

## **Constraints on the glacial history of West Antarctic nunataks from measurements of $^{10}\text{Be}$ , $^{26}\text{Al}$ , and $^{21}\text{Ne}$ in bedrock surfaces**

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We present measurements of  $^{10}\text{Be}$ ,  $^{26}\text{Al}$ , and  $^{21}\text{Ne}$  in bedrock surfaces from three isolated nunatak groups in West Antarctica. These are the Pirrit and Nash Hills, located midway between the grounding line and the ice-sheet divide, and the Whitmore Mountains, located at high elevation on the divide. Bedrock samples from the lower flanks of the Pirrit and Nash Hills have nuclide concentrations indicating varying degrees of past ice cover. Nevertheless, these samples all have cumulative exposure ages between 200 kyr and 1.4 Myr, demonstrating that past ice cover was cold-based, which is consistent with glacial geological observations.

Nuclide concentrations measured in samples from higher elevations at the Pirrit Hills (the upper flanks of the Nash Hills were not visited) and in all of the bedrock collected from the Whitmore Mountains show that these samples have experienced prolonged exposure at extremely low erosion rates. The samples have  $^{21}\text{Ne}$  exposure ages of ~2-12 Myr, and several samples from the Whitmore Mountains have  $^{26}\text{Al}$  and  $^{10}\text{Be}$  concentrations which exceed saturation concentrations predicted by the scaling method of Lal [1] and Stone [2]. The scaling method of Lifton *et al.* [3], however, indicates that these samples are at or below saturation. If these surfaces were ever buried by thicker ice in the past, such episodes were of very limited duration and by cold-based, minimally erosive ice.

These results demonstrate that ice-sheet thickening during past glacial periods was limited to no more than a few hundred meters at these sites. Nuclide concentrations are incompatible with significant subglacial or subaerial erosion, which (i) establishes that thicker-than-present ice was cold-based and preserved subglacial bedrock surfaces, and (ii) suggests that a cold and arid climate has persisted in West Antarctica since at least the late Miocene.

[1] Lal (1991), *Earth and Planetary Science Letters*, 104, 424-439. [2] Stone (2000), *Journal of Geophysical Research*, 105, 23,753-23,759. [3] Lifton, Sato, & Dunai (2014), *Earth and Planetary Science Letters*, 386, 149-160.