

## **Advances in Antarctic ice-sheet reconstructions from geological archives: Recent reconstructions (Last Interglacial to present)**

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### **Abstract**

The geological evidence for past extent, thickness and behaviour of the Antarctic ice sheets (AIS) has been studied for over a century. Such evidence is used to develop reconstructions of past AIS configuration, which are valuable for ice sheet model testing, providing glacial isostatic adjustment (GIA) corrections to contemporary mass balance measurements, to understand forcing factors of change, and as an analogy for future behaviour.

The reconstruction of the AIS has become increasingly interdisciplinary and the questions being asked have evolved. For several decades there was a focus on the Last Glacial Maximum configurations of the ice sheets, and these are still of enormous interest, especially as a prime constraint for models. But recent years have seen increasing emphasis on interglacial configurations (especially Last Interglacial and Holocene) and periods of rapid retreat, including the post-LGM history. The reason is evident: as climate warms there is an increasing need to understand what the AIS might look like in a warmer climate, and how it might reach that configuration. But another driver to understand the Holocene is that the GIA signal we see now may be largely dependent on Holocene ice load history. There is also a growing body of evidence that the West Antarctic Ice Sheet may have retreated behind current margins in the Holocene. Both of these matter for understanding contemporary ice sheet behaviour.

The changes in questions have been accompanied by advances in reconstructions of the AIS that can be grouped into three main areas: (i) development of novel proxies for ice sheet presence/absence, (ii) use of data-constrained models, and (iii) new approaches to determining ice sheet history. Novel proxies include meteoric beryllium-10 in marine sediment, a range of biological (including genetic) proxies of ice absence, and advanced geochemical proxies of sediment provenance. Less recently, the reconstruction of ice extent on the shelf was unquestionably transformed by the advent of swath bathymetry. As ice sheet models have developed substantially in recent years and geological data has burgeoned there has been an accompanying upsurge in data-constrained ice sheet model experiments. These attempt to simulate former ice sheet configurations whilst satisfying the geological data, and are at the centre of important debates on former ice sheet volume and deglacial behaviour.

New approaches to ice sheet reconstruction include drilling through the ice to recover bedrock samples containing cosmogenic isotopes, whose concentration provides a record of past exposure and thus past ice sheet absence. This approach is particularly well-suited to understanding past interglacial configurations of the ice sheet. Our understanding of Last Interglacial behaviour of the AIS remains surprisingly poor but several of the recent innovations are directly addressing this deficit, and future prospects for the next several years are suggested.

**Keywords:** Antarctic ice sheet; glacial geology; ice sheet modelling