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THE LATE QUATERNARY OF ARCTIC CANADA: THE INTERPLAY OF CLIMATE, SEA-LEVEL, ICE, AND OCEANS

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The Canadian Arctic Archipelago (CAA) represents a fundamental link in the global climate system via large-scale oceanic and atmospheric circulation, heat transport, and freshwater budgets. The region is highly dynamic, influenced by complex interactions between sea-level, glacial dynamics, oceanography and climate during and since the last deglaciation. Emerging marine records coupled with existing terrestrial data, provide crucial long-term insights into the environmental evolution of the CAA. Notably, the late Pleistocene to early Holocene is marked by the catastrophic advance and collapse of extensive Antarctic-scale ice shelves, and dramatically different oceanographic and sea-ice regimes controlled by glacio-isostatic sea-level.

In the central CAA, five marine piston/trigger weight cores along the E-W axis of the Northwest Passage were investigated for sedimentology, micropalaeontology, biogeochemistry (52 ^{14}C dates). These archives reveal rapid deglaciation (~11.0-10.8 cal ka) and particularly pronounced environmental shifts during the early to mid Holocene. One of the most striking palaeoenvironmental signals is the penetration of Atlantic-derived Arctic Intermediate Water (AIW) following deglaciation. This was facilitated by higher glacio-isostatic sea-levels permitting increased flow across inter-channel sills characterizing an oceanographic circulation marked by greater connection to adjacent basins. Postglacial amelioration (open-water season greater than at present) is recorded at ~10.0-7.0 cal ka BP. The exclusion of AIW due to glacio-isostatic shoaling, coupled with generally cooling climate, leads to modern-day oceanography and ecosystem configuration by ~6 cal ka BP, with small environmental changes since.

In the western CAA, terrestrial and marine data indicate the extremely rapid establishment of a floating ice shelf ~10.9 cal ka BP, some 105,000 km^2 in area, following regional deglaciation. Two marine piston cores analysed for ice-rafted debris, micropalaeontology, biogeochemistry, and chronostratigraphy suggest a rapid ice shelf advance into Viscount Melville Sound associated with northward streaming Laurentide ice permitting on-shore rafting of ice and formation of ice shelf moraines. Radiocarbon dates from above the stratigraphic transition from sub-ice shelf to fully marine sediments provide a minimum age on ice shelf collapse of ~10.6 cal ka BP. Critically, this suggests an even more dramatic and short-lived large scale and abrupt event than previously hypothesised; an ice shelf establishing itself in Viscount Melville Sound and then collapsing in <400 cal yrs. Fundamental to this hypothesis is the role of climatically and oceanographically influenced sea-ice in buttressing initial ice shelf formation, the subsequent catastrophic collapse of the ice shelf being potentially driven by the final decoupling of the Laurentide and Innuitian ice sheets and the establishment of early Holocene oceanographic throughflow.

These new marine data from across the CAA enable an improved knowledge of the environmental evolution of Arctic Canada. Critically, these reconstructions provide a long-term context and analogues for understanding ongoing and future environmental shifts. Our data highlight the complexities inherent to archipelago settings, where environmental change is forced by multiple inter-related drivers, including sea-level, oceanographic circulation, glacial dynamics, and climate. The interplay between these drivers, operating at a range of temporal and spatial scales, is frequently expressed by abrupt and dramatic environmental reconfiguration, as demonstrated by the sedimentary records presented here.