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East and West Antarctic ice sheet roles in glaciation of the western Ross Sea continental margin

S. L. Greenwood (1), R. Gyllencreutz (1), M. Jakobsson (1), and J. B. Anderson (2)

(1) Dept. of Geological Sciences, Stockholm University, Stockholm, Sweden, (2) Dept. of Earth Sciences, Rice University, Houston, Texas, USA

The western Ross Sea receives and delivers ice from both the East and West Antarctic Ice Sheets, making the palaeo-glacial record from this region valuable in understanding their relative long-term behaviour. Whilst the stability, or otherwise, of the East Antarctic ice sheet throughout the Plio-Pleistocene is a matter of some debate, we show here that even during the most recent glacial expansion ice flow characteristics in the western Ross Sea were subject to varying influences of East and West Antarctica at different periods through the glacial cycle. New, high resolution multibeam bathymetric data from the continental margin reveal snapshots of well-preserved glacial landforms on the seafloor around Ross Island and McMurdo Sound. Glacial lineations, grounding zone wedges, draped recessional moraines and meltwater channels record a series of different ice flow events in the region, contradictions between which require major phases of ice flow reorganisation. From the glacial geomorphology we reconstruct a four-stage model of ice flow evolution comprising: i) northeastwards flow into the Ross Sea from McMurdo Sound; ii) westward flow from the Ross Sea, around Ross Island and onto the Victoria Land coast and coastal seafloor trough; iii) a deglacial phase of ice sheet thinning, minor shifts in flow, and grounding line retreat into McMurdo Sound; and iv) grounding line pinning on Ross Island during regional retreat, uncoupling of a remnant Ross Island ice cap and local oscillation of Victoria Land outlet glaciers. It is clear that East Antarctic ice discharge had a strong influence on ice flow geometry in this part of the Ross Sea during the last glacial stage, but that it was not necessarily in phase with the behaviour of the West Antarctic Ice Sheet. It is similarly clear that the ice streams which drained the Ross Sea over the continental shelf at the last glacial maximum did not all operate synchronously, and exerted different drawdown power at different times. Finally, we conclude that Ross Island acts as an important pinning point in the Ross Sea ice sheet-shelf system, stabilising grounding line retreat and encouraging lasting ice shelf development. Our findings have considerable implications for how sediment and stratigraphic records of longer timescale ice sheet evolution are interpreted.