Depositional settings of an arctic coast:
a shallow seismic investigation

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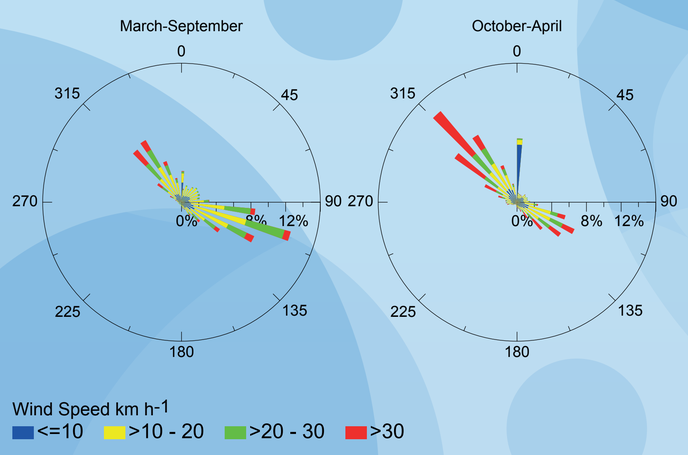
Introduction

Erosion of arctic coasts releases sediments and carbon which are thought to be exported to the atmosphere or deposited on the shelf. With the exception of breached thermokarst basins, the **arctic shoreface is considered erosional**, thus no sediment deposition or carbon burial can occur (Ruz et al., 1992). In this study, sub-bottom profiles were obtained using a **shallow seismic** device in the area of Herschel Island, Yukon Territory, Canada (Figure). Different areas of the nearshore around the island were surveyed to investigate if deposition can be ascertained based on stratigraphy shown on the seismograms.

Fig. 1. Wind chart showing frequency and direction of seasonal winds at nearby Tuktoyuktuk for the period 2009-2012.

Study Area

Herschel Island is located in the southern Beaufort Sea, about 70 km east of the Alaskan border. The island is an ice push moraine deposit (Mackay, 1959; Rampton, 1982), that formed during the Wiconsinian glaciation (Figure 2).
Coastal processes include wave and tide action, as well as storm surge, **ice rideup, ice pileup, thermal abrasion, and thaw subsidence**. Freeze-up typically begins by mid-October, and break-up in early June. Sea-ice follows the Beaufort Gyre westward. The mean tidal range generally <0.5 m. Wind influence on both ice, tidal and wave processes can be inferred from the wind roses shown in Figure 1.



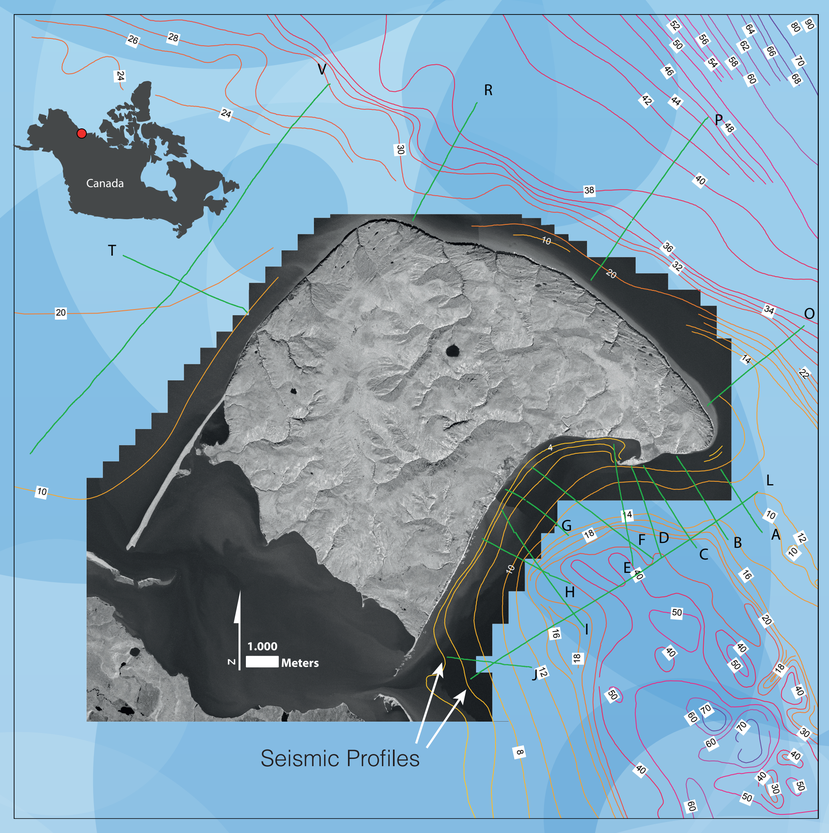


Fig. 2. The study area in the shallow nearshore around Herschel Island, Yukon Territory, Canada. Seismic profiles are indicated by green lines. Isobaths are also shown (2 m interval). The basin SE off the island was excavated during the Wisconsin glaciation.

Methods

An Innomar SES-2000 compact Sub-Bottom Profiler was used in the course of the study. The instrument was mounted on the AWI RV Christine (Fig. 3). Positional accuracy was <2 m with a WAAS corrected GPS antenna (Trimble R4), shown in Figure 4.

