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Ice-core Glaciochemical Reconnaissance in Inland West Antarctica

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advective cooling. The differences between ice streams disappear when the real bedrock topography, and the shape of the coastline of the Siple Coast, are replaced by a flat plane and a straightline coast, respectively. We may conjecture, therefore, that peculiarities of local topography may create a situation in which an ice stream develops at a local divide and consequently has a lower surface temperature and reduced shear stresses and internal friction. It is possible that this situation is characteristic of ice stream C, a conclusion we regard as tentative because only the simplest form of a sliding law was used, and also, a higher resolution may be necessary to make definitive conclusions. We also excluded from consideration the transition zone between an ice sheet and ice shelf. Consequently, our study is not intended to challenge existing hypotheses concerning ice stream C stagnation, but we do suggest that some distinctive features of the ice-stream structure found at the Siple Coast may have roots in its large-scale topography.

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Ice-core glaciochemical reconnaissance in inland West Antarctica

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To date, the highest resolution ice cores have come from Greenland [the U.S. Greenland Ice Sheet Project 2 (GISP2) and European Greenland Ice Core Project (GRIP)]. The ability to determine annual layering in these cores over at least the past 50,000 years has allowed the reconstruction of a detailed environmental history covering major glacial and interglacial climatic events (e.g., Mayewski et al. 1994; O'Brien et al. 1995). Although these cores have significantly advanced our understanding of paleoclimatic change in the Northern Hemisphere, questions remain as to whether the two hemispheres have responded synchronously to climate forcing through time. Determining the existence, similarity, and phasing of climatic change in the Southern Hemisphere is crucial to understanding the importance of various climate-forcing factors.

Two sites in West Antarctica (Siple Dome and inland West Antarctica) have been identified by the U.S. ice-core community as potential deep-drilling locations where records similar in quality to the Greenland cores may be recovered. Siple Dome (Mayewski, Twickler, and Whitlow 1995) is an ideal location for deep ice-core drilling, because of the homogeneous spatial variability of surface snow chemistry and well-preserved annual signals in chemical species and physical properties. In this article, we describe the initial results of work done at the second location in inland West Antarctica.

The 1995 field season involved drilling three ice cores and collecting snowpit samples along a 158-kilometer (km) traverse trending 26° (relative to true north) from Byrd Surface Camp (figure 1). Visual stratigraphy revealed numerous depth hoar and wind crust layers throughout the cores, but identifying distinct and consistent annual layering proved to be difficult. As a test, annual layer counting estimates were compared to the accumulation rate calculated from a beta profile. The prominent peak in radioactivity at 14.5 meters (m), corresponding to the height of bomb testing in 1964, suggests an

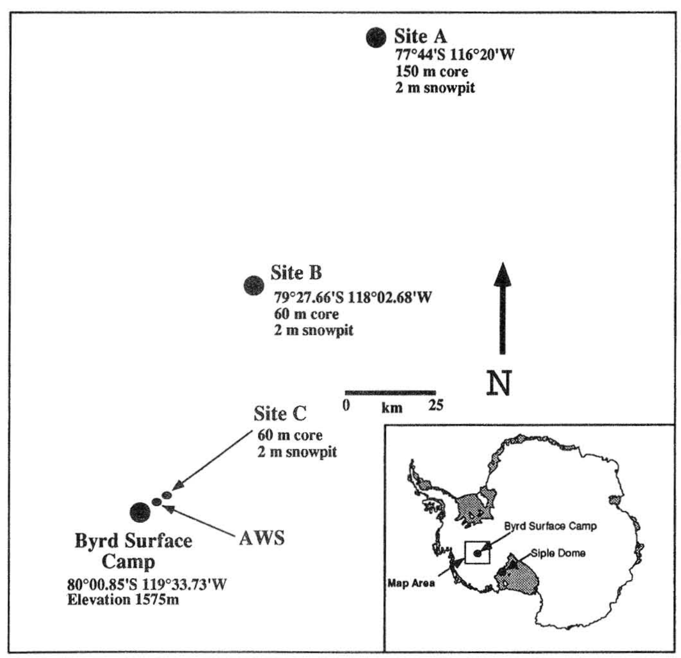

Figure 1. Location map. (AWS denotes automatic weather station.)

accumulation rate of 28.8 centimeters (cm) of ice per year at site A (Dibb personal communication; figure 2). An accumulation rate estimate based on annual layer counting is significantly lower (20 cm of ice per year), suggesting that more than one depth hoar layer forms during a year.

