Limited fluctuations of East Antarctic Interior in late Pliocene, and influences on meteorite concentrations.

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Introduction: Past ice elevation changes in the polar plateau interior are important for constraining the glacial history of the East Antarctic Ice Sheet, this information imprinted on the exposed surface rocks when ice retreats by the cosmogenic nuclides [1]. The glacial history of the central Transantarctic Mountains may differ from peripheral Antarctic mountain ranges, allowing drainage through a limited number of troughs [2]. The Miller Range located extends south along the edge of the Polar Plateau for over 100 km separating the upper Nimrod Glacier from the 25 km-wide Marsh Glacier, joining the Nimrod about 50-km downstream. Ice elevation in this region extends from 2200 m a.s.l on the southwest side of the Range to less than 1600m a.s.l on the northeast, a 600-m drop across the 30-km barrier (Figure 1). The occurrence of meteorite concentration in the blue ice area adjacent to Miller Range revealed that the ice movement rates are very low, and the deflation of the icesheet surface and redirection of ice flow might result from climate change at least since the Last Glacial Maximum (LGM) ~20,000 years ago [3]. Our study tests this theory by examining cosmogenic exposure ages of samples collected near the Miller Range icefields.

Methods and materials: Cosmogenic nuclide surface exposure age dating is a powerful tool to constrain glacial history of ice sheet margins. The fundamental factors that determine the nuclide accumulation in the rock minerals include the nuclide production rate and the rock erosion rate. The production rate is a function of the composition of minerals, cosmic ray flux, geomagnetic latitude, elevation position and shield factors. The rock erosion rate reflects the attenuation of surface accumulations and erosional strength of glacial activities. The cosmogenic nuclides ^{10}Be ($\tau_{1/2}$=1.36±0.07 Ma) and ^{26}Al ($\tau_{1/2}$=0.717±0.017 Ma) both generated by secondary cosmic radiations (dominantly by in-situ neutron spallation) have a known production ratio in quartz [4]. The quartz-bearing Precambrian gneisses and amphibolites that make up local bedrock in the

