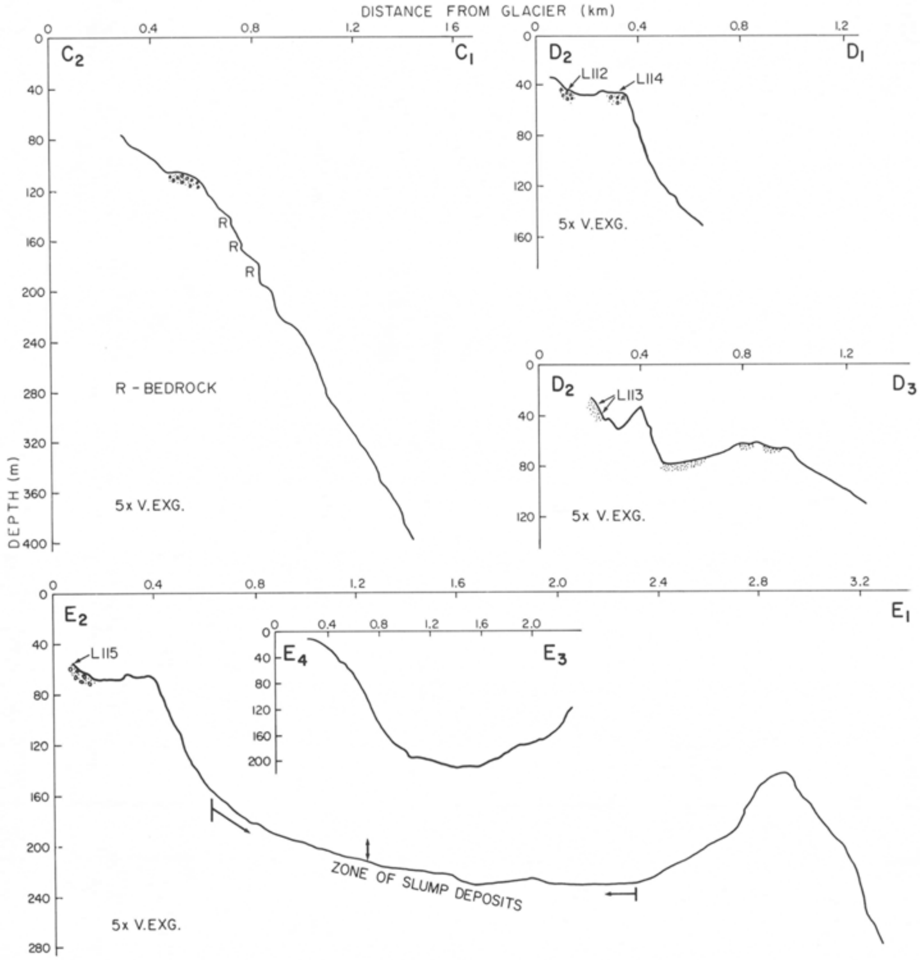

Figure 3.7

Cross-sectional profiles of the nearshore bottom off the tidewater glaciers surveyed between Capes Caledon and Fitz Roy. See Figure 3.4b for the location of survey lines.

