Evolution of Reedy Glacier from the last glacial maximum to present

Claire Todd, John Stone, Howard Conway; Department of Earth and Space Sciences, University of Washington

Gordon Bromley and Brenda Hall; Climate Change Institute and Department of Earth Sciences, University of Maine

The possibility that grounded ice may continue to retreat in the Ross Sea sector of the West Antarctic Ice Sheet (WAIS) is one aspect of uncertainty in predicting future sea-level change. Glaciers flowing from East Antarctica through the Transantarctic Mountains respond to changing ice elevations in the Ross Sea Embayment and can be used as indicators of grounding line migration. At the Last Glacial Maximum (LGM), thick ice in the Ross Sea dammed glacial flow [1,2]; during retreat of the ice sheet, thinning of this ice propagated up-glacier, stranding glacially transported material on emerging nunataks. Previous studies in the Transantarctic Mountains have tracked the retreat of the ice sheet as far south as Hatherton Glacier around 7000 cal. yr B.P. We are working to reconstruct the thinning history of Reedy Glacier, which flows through the Transantarctic Mountains south of the grounding line and thus remains sensitive to the level of ice in Mercer Ice Stream [3], in order to extend the chronology of WAIS retreat up to the present day.

During the LGM, Reedy Glacier thickened by more than 250 m at its outlet; 200-250 m in the Quartz Hills 90 km upstream, and 60 m at Hatcher Bluffs, close to where it enters the mountains from the polar plateau [4]. In the Quartz Hills, extensive ice-cored deposits cover a bench up to 200-250 m above glacier level and extend downslope 120-150 m from this limit. We interpret these deposits as material which emerged at an LGM ablation zone similar to the modern ablation area at the junction of Colorado and Reedy Glaciers. Ten samples from the upper edge of this deposit include five with apparent exposure ages greater than 30,000 years, which we interpret as recycled, and five with ages between 17,200 and 14,300 yr BP. The latter results suggest that Reedy Glacier stood 250 m higher than present 17,200 years ago, and remained at that elevation until at least 14,300 yr B.P., consistent with damming by the advanced WAIS occupying the inner Ross Sea. Samples collected downslope from the LGM limit include fewer pre-exposed rocks (3/13), but have a broad range of exposure ages from 15,000-8,000 years, which are largely independent of elevation or relative position. We interpret the range of ages as evidence that some of these rocks reached the ablating ice surface several thousand years before deposition. If so, the youngest sample at each site gives a maximum age for retreat of the glacier margin from that elevation. This suggests that Reedy Glacier had receded 60-90 m from its LGM position by 10,000 yr B.P., and 100-140 m by 8,000 yr B.P.

Down-glacier, close to the range front, peaks were completely overrun during the last glaciation. Thus, we can only infer a minimum LGM ice thickness. The highest peak

sampled is Langford Peak, ca. 25 km upstream from the junction with Mercer Ice Stream. An erratic from its summit indicates ice was 250 m thicker 8,000 yr B.P. At this time Reedy Glacier had receded by more than 100 m from the LGM limit upstream, suggesting substantially thicker LGM ice cover at Langford Peak also. Younger exposure ages from sites at the lower end of the glacier extend from 6,100-500 yr B.P. Their distribution with elevation and distance from the glacier margin indicates that most thinning was complete by 3,800 years ago, when the glacier surface elevation was no more than 30 m above the present level. Subsequent changes have included the emergence of several small nunataks close to the glacier margin within the last 900-500 years.

In summary: Exposure ages from the Quartz Hills suggest a prolonged stillstand at close to maximum thickness, covering at least the period 17-14 kyr B.P. Deglaciation of the southern Ross Sea was underway during the early Holocene, while the ice-sheet remained grounded in McMurdo Sound and at Hatherton Glacier [1,2,5]. Data from the mouth of the glacier indicate that thinning continued into the late Holocene, and that changes within the last few millennia account for only a small fraction of the original thickness of LGM ice. We are working on a flowline model like that of Anderson et al. [6] to link changes in the surface profile of Reedy Glacier to the position of the grounding line at the foot of Mercer Ice Stream.

References:
[1] Bockheim, J.G. et al., (1989) Quat. Res. 31, 229-254.
[2] Denton G.H. et al., Quat. Res. 31, 151-182.
[3] Mercer, J.H. (1968) GSA Bull. 79, 471-486.
[4] Bromley, G. (2005) Abstract; this meeting.
[5] Conway H. et al., (1999) Science 286, 280-283.
[6] Anderson, B.M. et al., Global Planet. Ch. 42, 143-153.