Grounding-line incursion into the southernmost Ross Sea - a comparison of lower Scott and Reedy Glaciers

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During the last glacial maximum (LGM), thickening of the grounded West Antarctic Ice Sheet in the Ross Sea dammed outlet glaciers crossing the Transantarctic Mountains and raised their surface elevations by hundreds of meters at the mountain front [1-4]. Subsequent retreat of the ice sheet re-opened glacier outlets, lowering surface elevations to the level of the Ross Ice Shelf [3-5]. Radiocarbon dating of ice-marginal deposits laid down during retreat show that the grounding line passed to the south of McMurdo Sound around 7,600 cal. yr BP [5], and reached the foot of Hatherton Glacier a few hundred years prior to 6,800 cal. yr BP [3-6]. In the same way, exposure dating of deposits stranded above the level of Scott and Reedy Glaciers in the southernmost Transantarctic Mountains can be used to constrain the final stages of grounding-line retreat into the inner Ross Sea Embayment [1]. Scott Glacier drains to the ice shelf a few kilometers northwest of the grounding zone at the foot of Mercer Ice Stream. Reedy Glacier, which cuts the range further to the south and east remains dammed by Mercer Ice Stream, and emerges from the mountain front at an elevation of 600 m, approximately 170 km upstream of the grounding zone.

During the 2004-05 field season we mapped and sampled glacial deposits on a group of small nunataks along the lower reaches of Reedy Glacier. These consist of small bedrock knolls rising 15-30 m above the shear margin of the glacier, and peaks set back 1-2 km from the glacier with up to 180 m of exposed relief. The presence of fresh erratics on the summits of these peaks indicates that all were overrun by substantially thicker ice during the last glacial maximum. Exposure ages measured so far show that Cohen Nunatak (745 m) emerged 6,800 +/- 500 years ago. Outcrops at only slightly lower elevation, but located at the modern glacier margin, emerged between 3,800 and 700 years ago. The youngest samples dated so far give a maximum age of 520 +/- 70 years for emergence of the lowest and smallest outcrop sampled. Collectively, these results suggest narrowing of the glacier's flow, and less than 100 m of thinning on Mercer Ice Stream at the Reedy Glacier confluence, during the past 7,000 years. Most post-LGM thinning on lower Reedy Glacier took place before 3,800 years ago, but slow-moving ice, separated from the glacier trunk, continued to recede from Cohen Nunatak up to 1,700 years ago. The level of the glacier margin has dropped by less than 30 m since 3,800 B.P. Exposure of the youngest erratics 500-900 years ago, at sites only a few meters above the glacier margin, may be related to the variations in discharge from Mercer Ice Stream that created distorted streakline patterns on the Ross Ice Shelf, such as the "Cassassa Bulge".

We also made a brief reconnaissance trip to Karo Hills, which overlook the Ross Ice Shelf at the mouth of Scott Glacier. Here, bedrock forms are streamlined and highly polished, indicating the the Hills were covered by thick, warm-based, erosive ice during the last (and former) glaciations.

The area is mantled by a continuous drift sheet extending from the bedrock summit (290 m) onto the adjacent glacier surface (ca. 120 m). Exposure ages of two erratics show that the summit of Karo Hills emerged 4,800-4,300 years ago. Samples from lower altitude define a trend of steadily decreasing age with decreasing elevation, to 3,000 yr B.P. at 180 m. Extrapolation of this trend suggests that Scott Glacier reached the level of the ice shelf roughly 2,000 years ago.

Based on the combined data from Scott and lower Reedy Glaciers, we conclude that: (i) The Ross Sea grounding line reached its present position at the foot of Mercer Ice Stream approximately 2,000 years ago, and has remained close to that position since. (ii) Changes in the width and discharge of Mercer Ice Stream, and the configuration of grounded ice at its mouth, during the past 2,000 years have had little effect on the surface elevation of Reedy Glacier upstream, lowering it by less than a few tens of meters. (iii) These observations are consistent with evidence from Conway Ridge that the present-day flow regime on Mercer and van der Veen Ice Streams was established roughly 2,000 years ago [7]. (iv) Although weakly grounded ice at the foot of Mercer Ice Stream may have lifted off and re-grounded intermittently during the past millennium, as suggested by distorted streakline patterns down-flow in the ice shelf [8], such behavior has not been accompanied by significant net retreat of the grounding zone.

References:

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