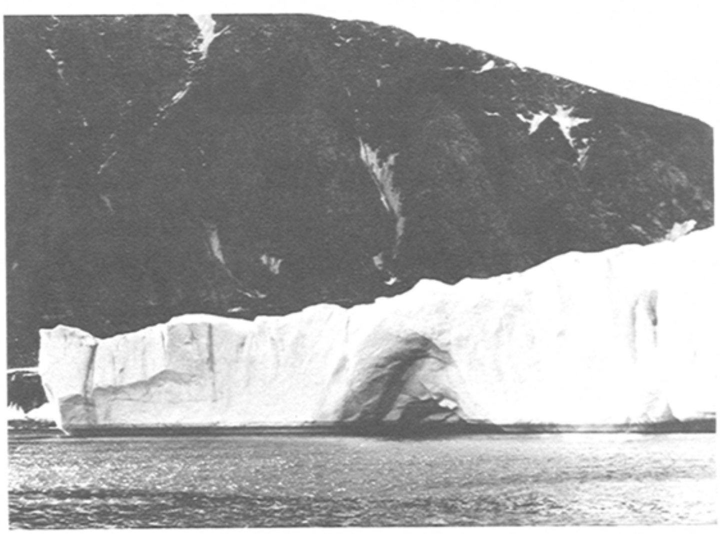

Figure 3.8. *At the second tidewater glacier surveyed east of Cape Caledon (Fig. 3.4b), the proglacial sediments are thought to be primarily derived from the sub or englacial stream which flows through a large arch in the central ice front. The subaerial ice front thickness is estimated to be 32-40 m.*

Unfortunately, problems with the echo sounder and sparker system prohibited the plotting of a continuous bottom profile. The range of depths encountered is marked in Figure 3.4b. The submarine topography of the inlet is very irregular. Changes in relief of 30 to 100 m occur commonly because of glacial debris deposited by side entrance glaciers. Shallowest water depths of 120 m were recorded near the small rock islands that are situated near the central part of the inlet. Toward the entrance of the inlet, several ridges exist in water depths nearing 200 m. A shallow sill was not observed. Off the tidewater glacier at the head of the inlet, a landward dipping shelf exists in water depths of 180-200 m (Fig. 3.9). The landward limit of this shelf and the possibility of another shelf closer to the present ice front could not be determined because the survey line terminated within 0.5 km of the ice face, for safety reasons. Bottom sediments resembling slump deposits cover the lower shelf foreslope and a large submarine ridge (moraine?) exists approximately 2 km offshore of the present ice front in water depths of about 290 m.

Discussion

Along northeast Devon Island, the tidewater glaciers examined were grounded and most had a total ice-front thickness of 55-76 m. Others such as the large tidewater glacier at the head of the unnamed inlet east of Cape Fitz Roy, had an ice thickness greater than 100 m. The proglacial environment in bays along northeast Devon Island resembles that described by Powell (1980) for the slowly retreating shallow water glaciers in Glacier Bay, Alaska. The Devon glaciers are

