# Ancient buried landscapes in the Weddell Sea Sector of Antarctica are records of restricted ice sheet extent in the past

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## Abstract

We aim to understand the evolution of the subglacial topography of the Weddell Sea sector of East Antarctica. We map the subglacial landscape by exploiting patterns visible at the ice surface in MODIS MOA and Radarsat AMM-1 data. The mapping identifies the locations of features including subglacial valleys, ridges and buried cirques in clearer planform detail than is possible in Bedmap2. These features can be related to past and present ice flow and erosion patterns as well as tectonic structure.

We link these features to their mode of evolution, and in particular, the scale of ice mass which cut the valleys. In some cases, valley distribution reflects modern or continental ice sheet erosion and the underlying tectonic fingerprint of the region. However, we also identify many small-scale valleys and cirques which may represent glacial erosion under alpine-style glaciation and which therefore reflect a time when the East Antarctic Ice Sheet (EAIS) was smaller. One possibility is that these landscapes may document a past retreat of the EAIS, for example during the Pliocene, such that localised ice caps or icefields existed separately from a smaller than present ice sheet. Alternatively, these features may record the configuration of ice prior to the establishment of polar conditions during the mid-Miocene, or even the development of localised ice masses prior to the Eocene-Oligocene transition.

Records of past ice sheet extent are largely focussed in the continental shelf beyond the current ice margin. However, we suggest that our mapping of buried features, which are inconsistent with modern day patterns of ice flow and erosion, could potentially be used as new constraints for palaeo ice sheet models. By simulating ice sheets that produce localised ice flow in the correct areas of the landscape, it would be possible to quantify the degree to which the EAIS has retreated and sub-divided in the past.

A further advantage of our mapping is that we can infer not only past and present patterns of erosion and ice flow, but also past and present basal thermal regime. For example, the numerous zones of alpine topography must have been eroded by relatively localised and warm-based ice masses. However, for such local-scale morphological landscapes to then have survived under the modern ice sheet for periods of millions of years or longer there must have been little subsequent erosion. One route to preserving these alpine landscapes is via significant incision in the large-scale troughs that bound alpine topographies. Rapid incision, for example at the onset of continental-scale ice sheet drainage, would drive uplift of these adjacent alpine systems, isolating them beneath a cover of relatively thin, cold-based ice.

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