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High-latitude continental slope geomorphology: a comparison of some Arctic and Antarctic submarine gullies

Jenny Gales (1), Matthias Forwick (2), Jan Sverre Laberg (2), Robert Larter (1), and Neil Mitchell (3)

(1) British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET, UK (jenles@bas.ac.uk), (2) University of Tromsø, Department of Geology, N-9037, Tromsø, Norway, (3) University of Manchester, Williamson Building 2.46, School of Earth, Atmospheric and Environmental Sciences, Manchester, M13 9PL, UK

Submarine gullies are common features of high-latitude continental slopes, however the processes which form these gullies and the timescales over which they form remain poorly constrained. The objectives were to investigate differences in submarine gully morphology from Arctic and Antarctic continental margins, including the Weddell, Bellingshausen and Amundsen seas, west Antarctic Peninsula, northern Norway, SW Barents Sea and western Svalbard. By comparing these previously glaciated environments, we aim to identify differences in slope character, processes operating in these environments and factors influencing gully formation.

Different gully types are identified from multibeam data based on their geomorphic signature, including gully length, width, depth, branching order, sinuosity, shelf incision, cross-sectional shape, density and gradient. Quantitative analysis of 2550 km of shelf edge data and over 500 gullies show that six geomorphically distinct gully types exist on high latitude continental margins. Although both hemispheres share similar gully characteristics, we identify two distinct differences between Arctic and Antarctic gully morphologies. Firstly, there is a lack of both deeply incised (>30 m gully depth at 50 m below the shelf edge) and shelf-incising gullies in the Arctic continental margin datasets that we examined. Secondly, unique gully signatures are observed on both Arctic and Antarctic margins.

The differences in gully depth and shelf incision have implications for both the timescales over which these features were formed and the magnitude of the flows which formed them. We consider three hypotheses for these differences: 1) Antarctic gullies are older features which were formed over multiple glacial cycles and date back to ages older than the Last Glacial Maximum; 2) Antarctic gullies were formed over longer time periods since the Last Glacial Maximum; and 3) erosive flows (i.e. sediment-laden subglacial meltwater) were more abundant in Antarctica over shorter timescales. We suggest that the timing and rate of deglaciation is responsible for the significant difference in gully depth and shelf incision observed between Arctic and Antarctic submarine gullies.