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The late Quaternary environmental evolution of the Northwest Passage: a marine perspective

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Although the Canadian Arctic Archipelago (CAA) is characterised by an extensive network of marine channels ("the Northwest Passage"), the wealth of our knowledge of late Quaternary environments has been primarily derived from coastal sediments now isostatically uplifted above modern sea-level. Here we present direct marine data from three long (piston and trigger weight) sediment cores from the central Northwest Passage (Lancaster Sound/Barrow Strait: core 86027-154; southeastern Barrow Strait: 86027-144; western Barrow Strait: 9722-004), investigated in a multiproxy approach for sedimentological characteristics, microfossils (dinocysts, non-pollen palynomorphs, benthic and planktonic foraminifera, ostracods), and stable isotope ratios. All cores extend to the end of the last regional glaciation, bottoming out on diamicton. Our data suggest grounded glacial ice in Barrow Strait, followed by rapid deglaciation, with a progression from ice-proximal to ice-distal conditions interrupted by an interval of pervasive landfast sea-ice. Although the timing of deglaciation is difficult to determine due to the absence of dateable materials at the diamicton/glaciomarine transition and chronological complexities such as the Portlandia Effect, age-depth model extrapolations suggest deglaciation at $\sim$10.8 cal ka BP. Noticeable biological activity commences in the early Holocene, a prominent signal of planktonic foraminifera (Neogloboquadrina pachyderma) appearing at $\sim$10.5 cal ka BP. This marks the penetration of deep (Atlantic-derived) Arctic Intermediate Water (AIW) into the archipelago following deglaciation, likely facilitated by higher sea-level permitting increased flow across inter-channel sills. Postglacial amelioration (open-water season greater than present) is subsequently recorded at $\sim$10.0-7.0 cal ka BP, potentially corresponding to a regional "Holocene Thermal Optimum". The exclusion of AIW due to glacio-isostatic shallowing, coupled with a generally cooling climate, eventually leads to increased sea-ice and modern microfossil assemblages, with conditions similar to modern commencing at $\sim$6.0 cal ka BP. Our data indicate that although climate ultimately forces long-term environmental shifts, regional dynamics, especially sea-level changes, exert a significant control on marine conditions throughout the CAA.