Preservation of Pliocene age surfaces beneath the WAIS: Insights from emergent nunataks in the Ohio Range

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The granitic bedrock forming the Ohio Range Escarpment and adjacent Bennett and Tuning Nunataks is typically cavernously weathered with pits ranging from a few cm to > 100 cm. The rock remaining between pits often forms delicate structures only several cm thick (tafoni). Cosmogenic ^{21}Ne and ^{10}Be concentrations indicate that the weathered bedrock surfaces are at least 4 million years old with average erosion rates of 15-35 cm /Ma on surfaces between pits. However, exposure ages of erratics on the escarpment 125 m above the present WAIS surface (~1500 m) indicates that the nunataks were buried by the WAIS 10,000 years ago (Ackert et al., 2007).

Ice temperatures at these relatively shallow depths would be well below freezing, and the WAIS remained cold-based. Consequently, glacial erosion has been minimal, generally restricted to breakage of only the most delicate weathering structures. Tuning Nunatak is located in an area with higher ice velocities as indicated by crevasses and steeper surface slopes. There, limited quarrying of horizontally jointed bedrock has locally removed up to 1 m of rock and produced a few glacial scratches. Paired ^{21}Ne and ^{10}Be data indicate that the duration of ice cover was limited. Samples of bedrock from three nunataks fall within the zone of simple exposure on ^{21}Ne/^{10}Be vs.^{10}Be plots indicating that unsupported decay of ^{10}Be (half life = 1.5 Myr) was minimal, and no recent burial event exceeded 50, 000 years.

Wind scoops (areas of enhanced ablation) surround the Bennett Nunataks and expose cavernously weathered rock at the base of the nunataks, 40 m below the level of the surrounding WAIS surface. Presumably, the weathered bedrock extends below the WAIS surface to the average trimline elevation during the Pliocene. Ice sheet models suggest that the northern flank of the Transantarctic Mountains near the Ohio Range remained ice-covered during WAIS collapse events with average ice elevations several hundred meters below present, and that the "collapse state" was the usual WAIS configuration 3-5 Ma (Pollard and DeConto, 2009). In principle, paired ^{21}Ne and ^{10}Be from bedrock samples beneath the WAIS could be used to map ancient trimlines and test models of WAIS history. We speculate that bedrock samples from beneath the WAIS in the Ohio Range would show progressively increasing disequilibrium between stable and radioactive cosmogenic nuclides with depth as the integrated duration of Pleistocene ice cover increases, assuming ice temperatures remained below the pressure melting point. Below depths where glacial erosion occurs, stable cosmogenic nuclide concentrations in bedrock will decrease and evidence for past exposure will be lost.

References:

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