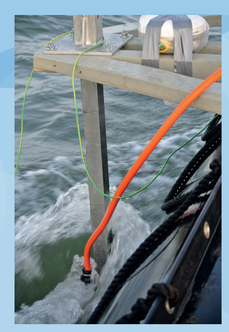


Fig. 3. The AWI RV Christine was used to carry out the seismic surveys. The SES2000 can be seen on the port side of the vessel.

Fig. 4. A WAAS corrected position was obtained with a Trimble R4 antenna.

Results

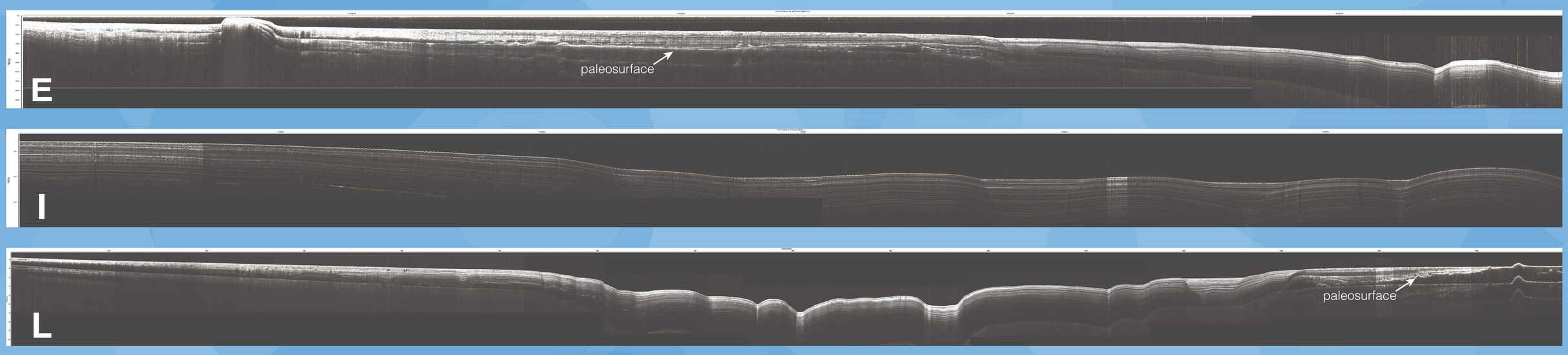


Fig. 5. Profiles E, I, and L from the SE quadrant of the Herschel Island nearshore. The presence of Herschel Basin and the glacial paleotopography amount to greater accommodation space. In addition, Herschel Island shields this area from ice rafted onto the shelf after the spring breakup, and the grounding of ice floes drifting westward during winter. The presence of stratigraphy indicates deposition in this area. Only areas shallower than ~6 m are disturbed.

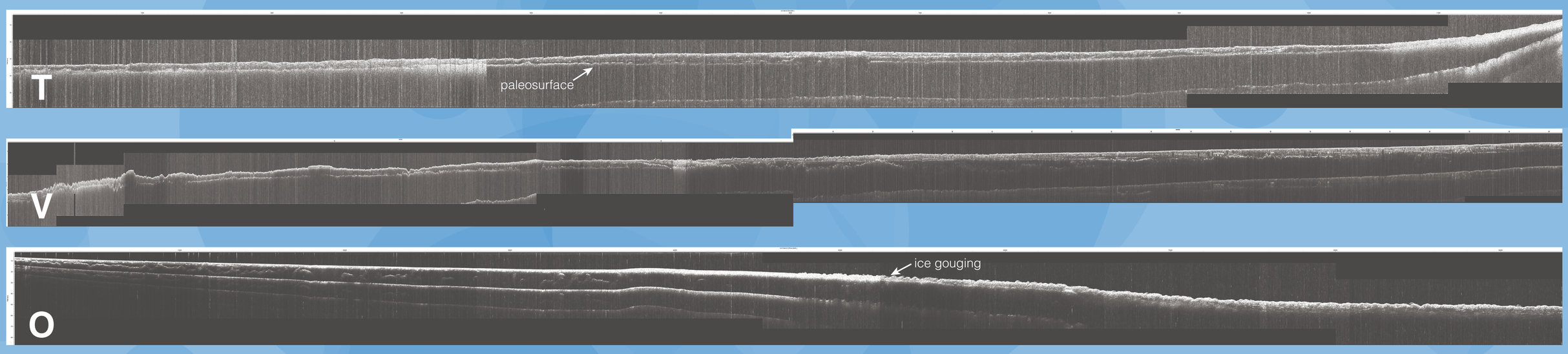


Fig. 5. Profiles T, V, and O from the NW and NE quadrant of the Herschel Island nearshore. All profiles show very little stratigraphy and a shallow contact to the paleotopography. Intense ice gouging of the sea floor is evident in the rough surface. Combined with the gentle slope of the shelf deposition in these areas is unlikely.

Discussion

The results of this study indicate:

- Disturbed stratigraphy to the NE and NW of Herschel Island due to gentle slope and intense cryogenic processes point to erosional nature of shoreface with little or no deposition
- The presence of Herschel Island shields the SE area from ice disturbance during conditions of complete ice cover
- The steeper shoreface profile of glaciogenic origin provides for accommodation space where sediments and possibly carbon are deposited

Refrences

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Ruz, M.H., Héquette, A., Hill, P.R., 1992. A model of coastal evolution in a transgressed thermokarst topography, Canadian Beaufort Sea. Mar. Geol. 106, 251–278.

Have questions? Feel free to contact me!
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