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Reflection seismic investigations of the Beaufort Sea margin, Arctic Ocean: Variable history of Quaternary ice-sheet advance

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The seismic stratigraphy and sedimentary architecture of the formerly-glaciated Beaufort Sea shelf and adjacent slope are investigated using a comprehensive grid of high-resolution 2-D seismic reflection data collected by ION Geophysical Corporation as part of the BeaufortSPAN East survey. Three cross-shelf troughs, representing locations of former ice streams draining a 1000 km-long section of the Laurentide Ice Sheet are examined; the Mackenzie, Amundsen Gulf and M'Clure Strait systems. These palaeo-ice streams operated during the last, Late Wisconsinan, glacial maximum and a hitherto unknown number of earlier glacial periods. Their dynamics influenced past ice-sheet configuration and may have forced abrupt climate change through transport of ice and freshwater to the Arctic Ocean. The objectives of this work are to constrain the number of ice advances through each trough, to discuss the possible timing of these events, and to examine the impact of Quaternary glaciation on the continental shelf and adjacent slope.

The number of cycles of ice-sheet growth and decay varies markedly between the Mackenzie Trough on the western Beaufort Sea margin, with only two recorded events, and the Amundsen Gulf Trough to the east, with at least nine. The Mackenzie Trough was probably occupied by an ice stream during the Late Wisconsinan and either the Illinoian or Early Wisconsinan glaciation. The Amundsen Gulf ice stream was initiated earlier in the Quaternary, suggesting that the onset of cross-shelf glaciation on the eastern Beaufort Sea margin occurred significantly prior to initial glaciation of Mackenzie Trough to the west. Whereas the continental slope beyond the Mackenzie Trough lacks a significant glacial-sedimentary depocentre, major trough-mouth fans (of volumes $\sim$10,000 km^3 and $\sim$60,000 km^3) are present beyond the Amundsen Gulf and M'Clure Strait, respectively.

A number of buried glacigenic landforms, including grounding-zone wedges and lateral moraines, are identified from the Mackenzie and Amundsen Gulf troughs, recording the former positions of still-stands or re-advances in the ice margin. A 290 m-thick unit of prograded sediment is identified at the southern edge of Amundsen Gulf. This sediment is interpreted to have been deposited by a smaller subsidiary ice stream, the Anderson ice stream, which may have terminated in this location subsequent to ice retreat through the Amundsen Gulf. This provides evidence of dynamic ice-stream behaviour and the possible reorganisation of the northwest sector of the Laurentide Ice Sheet during the last deglaciation.