

Deglacial sedimentation and the origin of deep-keeled icebergs in the Beaufort Sea

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Abstract

Ice scours in the Amundsen Gulf and Mackenzie Trough are found at water depths of less than 400 m. Late Pleistocene sea level lowering cannot reconcile these deepwater scours with modern observations on sea ice pressure ridge scouring on the Beaufort Shelf, which is found in water depths of < 55 m.

In the Mackenzie Trough these scours are buried by a thick sedimentary cover (15+ m). Shallow piston cores from the area indicate that the base of the Holocene occurs around 10-15 mbsl. Indicating that the ice scours were formed during the deglacial retreat of ice streams from one of the major cross-shelf troughs in the Canadian Arctic. The similarity in the maximum depth of relict ice scours in the Mackenzie Trough, interior Amundsen Gulf, and the shelf break of the Amundsen Gulf, suggest a common origin for the deep-keeled icebergs that caused scouring.

A preliminary compilation of subbottom data, bathymetry and age control from cores in the Amundsen Gulf and Mackenzie Trough indicates that the timing for these deep water scours appears synchronous, and occurred between 12 and 14 ka. Icebergs calved from the retreating Amundsen Gulf ice stream remain a likely agent for the deepwater scours, but we cannot rule out icebergs calved from further east.

Bathymetry and Stratigraphy

Mackenzie Trough

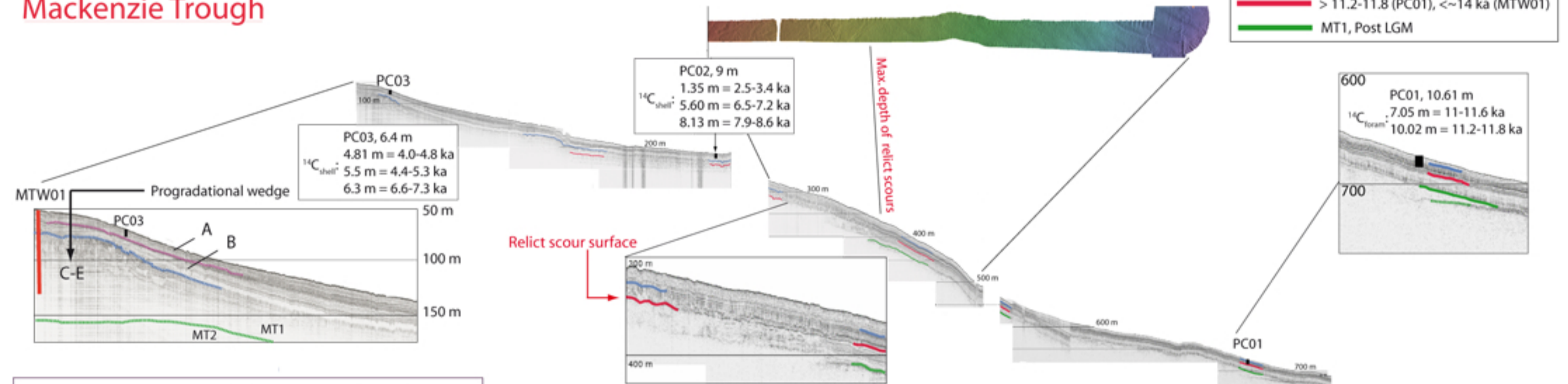


Figure 3. Compiled subbottom data from the Mackenzie Trough showing projected position of cores with age control (PC01, PC02, PC03 & MTW01). These are used to constrain the ages of key seismic markers. Ice scouring in the Mackenzie Trough is found to depths of 350-400 mbsl. The scours are only weakly expressed on the seafloor, with maximum topography of 2-3 m. Acoustic blanking of scoured sediments is evident in the subbottom data, and indicates that the scours are relict features. Dating of key seismic horizons suggests that the scours formed more than 11.2-11.8 ka (i.e. found deeper than the base of PC01), but less than 14 ka (the estimated age for the base of the 80 m MTW01 borehole).

Amundsen Gulf Shelf Break

Amundsen Gulf Interior

Figure 4. Evidence of ice scouring exists between 100-400 mbsl in the interior slopes of the Amundsen Gulf. Most of these plough marks are oriented parallel to the strike of the trough. Core PC124 (426 mbsl) contains a lense of IRD rich material between 1.1-1.3 mbsf, which is dated at 12.6 ka (2 foram based dates) (Scott et al., 2009). Upslope from this core the thin veneer of acoustically laminated sediments is disturbed by ice scouring. This suggests that the ice scouring occurred before ~12.6 ka.

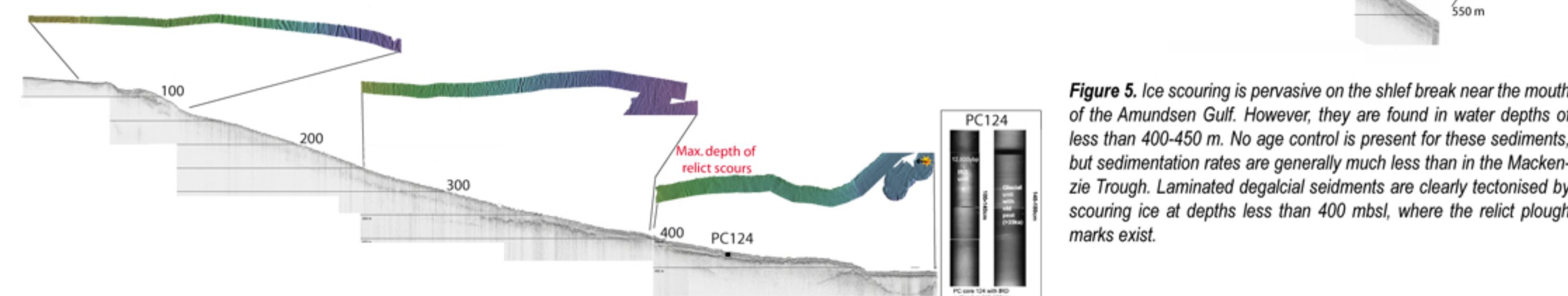


Figure 5. Ice scouring is pervasive on the shelf break near the mouth of the Amundsen Gulf. However, they are found in water depths of less than 400-450 m. No age control is present for these sediments, but sedimentation rates are generally much less than in the Mackenzie Trough. Laminated deglacial sediments are clearly tectonised by scouring ice at depths less than 400 mbsl, where the relict plough marks exist.