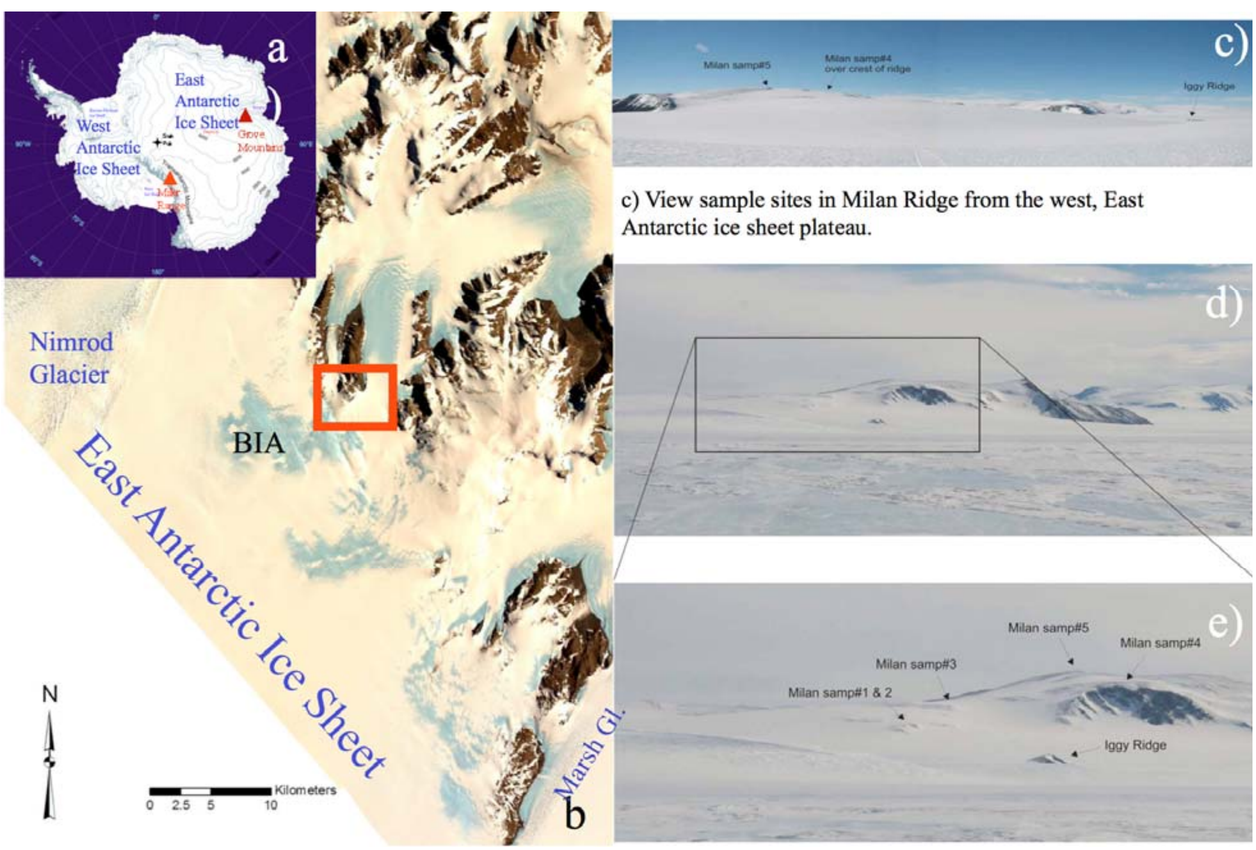

Figure 1. Miller Range and Grove Mountains locations in Antarctica and cosmogenic nuclide surface exposure age dating sample sites on Milan Ridge and Iggy Ridge.

Miller Range are well-suited for such studies. In order to constrain the glacial history of this region, we collected samples of both bedrock and moraine erratics on two potential ice barriers (Iggy Ridge and Milan Ridge) for surface exposure age dating.

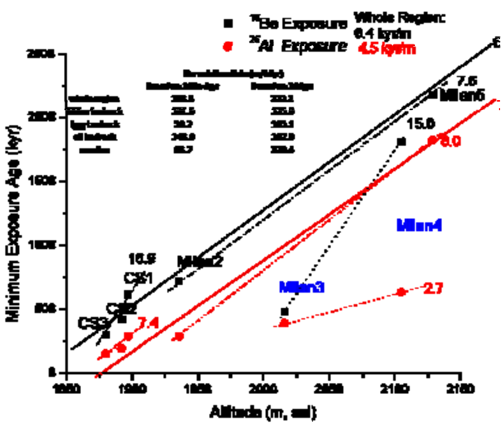

Figure 2. Surface exposure ages of erratic and bedrock samples in the Miller Range. ^{10}Be and ^{26}Al data are distinguished in color. Each sample with corresponding ^{10}Be (black square) and ^{26}Al (red dot)exposure ages is plotting along elevation. Inset table Bedrock sample names are in black, and erratic names are in blue. Lines with numbers indicate the exposure slope.

Results: Apparent exposure ages of Iggy Ridge erratic and bedrock samples range from 106±11 ka to 185±19 ka (^{26}Al age) and 221±24 ka to 460±51 ka (^{10}Be age) increasing with the elevations. These ages are extremely high given that they were collected from the ice margin to no more than 15 m above present-day ice surface. The long burial (688±54~912±109 ka) and much longer exposure history (1104±262~2695±492 ka) with low erosion rate of 14~30cm/Ma shown by these samples suggest they were carried by cold-based glaciers and experienced limited erosion during past glacial advances. The samples (Milan2~Milan5) in the Milan Ridge have slightly different exposure histories. They have a consistent appearanr exposure ages ranging from 136±14 ka to 684±93 ka increasing with the elevation from the current ice margin to the ridge top. One inconsistency is that the ^{10}Be age of the 80-m higher erratic sample (Milan3 381±46 ka) is younger than the bedrock sample (Milan2 550±61 ka) near the current ice margin, which suggests the bedrock sample has prior exposure inheritance. Another erratic sample (Milan 4, ~170 m above current ice margin) and the ridge top bedrock (Milan5, ~190 m above current ice margin) have appearant exposure ages of 1315±182 and 1707±280 ka (^{10}Be) or 454±53 and 684±93 ka (^{26}Al), respectively, with little burial and erosion (Figure 2).

Interpretations: These exposure ages are much older than those from peripheral Antarctic mountain ranges and suggest that the outlet glacier system severely limits icesheet response to climate change [5]. Compared with the exposure histories of the Grove Mountains, which is on the opposite side of Dome Argus in the East Antarctic Ice Sheet, we confirm that the EAIS interior surface elevation has been relative stable in the recent 2 million years, and even the recent overwhelming LGM event has no significant impact on this region [6].

The implications for meteorite stranding surfaces are significant. The relative stability of the East Antarctic icesheet where it meets mountainous barriers suggests that the blue ice fields are also likely to be stable features on timescales approaching 10^6 years. Furthermore, while small fluctuations in the level of the East Antarctic icesheet adjacent to the Transantarctic mountains may take place, and alter highly-localized details concerning a blue-ice meteorite stranding surface, these surface are unlikely to change dramatically (disappearing or moving significant distances). Typical meteorite stranding surfaces are therefore likely to record a history of meteorite falls ranging far back into the Quaternary.

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