

Cosmogenic exposure dating in Antarctica: what can we learn about ice-sheet history?

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Abstract

Cosmogenic-nuclide exposure dating of glacial deposits is uniquely suited to reconstructing Antarctic ice-sheet history (Balco 2011). Glacial deposits are found in all ice-free regions of Antarctica, and exposure-dated chronologies have the potential to extend the record of ice-sheet observations from the historic age of Antarctic exploration (late 19th Century) back to the Last Glacial Maximum and earlier. Cosmogenic exposure dating has provided discoveries that have caused us to rethink how ice sheets respond to climate forcing (Johnson et al. 2014, Jones et al. 2015). It has also provided powerful datasets for evaluating models of Antarctic deglaciation (Whitehouse et al. 2012, Briggs and Tarasov 2013), that are used to constrain contemporary satellite observations of ice sheet mass balance, and sea-level contributions (King et al. 2012).

In spite of these advantages, cosmogenic-exposure dating in Antarctica has had mixed success. Many datasets record complex histories of repeated exposure and subsequent burial by cold-based ice sheets, making it challenging to reconstruct unique ice-sheet histories. To maximise the potential for recovering high-quality, Last Glacial Maximum to present ice sheet chronologies, we target glacial sediment deposited on mountains that abut or protrude through the lower reaches of fast-flowing, warm-based outlet glaciers. Drawing on examples from East Antarctica (Mackintosh et al. 2011, Jones et al. 2015), we show how cosmogenic exposure dating can reconstruct rates, magnitudes and durations of outlet-glacier changes over timescales from centuries to millennia. We also outline our current and future work at three outlet glaciers in Northern Victoria Land; Mawson Glacier (2015/16 field season), Tucker Glacier (2016/17 field season) and David Glacier (2017/18 field season). We are using cosmogenic exposure dating at these three locations to answer the following questions: (1) What are the primary drivers and mechanisms that have forced outlet glacier changes over recent timescales? (2) How can we refine current estimates of ice sheet mass balance, and future sea level contributions using cosmogenic exposure dating?

Keywords: Antarctic ice-sheet history, cosmogenic exposure dating, ice-sheet modelling

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