Deglaciation and future stability of the Coats Land ice margin, Antarctica

Dominic A Hodgson[1,2], Kelly Hogan[1], Rob Larter[1], Claus-Dieter Hillenbrand[1], James Smith[1], James A Smith[1], Alastair G C Graham[3], Peter Fretwell[1], Claire Allen[1], Vicky Peck[1], Mike Bentley[2]

[1]British Antarctic Survey, High Cross, Madingley Road, Cambridge, CB3 0ET; daho@bas.ac.uk
[2]Department of Geography, University of Durham, Durham, DH1 3LE;
[3]Department of Geography, University of Exeter, Exeter, EX4 4RJ.

Abstract

The westernmost part of the East Antarctic Ice Sheet discharges into the Weddell Sea via the Coats Land ice margin. Situated between the Filchner and Riiser-Larsen ice shelves, the ice margin consists of 600 km of marine-terminating glaciers and ice shelves. There is conflicting data on the Last Glacial Maximum ice sheet in this region with terrestrial glacial geomorphology showing little or no change in interior ice sheet thickness at the LGM, and offshore glacial geomorphology showing the imprint of large ice advances. The deglaciation, present and future stability of the region are also poorly understood. The aims of this study were to determine how ice from Coats Land interacted with the palaeo-Filchner Ice Stream during the last glacial advance, to document the geomorphological signatures of deglaciation, and to assess physical constraints on the future stability of the Coats Land ice margin and its ice shelves, including the Brunt Stancomb Wills Ice Shelf. The glacial geomorphology was studied in seven glacial troughs using high-resolution multibeam-bathymetry, sub-bottom profiles, seismic-reflection profiles, and sediment cores. Mechanical contact between extant ice shelves and the bed was studied using measurements of vertical ice displacement from satellite altimetry. Results showed that the glacial troughs have reverse-bed slopes with seafloor landforms including glacial lineations, drumlinised bedforms, moraines, over-deepened basins, and grounding-zone wedges. In troughs fed by higher velocity glaciers the surveys revealed medial moraines where the coastal glaciers merged with the palaeo-Filchner Ice Stream draining through Filchner Trough, indicating that these two systems were operating at the same time. The presence of grounding-zone wedges in the troughs suggests episodic retreat of the glaciers with ice shelves at their termini following the southward migration of, and their separation from, the palaeo-Filchner Ice Stream. Subsequent retreat was then marked by lift off from the bed. Once unpinned from the bed the ice shelves were then predisposed to rapid retreat back to the coastal grounding line due to the absence of further pinning points in the troughs, and to inbuilt weaknesses in the ice arising from prior fragmentation into icebergs as they flowed across the hinge line. As a result, in the absence of lateral and frontal buttressing, no ice shelves remain intact on this coast once fully detached from the bed.

Keywords: East Antarctic Ice Sheet, Weddell Sea, deglaciation, future stability