References

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- Stokes CR and L. Tarasov, (2010), Ice streaming in the Laurentide Ice Sheet: A first comparison between data-calibrated numerical model output and geological evidence, *GRL*, 37, L01501.

Deglacial Chronology & Study Areas

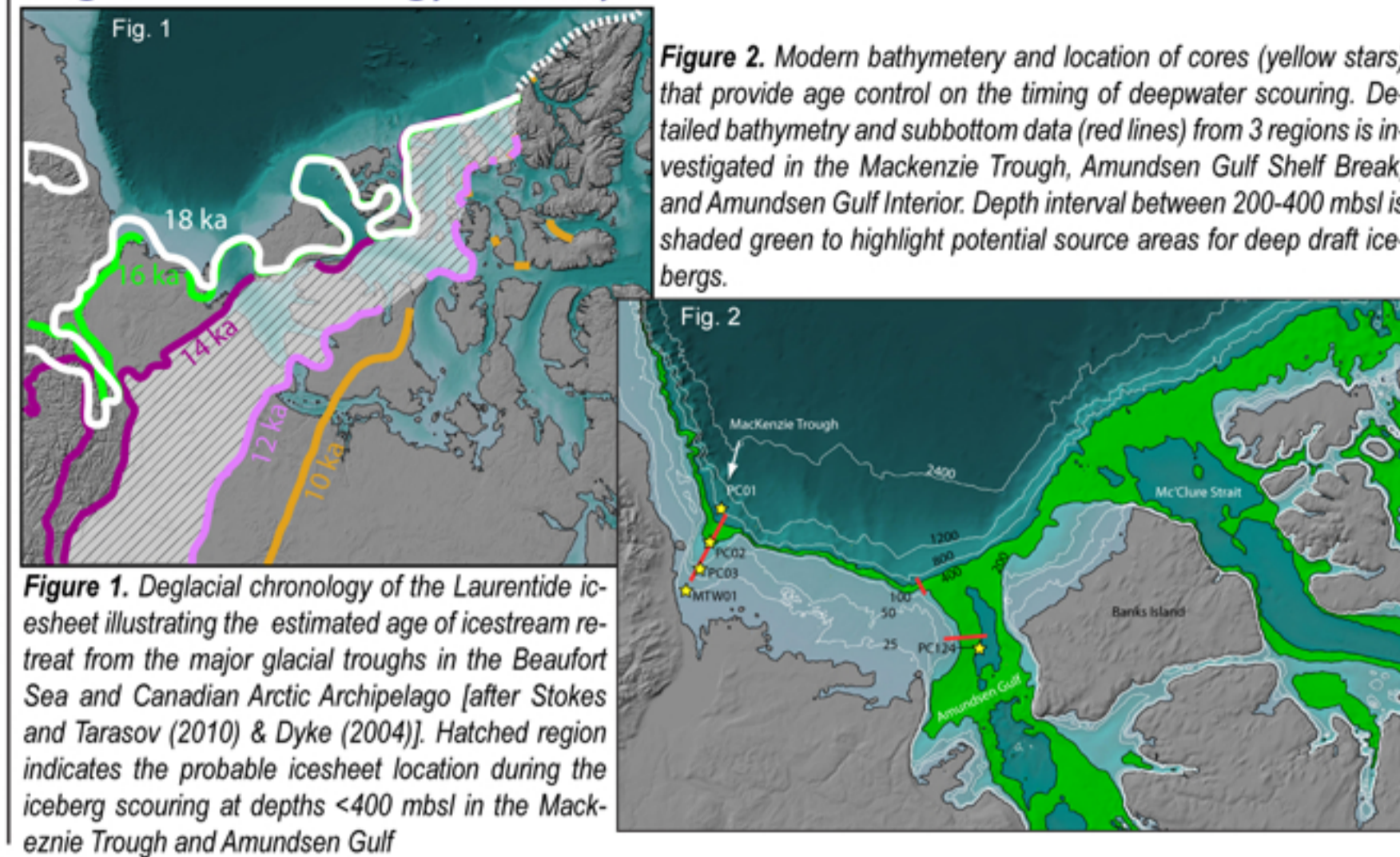


Figure 1. Deglacial chronology of the Laurentide ice-sheet illustrating the estimated age of icestream retreat from the major glacial troughs in the Beaufort Sea and Canadian Arctic Archipelago [after Stokes and Tarasov (2010) & Dyke (2004)]. Hatched region indicates the probable ice-sheet location during the iceberg scouring at depths <400 mbsl in the Mackenzie Trough and Amundsen Gulf

Figure 2. Modern bathymetry and location of cores (yellow stars) that provide age control on the timing of deepwater scouring. Detailed bathymetry and subbottom data (red lines) from 3 regions is investigated in the Mackenzie Trough, Amundsen Gulf Shelf Break, and Amundsen Gulf Interior. Depth interval between 200-400 mbsl is shaded green to highlight potential source areas for deep draft icebergs.