

Understanding paleoclimate through polar ice cores

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Deep polar ice cores preserve ancient atmospheric gases and aerosols, which are essential for paleoclimate studies. For example, reconstructing past atmospheric GHG (CO_2 , CH_4 , N_2O) concentrations, the primary productivity of the Southern Ocean, and records of past moderate-to-explosive volcanic eruptions are possible by analyzing the trapped air and/or aerosols within deep polar ice cores. Ancient ice can be retrieved not only from deep-ice-core-drilling projects but also through shallow-drilling from the surface in blue-ice areas (BIAs), where large quantities of bare glacier ice are exposed. Collecting ancient ice from BIAs is not only easier and less costly than deep-ice-core-drilling projects, but also provides virtually unlimited amounts of ancient ice for analysis. This allows the analyses of trace components that may not be available through deep-drilled ice cores.

A novel paleoclimate record from Larsen BIA, Antarctica has been established. Multiple dating techniques and paleoclimate reconstructions suggest that surface temperature increased by at least 10 °C during the last deglaciation in northern Victoria Land, East Antarctica. Meanwhile, greenhouse gas (GHG) concentrations trapped in the Larsen glacier were considerably altered. Analyses of isotope ratios of lead (Pb), nitrogen ($\delta^{15}\text{N-N}_2$), oxygen ($\delta^{18}\text{O-O}_2$), and carbon ($\delta^{13}\text{C-CO}_2$), suggest that GHGs were likely altered by UV photochemical processes within the glacial ice. Additionally, analyses on ice cores from the Elephant and Reckling Moraine Icefields in Antarctica indicate that these areas are promising sites for finding the oldest ice.

Ancient sulfate aerosols and tephra shards from the volcanic eruption of Mt. Baekdu (the Millennium Eruption) were analyzed using a Greenland ice core from the NGRIP site. One significant outcome of this study is the identification of a maximum two-month hiatus between the two eruptive phases of the Millennium Eruption. In addition, sulfur isotope analysis suggests that the sulfur injection height of the eruption was relatively low, which may have contributed to its limited climatic impact.