# West Antarctic Ice Sheet Elevations near the Ice Divide prior to the LGM

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The surface elevation history of the West Antarctic Ice Sheet (WAIS) prior to the last glacial maximum (LGM) is largely unknown. Knowledge of the timing and extent of past WAIS elevation changes provides insight to the WAIS response to sea level and climate forcing. The history of WAIS elevation changes also provides crucial constraints for dynamic ice sheet models necessary to predict the future behavior of the WAIS. Surface exposure ages of glacial erratics near the WAIS divide at Mt. Waesche in Marie Byrd Land (MBL), and at the Ohio Range in the Transantarctic Mountains, range from ~6 ka to > 400 ka without a dependence on elevation. At both locations, maximum ice elevations recorded by moraines or erratics were reached ~10 ka (Ackert et al., 2007; Ackert et al., 1999).

However, most exposure ages are older than the LGM and cluster around ~45 ka and ~75 ka (Figure 1a). Similar exposure age distributions obtained from ice-cored moraines on the WAIS in the Ohio Range indicate that the exposure ages relate to emergence of debris in the ablation zones. We infer that local WAIS elevations, flow patterns and ablation areas have remained similar to those at present for at least ~100 kyr. Tephra layers as old as 117±7 ka at Mt. Waesche indicate similar relative WAIS stability in MBL (Dunbar et al., 1998). The presence of a few exposure ages spanning the last interglacial within the ice-cored debris at both sites suggests that ice elevations and ice flow regimes were not significantly different during the last interglacial. Such limited changes in ice elevation and flow regime would seem inconsistent with a complete WAIS collapse.

The intervals round 45 and 75 ka are roughly synchronous with obliquity-driven isolation maximums, warmer Antarctic temperatures and with exposure ages of alpine moraine boulders in the Ohio Range. These intervals likely correspond to pulses in the debris flux and higher accumulation rates. A combined ice sheet/ice shelf model driven by marine $\delta^{18}O$ predicts that

WAIS elevations near the Ohio Range have varied only ~150 m over the last glacial cycle (Pollard and DeConto, 2009). In the model simulation, relative high stands occurred ~50 and ~80 ka with maximum ice elevation reached ~10 ka (Figure 1b). The lag between modeled ice sheet high stands and peaks in the exposure age distribution suggests that debris flux into the ablation zone is maximized during down draw of the WAIS surface. The general correspondence between the model results and observations at the Ohio Range and Mt. Waesche supports the conclusion that interior WAIS elevation changes were limited to ~150 m during the last glacial cycle and are controlled primarily by accumulation rates (temperature) rather than the aerial ice sheet extent (sea level).

*References*

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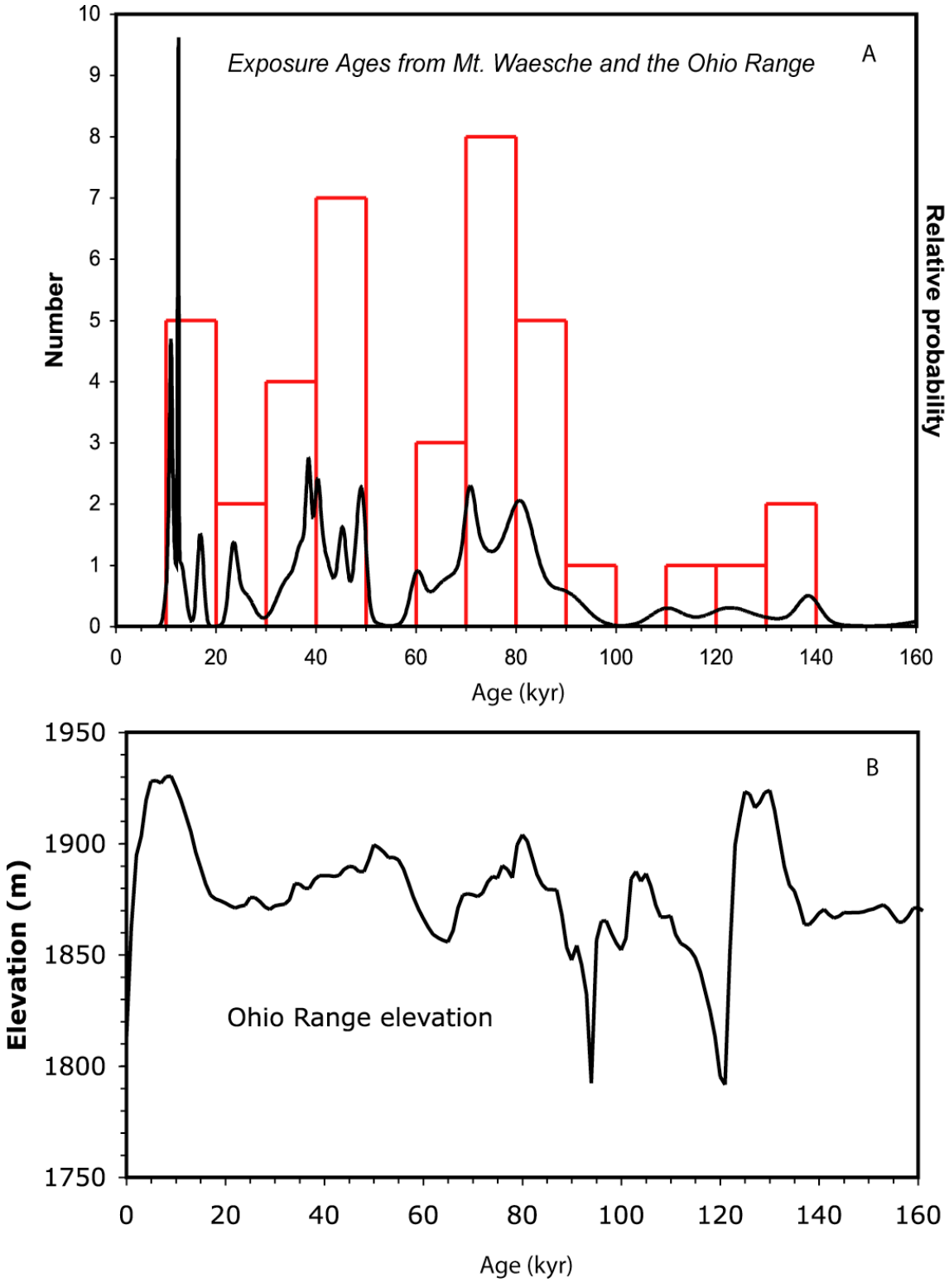
Figure 1. A) Histogram and probability density function (PDF) of surface exposure ages of erratics and moraine boulders from the Ohio Range and Mt Waesche. The exposure ages cluster in the intervals 40-50 ka and 70-80 ka. B) Modeled WAIS elevation at the grid point nearest the Ohio Range from 160 ka to the present. Output is from WAIS model presented in Pollard and DeConto (2009). The relative highstands that occur ~50 and ~80 ka correspond to peaks in the PDF of exposure ages, suggesting pulses of debris coincided with the highstands.


Exposure Ages from Mt. Waesche and the Ohio Range
A
Number
Relative probability
Age (kyr)
B
Elevation (m)
Ohio Range elevation
Age (kyr)