Reflection Seismic Investigations of the Beaufort Sea Margin

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Summary

The seismic stratigraphy and sedimentary architecture of the Mackenzie Trough and the Amundsen Gulf Trough, Beaufort margin, are investigated using high-resolution 2-D seismic reflection data.

The interpretation of eight seismic facies and five sequences from the Mackenzie Trough (Fig. 1) has provided evidence for two ice advances to the shelf break. The architecture of the adjacent continental slope is characterised by mass wasting and glacigenic debris flow deposits.

The Amundsen Gulf Trough contains three seismic facies and twelve sequences. Ice is interpreted to have advanced to the shelf break at least five times during the Late Cenozoic, producing a trough-mouth fan on the continental slope.

Introduction

The Laurentide Ice Sheet, which existed in North America and Canada during a number of glacial stages in the Late Cenozoic, displayed dynamic flow patterns and was partitioned into ice streams, surrounding by slower-flowing inter-ice stream regions (e.g. Dyke and Prest, 1987). A number of ice streams existed in the north-west sector of the Laurentide Ice Sheet, including those which occupied the Mackenzie Trough (Blasco et al., 1990) and the Amundsen Gulf Trough on the Beaufort margin (Sharp, 1988; Blasco et al., 2005; Stokes et al., 2006).

Whilst the maximum terrestrial ice extent on the Beaufort margin has been partially mapped (Rampton, 1988), the extent of ice on the continental shelf during the Late Wisconsinan and earlier glacial periods is not currently known.

Analysis of an extensive suite of seismic reflection data, primarily based on the GXT Beaufort SPAN dataset, has allowed for the construction of a comprehensive stratigraphy of this high-latitude passive margin. Knowledge of geological and glaciological processes has enabled the identification and interpretation of subsurface features and landform assemblages on the continental shelf and slope. Observations from the Mackenzie Trough and the Amundsen Gulf Trough will be considered in relation to their implications for the dynamics of the Laurentide Ice Sheet and the glacial history of the Beaufort margin.

Theory and/or Method

The seismic stratigraphy of the Beaufort shelf and upper continental slope is investigated using high-resolution 2-D seismic reflection data. Seismic profiles were interpreted over an area of more than 60, 000 km², with maximum data gaps of between 10 and 15 km. Once smoothed and depth-converted, the horizons were gridded at a scale of1 km to produce a series of structure maps and isopach maps for each seismic sequence.

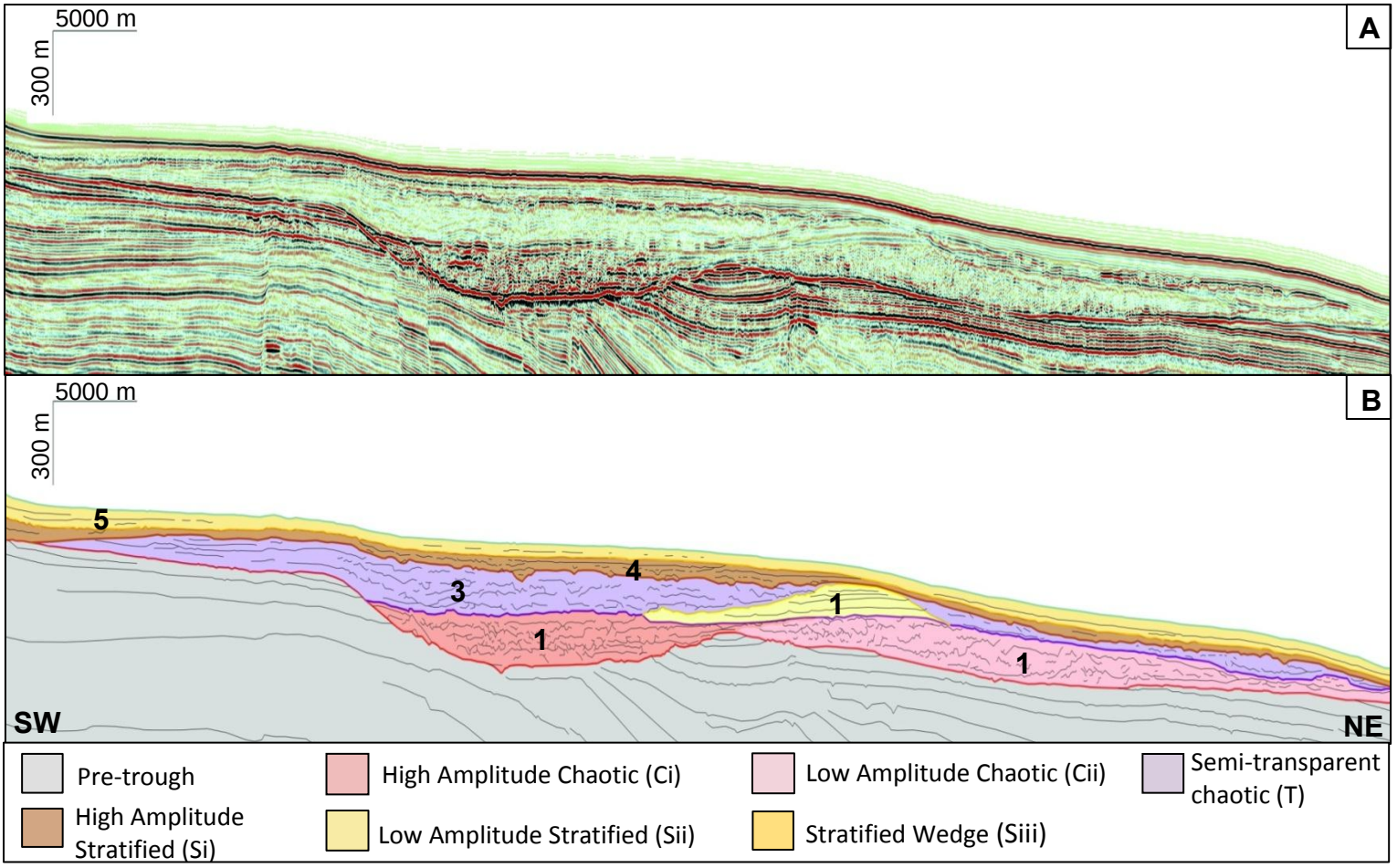

Figure 1: A) Section of a seismic dip line through the Mackenzie Trough, B) Schematic line drawing, illustrating the distribution of some of the seismic facies and sequences within the Mackenzie Trough

Examples

Two ice advances through the Mackenzie Trough are inferred due to the presence of two sequences of seismically chaotic to transparent facies (Fig. 1), which are interpreted as subglacial till. Within the Amundsen Gulf Trough, at least five advances through the trough have been inferred from several, stacked sequences of seismically transparent sediment, interpreted as till sheets.

Asymmetric wedges of seismically stratified to transparent facies with dipping internal reflectors have been identified in both troughs and are interpreted as grounding-zone wedges, formed by still-stands of the ice margin during retreat.

Conclusions

The differences in sedimentary architecture and past ice dynamics between the Mackenzie and Amundsen Gulf troughs are largely explained by their location. The Mackenzie Trough was occupied during only two ice advances as a result of its location at the north-west margin of the Laurentide Ice Sheet. In contrast, the Amundsen Gulf Trough experienced at least five ice advances to the shelf break due to its location closer to the centre of the ice sheet and its larger drainage basin. Whereas the Mackenzie Trough has been partially infilled by high rates of post-glacial, fluvial sedimentation, low rates of post-glacial, hemipelagic sedimentation in the Amundsen Gulf Trough have enabled the preservation of glacigenic landforms, such as grounding-zone wedges, on the sea floor.

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