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The late Quaternary environmental evolution of marine Arctic Canada: Barrow Strait to Lancaster Sound

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ABSTRACT

A marine sediment core from the east-central Canadian Arctic Archipelago (Core 86027-154; 74° 22.01′N 89° 51.26′W; 329 m water depth), studied by a multiproxy approach [lithostratigraphy, biogeochemistry, micropalaeontology (dinoflagellate cysts, other non-pollen palynomorphs, benthic and planktonic foraminifera, ostracods)], and encompassing 14 AMS ^{14}C dates, provides valuable insights into regional deglacial to Holocene palaeoenvironments. Six palaeoenvironmental zones are recognized, based on prominent changes in the litho- and biostratigraphy. The waterlain diamicton of Zone I records immediate deglaciation, being derived from lift-off and calving of previously grounded glacial ice. Though deglacial timing is complicated by the sparsity of dating materials and the Portlandia Effect, age–depth model extrapolation places deglaciation at 11.54 cal ka BP. Zone II (11.5–11.0 cal ka BP) represents a distinct progression from initially ice-proximal to increasingly ice-distal conditions, interrupted by an interval of pervasive sea-ice (11.4–11.2 cal ka BP). Noteworthy biological activity commences in Zone III (11.0–9.7 cal ka BP) with a prominent signal of planktonic foraminifera (*Neogloboquadrina pachyderma*). This likely signifies penetration of deeper, Atlantic-derived water through the central Canadian Arctic Archipelago upon deglaciation, facilitated by the greater, glacioisostatically-induced water depths (+80 m), and implies separation of Laurentide and Innuitian ice sheets by ~11.0 cal ka BP. Zone IV (9.7–7.2 cal ka BP) records ameliorated, biologically favourable conditions with reduced seasonal sea-ice accompanied by high microfossil species diversity and the presence of subpolar taxa. Zone V (7.2–6.5 cal ka BP) signals the exclusion of Atlantic-derived water, concomitant with increasing sea-ice, simultaneously representing the termination of the dynamic deglacial to early Holocene environments (zones I–IV). Conditions similar to modern typified by uniform sediment characteristics, present-day microfossil assemblage structures, and sparse benthic foraminifera were established by 5.6 cal ka BP (Zone VI).

1. Introduction

More than four decades of terrestrial fieldwork across the Canadian Arctic Archipelago (CAA; Fig. 1) underlie our knowledge of this region's late Quaternary environmental evolution (e.g., Prest et al., 1968; Blake, 1972; England, 1976, 1987; Hodgson and Vincent, 1984; Dyke and Prest, 1987; Dyke, 1999, 2004; England et al., 2004, 2006, 2009). Studies based on radiocarbon-dated marine materials (driftwood, molluscs, marine mammals) from postglacially raised shorelines have highlighted key environmental changes during, and subsequent to, the last retreat of the Laurentide and Innuitian ice sheets (Last Glacial Maximum, ~18 ^{14}C ka BP), including higher deglacial sea-level (e.g., Dyke et al., 1991, 2005; England et al., 2006), significant glacioisostatic rebound (Dyke and Peltier, 2000), and meltwater discharge (Andrews et al., 1993; Dyke et al., 1996b, 1997). Regional marine studies from the CAA channels (the "Northwest Passage") are gaining attention though most have been focused on the Holocene rather than extending to deglaciation (e.g., Vilks, 1974; MacLean et al., 1989, 2010; Vare et al., 2009; Belt et al., 2010; Ledu et al., 2010a,b; Jennings et al., 2011; Pieńkowski et al., 2012, 2013a). Such data offer a valuable direct marine perspective on environmental histories derived from the adjacent islands, and provide an essential long-term context for current and

