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Evolution of the polar oceans: the late Quaternary palaeoceanography of the Northwest Passage

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The marine channels of the Canadian Arctic Archipelago, collectively known as the "Northwest Passage" (= NWP), cover some 1.1 million km2 on the North American continental shelf and constitute one of two primary pathways for water and heat exchange between the Arctic and Atlantic oceans. Modern circulation is characterized by a net southeastward flow from the Arctic Ocean through Parry Channel (the main W-E axis of the NWP) towards Baffin Bay, with Arctic Ocean Surface Water primarily occupying the NWP channels. Data from recent and ongoing marine work* highlight a dynamic oceanographic environment since the last glaciation. A suite of five sediment records (piston and trigger weight cores) taken in a transect through Parry Channel provide important information on the long-term (deglacial to postglacial) environmental and oceanographic evolution of the region. The cores were studied by a multiproxy approach encompassing sedimentology, micropalaeontology, biogeochemistry, constrained by a chronological framework of 58 AMS radiocarbon dates.

Our data suggest grounded glacial ice in the channels of the Canadian Arctic Archipelago, rapid deglaciation, and a characteristic progression from ice-proximal to ice-distal conditions. Age model extrapolations place deglaciation at ∼13.0-10.3 cal ka BP (location dependent). Noticeable biological activity is marked by the appearance of planktonic foraminifera (Neogloboquadrina pachyderma) at ∼11.0 cal ka BP – an important signal given the absence of these organisms in the modern NWP. This likely marks the penetration of Atlantic-derived water (Arctic Intermediate Water) into the central NWP following deglaciation, likely facilitated by higher deglacial sea-levels permitting increased flow across inter-channel sills. Though the route of this Atlantic-derived water is currently being resolved, it may have penetrated from Baffin Bay in the East into the NWP, contrary to the modern circulation. Subsequent (∼9.7-7.0 cal ka BP) ameliorated conditions (open-water season greater than present) marked by substantial diversification and abundance across all microfossil groups may correspond to a previously postulated regional "Holocene Thermal Optimum". After ∼7.0 cal ka BP increased sea-ice and modern microfossil assemblages imply conditions similar to modern, likely due to the exclusion of Arctic Intermediate Water due to glacio-isostatic shallowing combined with climate cooling.

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