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Deglacial Volcanism as an Extreme Aerosol Forcing on Subpolar North Atlantic Climate and Carbon Cycling

THENA THULASI DOSS, NISHA NAIR AND JOHN KURIAN

National Centre for Polar and Ocean Research

The present study investigates the impact of volcanic eruptions during the transition from the last Ice Age on climate and biogeochemical cycles in the North Atlantic region. These tephra layers serve as precise chronological markers, enabling us to correlate volcanic events with significant climatic changes and shifts in sea surface temperature (SST). Specifically, we focus on volcanic ash layers found within marine sediment cores collected from depths of 20 to 70 meters below the seafloor. By examining the thickness and distribution of these ash layers, we found that they vary from several centimetres to very fine-grained sediments intermixed with silt, indicating a history of moderate bioturbation. Clusters of tephra deposition are preferentially associated with deglacial intervals characterised by rapid ice-sheet retreat and increasing atmospheric CO_2 concentrations (from ~180 to >260 ppm), suggesting enhanced volcanic activity linked to glacial unloading. While the CO_2 record constrains the first-order evolution of the global carbon cycle, sedimentary archives from Bjørn Drift provide insights into the regional oceanic mechanisms operating during these transitions. Bulk sediment stable isotope analysis of carbon ($\delta^{13}C$) ranging from −22‰ to −27‰, and nitrogen ($\delta^{15}N$) values ranging between ~3‰ and 8‰, reveals variations in organic matter source, carbon export efficiency, across changes in nutrient utilisation and nitrogen cycling under differing surface ocean stratification and circulation regimes across glacial and deglacial phases. Enriched $\delta^{13}C$ and $\delta^{15}N$ values during ash-associated intervals suggest enhanced biological export and modified nutrient dynamics under weakened overturning circulation. Integration of SST, bulk stable isotope records, and tephrochronology indicates that deglacial volcanism exerted a transient but measurable influence on subpolar North Atlantic climate and biogeochemical processes, superimposed on long-term greenhouse forcing. These findings highlight the importance of extreme aerosol forcing in regulating regional ocean–carbon feedbacks during Late Pleistocene climatic transitions.