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GRACE satellite data and cosmogenic exposure ages in Enderby Land, Antarctica: ice mass increase or uncorrected post-glacial rebound?

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Measuring present day changes in the volume of the Antarctic ice sheet has traditionally been difficult, due to its remote nature and vast size. Over the past decade, the GRACE (Gravity Recovery and Climate Experiment) and ICEsat (Ice, Cloud and land Elevation) satellite systems have vastly improved these measurements by accurately measuring changes in the gravity exerted by the ice sheet, and the ice sheet surface height respectively. However, data sets from both these systems require various corrections related to an understanding of the rate of post-glacial rebound across the continent in order to make accurate measurements of ice loss or gain.

GRACE measurements have consistently observed a substantial apparent gain in ice mass in the Enderby Land region of East Antarctica (e.g. Chen et al., 2006). This large region has until recently been given little attention and there is an absence of detailed geomorphic and geologic studies with no present-day assessment of uplift. This in turn places some doubt on the implications of the Enderby Land GRACE data and its relationship to modern day climate change.

To address this problem, a reconnaissance survey to the Rayner Glacier region in Enderby Land was conducted during Polarstern Cruise ANT XXIII/9 in 2007. Observations of relatively unweathered erratics on Demidov Island and the Condon Hills provided strong evidence that the Rayner Glacier has lowered by at least 400 m, and retreated by at least 10 km during the late Quaternary. 10Be and 26Al dating of erratics and bedrock collected from three sites during this survey indicate that this deglaciation occurred early in the Holocene ($\sim$7 to 9 ka BP), and that ice retreat and lowering were effectively synchronous.

The timing of this deglaciation is about the same as that used to model the post-glacial rebound in previous GRACE measurements (Ivins and James, 2005). However, these models assumed as little as 1-200 m of ice loss at this time, which is much less than that observed in the field. Thus, it is likely that the post-glacial rebound model underestimates the required correction in this area. This in turn, will mean that the overall rate of mass loss calculated by GRACE measurements that have been corrected using the Ivins and James post-glacial rebound model will underestimate the true rate of modern ice loss in East Antarctica.

Chen, J.L., Wilson, C.R., Blankenship, D.D., Tapley. B.D., 2006. Antarctic Mass rates from GRACE, Geophysical Research Letters, 33, L11502.

Ivins, E., James, T., 2005. Antarctic glacial isostatic adjustment: a new assessment. Antarctic Science, 17 (4), 541-553.