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A subglacial landform assemblage on the outer-shelf of M'Clure Strait, Canadian Arctic, ploughed by deglacial iceberg keels

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M'Clure Strait in the Canadian Beaufort Sea is one of the largest cross-shelf troughs in the High Arctic, with a length of over 1000 km and a maximum cross-trough width of around 250 km. M'Clure Strait has been suggested to be the former location of a fast-flowing ice stream which drained the northwestern margin of the Laurentide Ice Sheet during the Late Wisconsinan glaciation, and probably also during a number of earlier Quaternary full-glacial periods. The Late Wisconsinan ice stream in M'Clure Strait is interpreted to have extended to the shelf break between 21 and 16 ka ago, before undergoing rapid retreat. The ice stream has been suggested to have undergone vigorous episodes of activity during the last deglaciation; ice export events from the M'Clure Strait ice stream may have been responsible for the formation of distinctive layers of ice-rafted debris in the Arctic Ocean during regional deglaciation.

Here, we present multibeam bathymetric data of the seafloor of outermost M'Clure Strait. Low rates of post-glacial sedimentation have led to the preservation of an unusual assemblage of cross-cutting subglacial, glacifluvial and glacimarine landforms on the M'Clure Strait seafloor. The assemblage of glacigenic landforms records the advance and retreat of a fast-flowing ice stream. Highly-elongate mega-scale glacial lineations (MSGLs) provide evidence for the advance of the last, Late Wisconsinan ice stream through M'Clure Strait to within at least 8 km of the shelf break. The preservation of the MSGLs and the lack of ice-flow transverse landforms indicate rapid ice retreat from this region of the outer-shelf. Trough-parallel sinuous esker-like ridges of sediment are also identified. These were probably formed by the sedimentary infilling of ice-walled subglacial meltwater conduits during deglaciation. This interpretation requires considerable volumes of meltwater and sediment to have been transported within subglacial channels beneath the M'Clure Strait ice stream.

The subglacial landforms and sediments in M'Clure Strait were subsequently traversed and reworked by the keels of deep-drafted icebergs (up to 280 m thick) during deglaciation. Groups of parallel to subparallel iceberg ploughmarks indicate a uniform pattern of iceberg drift to the west and northwest during deglaciation. The ploughmarks were formed either by large individual icebergs with wide and uneven keels, or by several deep-keeled icebergs drifting uniformly while trapped within a thick multi-year sea-ice floe. It is possible that multi-year sea-ice cover developed in the relatively protected setting between the islands that flank M'Clure Strait. The iceberg keels which formed the parallel to subparallel ploughmarks also dissected some of the esker-like ridges, redistributing the sediment from the ridges across the seafloor. Isolated linear to curvilinear ploughmarks with highly-irregular orientations record the grounding of individual iceberg keels in seafloor sediments during the later stages of deglaciation.