Eight Million Years of Land-Based Antarctic Ice Sheet Stability Recorded By *In Situ* ^{10}Be from the ANDRILL-1B Core

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Abstract

The response of the East Antarctic Ice Sheet (EAIS) to Pliocene warmth provides a critical way to gauge its sensitivity to climate change. Considerable uncertainty surrounds the Pliocene behavior of the EAIS, however. For instance, global sea level estimates for the mid-Pliocene warm period range from <10 m to >30 m, and numerous cosmogenic nuclide and sedimentological studies from the Transantarctic Mountains imply extreme landscape stability over the last several Myr whereas ocean records suggest orbital-scale instability of at least marine-based sectors of the ice sheet. These stabilist versus dynamicist views are difficult to resolve because onshore records are generally biased toward intervals of expanded ice cover and limited to areas with exposed land, while marine sediments typically provide indirect evidence for conditions on land and cannot distinguish between marine versus land-based ice sheet collapse. The AND-1B marine sediment core drilled beneath the Ross Ice Shelf contains a remarkably complete late Cenozoic sequence of glacial diamictons sourced from the adjacent EAIS, intercalated with open-water sediments likely associated with West Antarctic Ice Sheet collapse. We measured concentrations of in situ 10Be produced only when ice cover is reduced and the landscape is exposed in eight samples of glacially-derived quartz sand from AND-1B spanning parts of the last 8 Myr. Decay-corrected concentrations are low and show a long-term decline from 13,000 atoms/g to 1000 atoms/g over the record. These low values and the monotonic trend suggest that land-based ice sheet sectors have experienced little, if any, exposure during the past 8 Myr; the 10Be concentrations we measured are equivalent to only centuries or a few kyr of surface exposure. Perhaps more likely, the small quantities of 10Be were produced prior to the establishment of a full EAIS in the mid-Miocene, and reflect deeply-exhumed and thus 10Be-poor material that has been radioactively decaying beneath near-continuous ice sheet cover. In either case, these results strongly suggest that land-based portions of the EAIS draining into the Ross Embayment have been stable over the range of climatic conditions experienced during the late Cenozoic and exhibited, at most, short-lived ice margin responses to Pliocene warmth.

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