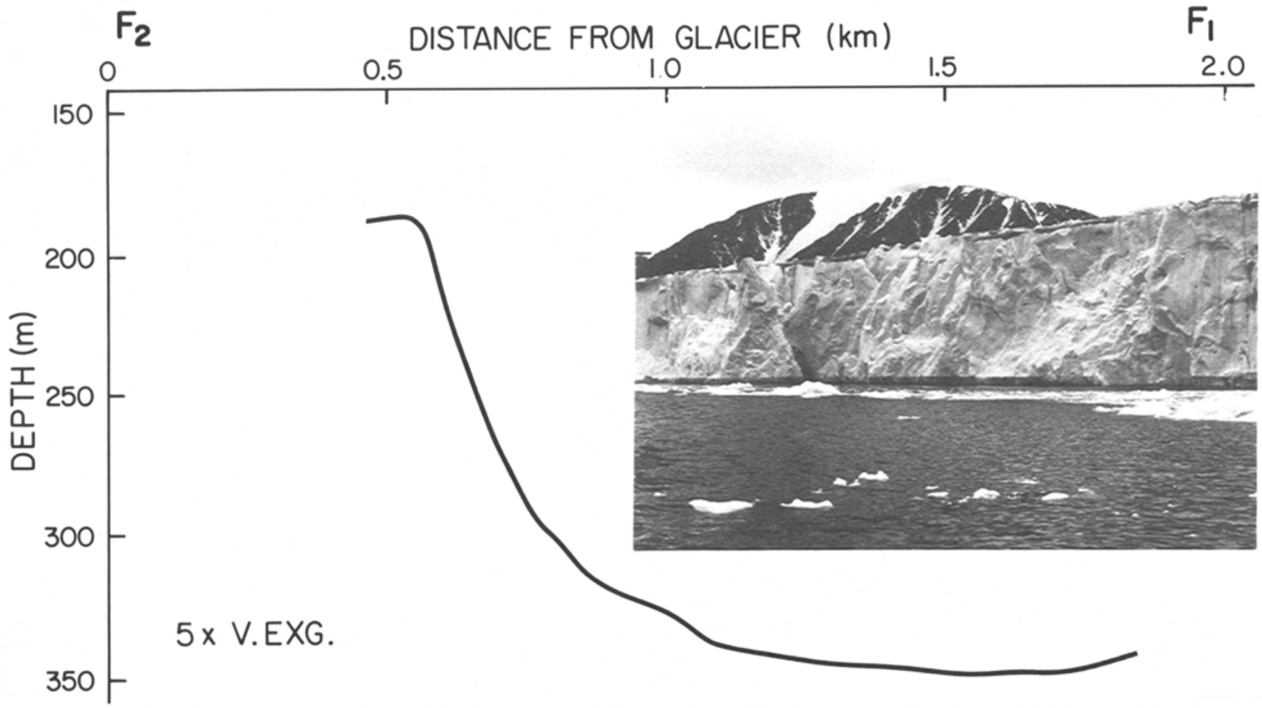

Figure 3.9. *Proglacial bottom morphology and photo of ice front at the head of the unnamed inlet between Cape Fitz Roy and Raper Point. Subaerial ice front thickness is approximately 37 m. Note the tidal line cut in the base of the ice face and the layer of supraglacial debris at the top of the ice face. Location of section* F_1-F_2 *is shown in Figure 3.4b.*

fringed by an ice-proximal shelf that is covered by silts and coarser clasts derived from melting of the ice and from the dumping of supraglacial debris. The shelf foreslope extends to depths of 160 to 340 m where proglacial basins have been infilled by at least 10 m (limit of penetration by instrument) of acoustically transparent sediment. Seismic records show that subaqueous sediment gravity flows do occur down the shelf foreslope and that this process is responsible for a large proportion of the sediment deposited in the proglacial basins. On their seaward side, the basins are outlined by morainal banks or sills which are mantled by cobble-boulder lag deposits. Shoaling waves and grounding sea ice are responsible for the winnowing of the fines from the shallow morainal banks. Similarly, off the non-tidewater glacier in eastern Brae Bay, the nearshore bottom is composed of wave-reworked glacial debris which is devoid of finer sediment.

Geomorphological evidence suggests that most but not all of the tidewater glaciers along northeast Devon Island are receding. Submarine glacial deposits in the shallow bay environments indicate that valley glaciers once extended at least 2 to 7 km farther offshore than today. However, along the outer coast of Devon Island where water depths exceed 400 m, no evidence of valley-glacier ice-front positions was found. The apparent deposits of till observed farther offshore (MacLean et al., 1984) are thought to be related to more regionally extensive Pleistocene glaciations. The best field evidence of valley-glacier activity was collected during the launch surveys off Sverdrup Glacier. The extensive bank of sediment 3 to 7 km offshore in Brae Bay provides evidence that Sverdrup glacier remained at that distance offshore for a considerable time. The double ridge observed on line A_1-A_2 (Fig. 3.6) suggests that more than one ice still stand may have occurred in this part of the bay. Moreover, the absence of submarine ridges, i.e. moraines, closer inshore suggests that Sverdrup Glacier rapidly retreated to near its present position following the still stand. Today Sverdrup Glacier is near the head of the bay and it is fringed by an ice proximal shelf which may indicate that its retreat has slowed down again. Some calving presently takes place at the ice front; however, melting appears to be a more important mechanism of retreat. Slight variations in the location and morphology of proglacial submarine features were observed along the other tidewater glaciers of northeast Devon Island; the geomorphological and sedimentological evidence collected, however, supports the conclusions drawn from glacier activity in Brae Bay.

Future research will focus on the analysis of the bottom sediment samples collected at the glacier fronts, particularly in regard to the characteristics of their contained foraminiferal assemblages at various distances from the ice face.

Acknowledgments

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