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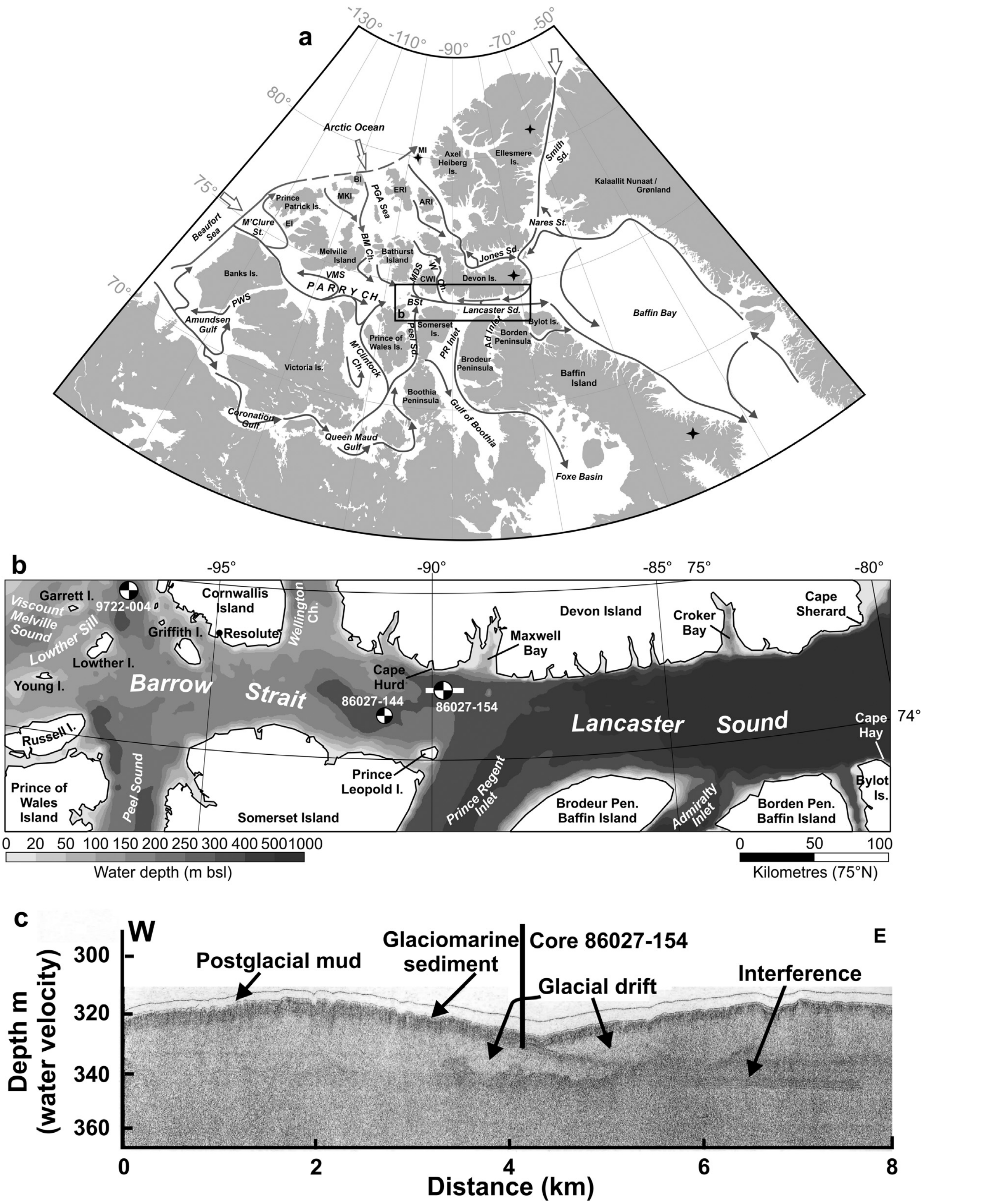

Fig. 1. Outline of study area. (a) The Canadian Arctic Archipelago, showing the general modern oceanographic circulation (Ingram and Prinsenberg, 1998; Michel et al., 2006). Ice core records mentioned in the text are indicated by a star, including the Meighen, Devon, Agassiz (Ellesmere Island), and Penny (Baffin Island) ice caps. Abbreviations: AD Inlet = Admiralty Inlet; ARI = Amund Ringnes Islands; BI = Borden Island; BM Ch. = Byam Martin Channel; BSt = Barrow Strait; CWI = Cornwallis Island; EI = Eglington Island; ERI = Ellef Ringnes Island; MDS = McDougall Sound; MI = Meighen Island; MKI = Mackenzie King Island; PGA Sea = Prince Gustav Adolf Sea; PR Inlet = Prince Regent Inlet; PSt = Penny Strait; PWS = Prince of Wales Strait; QM Gulf = Queen Maud Gulf; VMS = Viscount Melville Sound; W Ch. = Wellington Channel. (b) Detailed inset of Barrow Strait–Lancaster Sound, indicating the 86027-154 core site and the seismic track line (shown by solid white line), as well as bathymetry (Jacobsson et al., 2008). The location of cores 86027-144 (Pieńkowski et al., 2012) and 9722-004 (Pieńkowski et al., 2013a) is also shown. (c) Huntec seismic reflectivity profile across the study site, indicating the core 86027-154 sampling site. Note the second, upper drift to the east, which pinches out before reaching the core 154 site. The boundary separating Lancaster Sound from Barrow Strait is located between Prince Leopold Island and Cape Hurd (SW Devon Island; Fig. 1b; Pharand, 1984).