Glaciochemical concentrations of major anions, cations, and methanesulfonic acid (MSA) have been performed on snowpit samples. The most distinct annual signals are present in sulfate ($SO_4^=$) and MSA profiles (figure 3). There appears to be more than one depth hoar layer corresponding to each summer peak in $SO_4^=$ and MSA. Average values for all seasalt species are significantly lower than those found at more coastal sites and Siple Dome, suggesting that marine influence is greatly reduced on the west antarctic polar plateau (Mulvaney and Wolff 1994). Species with gaseous precursors [nitrate (NO_3^-), $SO_4^=$, and ammonium (NH_4^+)] have concentrations consistent with those found in other antarctic locations, suggesting that elevation and distance from the coast have little influence on their concentration (Mulvaney and Wolff 1994).

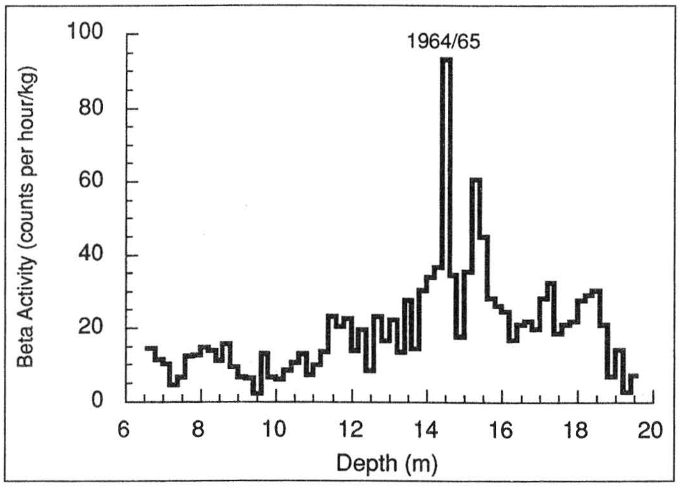

Figure 2. Radioactive bomb fallout peaks at site A. (kg denotes kilogram.)

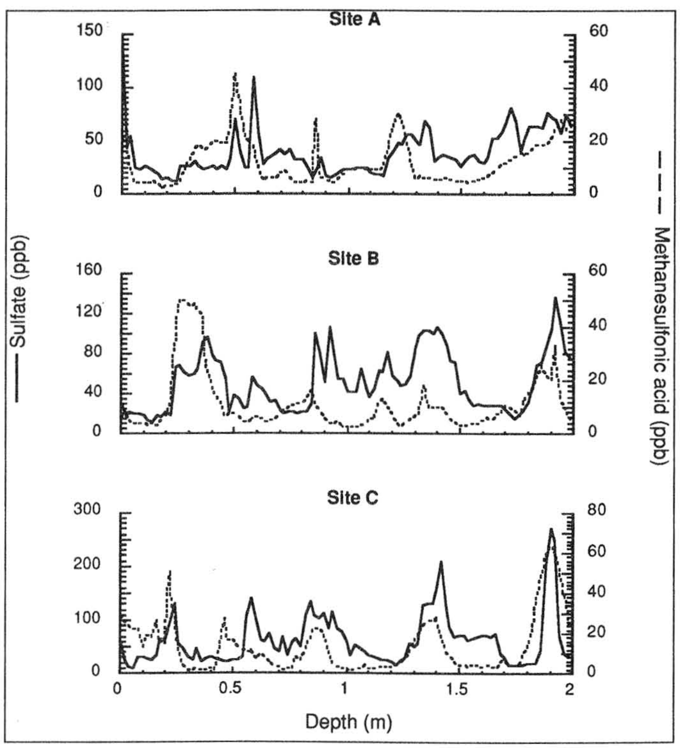

Figure 3. Sulfate and methanesulfonic acid concentrations in snowpits. (ppb denotes parts per billion.)

Snowpit data from the three sites in this study display significant spatial variability (figure 3). One possible explanation for this difference would be the existence of an ice divide between sites A and B. Atmospheric circulation in the area may be significantly altered by the presence of such a divide, thereby causing the observed changes in chemical concentrations. The spatial variability displayed in the snowpit data suggests that the region has complex atmospheric circulation patterns and highlights the need for increased sampling in West Antarctica.

From the cores collected in this study, we plan to develop an approximately 1,000-year ice core record for inland West Antarctica. We are examining the 1,150-year Siple Dome record for information on several aspects of the climate system in West Antarctica, including marine cyclogenesis, marine biogenic productivity, stratospheric denitrification, and mass balance. New continuous, high-resolution multivariate ice-core records from inland West Antarctica are expected to provide insight into these same climate parameters. Ice-core records from Siple Dome and inland West Antarctica will be correlated with other cores within the Ross Ice Drainage System, one of the most climatologically and glaciologically dynamic areas of Antarctica. These cores are expected to be of the same quality as the Summit, Greenland, cores, allowing additional bipolar climate correlations to be attempted (Mayewski et al. 1996).

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