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Early Holocene deglaciation of northern Hudson Bay and Foxe Channel constrained by new radiocarbon ages and marine reservoir correction

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ABSTRACT

Radiocarbon ages from Southampton Island (Canada) provide new chronological control on the deglaciation of Foxe Channel and northern Hudson Bay, a strategic area for understanding the demise of a marine-based portion of the Laurentide Ice Sheet. A regional marine reservoir age of 630 ± 45 yr and a reservoir offset (ΔR) of 263 ± 48 yr were calculated from two early to mid-Holocene terrestrial/marine radiocarbon age pairs. These values are consistent with corrections based on early 20th century mollusks suggesting that following deglaciation the oceanic conditions controlling the regional reservoir effect rapidly became similar to those of modern times. However, our ΔR value is 352 ± 52 yr less than another correction from eastern Foxe Basin, which may be affected by ^{14}C dilution from carbonate rocks. Our ΔR value is used to calibrate new marine radiocarbon ages which help further develop the deglaciation history of Southampton Island, especially along the north coast where deglaciation of Foxe Channel appears to have been completed by 8100–7800 cal yr BP (2σ). This provides key chronological constraints on the development of a long marine ice margin in southern Foxe Basin prior to the final breakup of the Foxe ice dome.

Introduction

Northern Hudson Bay and Foxe Basin together represent a key area (Fig. 1) to investigate the demise of a marine-based portion of the Laurentide Ice Sheet (LIS) during the early Holocene. The early deglaciation phase of northern Hudson Bay is known to have been rapid (Andrews and Peltier, 1976; Hughes, 1987; Lajeunesse, 2008) and it culminated with a catastrophic drainage event of Lake Agassiz-Ojibway into the North Atlantic via Hudson Strait at about 8400 cal yr BP (Veillette, 1994; Barber et al., 1999; Lajeunesse and St-Onge, 2008). Following this major event, the remaining marine portion of the ice sheet in the region continued to retreat and concluded with the final breakup of the Foxe sector of the LIS by ca. 6800 cal yr BP (Dyke et al., 2003). The collapse of the marine-based Foxe ice dome of the LIS happened during a time interval characterized by rapid global sea level rise (~7600–6800 cal yr BP) (Blanchon and Shaw, 1995; Bard et al., 1996; Carlson et al., 2007; Yu et al., 2007). An improved reconstruction of the deglaciation chronology in the region, including determination of the deglacial marine reservoir effect, could provide important insights into the complex ice sheet-ocean interactions at times of ice sheet collapse and rapid sea level rise.

Any radiocarbon age of a marine fossil has to be corrected to account for the difference between the ^{14}C age of the ocean and that of the atmosphere, which is referred to as the marine reservoir age (Stuiver and Braziunas, 1993). Different and contrasting marine reservoir corrections have been proposed for the region, some based on pre-bomb mollusks from museum collections (e.g. Dyke et al., 2003; McNeely et al., 2006; Coulthard et al., 2010), others on Holocene marine/terrestrial age pairs from southwestern Baffin Island (Vickers et al., 2010). The corrections based on age pairs are considerably higher (more than 350 yr) than the ones obtained from pre-bomb mollusks, which led Vickers et al. (2010) to conclude that the regional marine reservoir effect has changed since the time of deglaciation. Changes in regional offset values through time limits the usefulness of reservoir correction values derived from early 20th century mollusks in paleo-environmental reconstructions. This is especially true for certain time periods (e.g. the Younger Dryas) during which abrupt changes in oceanic regime took place (e.g. Murton et al., 2010), considerably affecting the apparent radiocarbon age of seawater in many regions (Bondevik et al., 2006).

It is unclear, however, whether the higher marine reservoir correction obtained by Vickers et al. (2010) is also representative of the deglacial reservoir effect of other parts of Foxe Basin, especially considering the possibility for variable ^{14}C dilution (ageing effect) from carbonate rocks around Foxe Basin. Reservoir age estimates of

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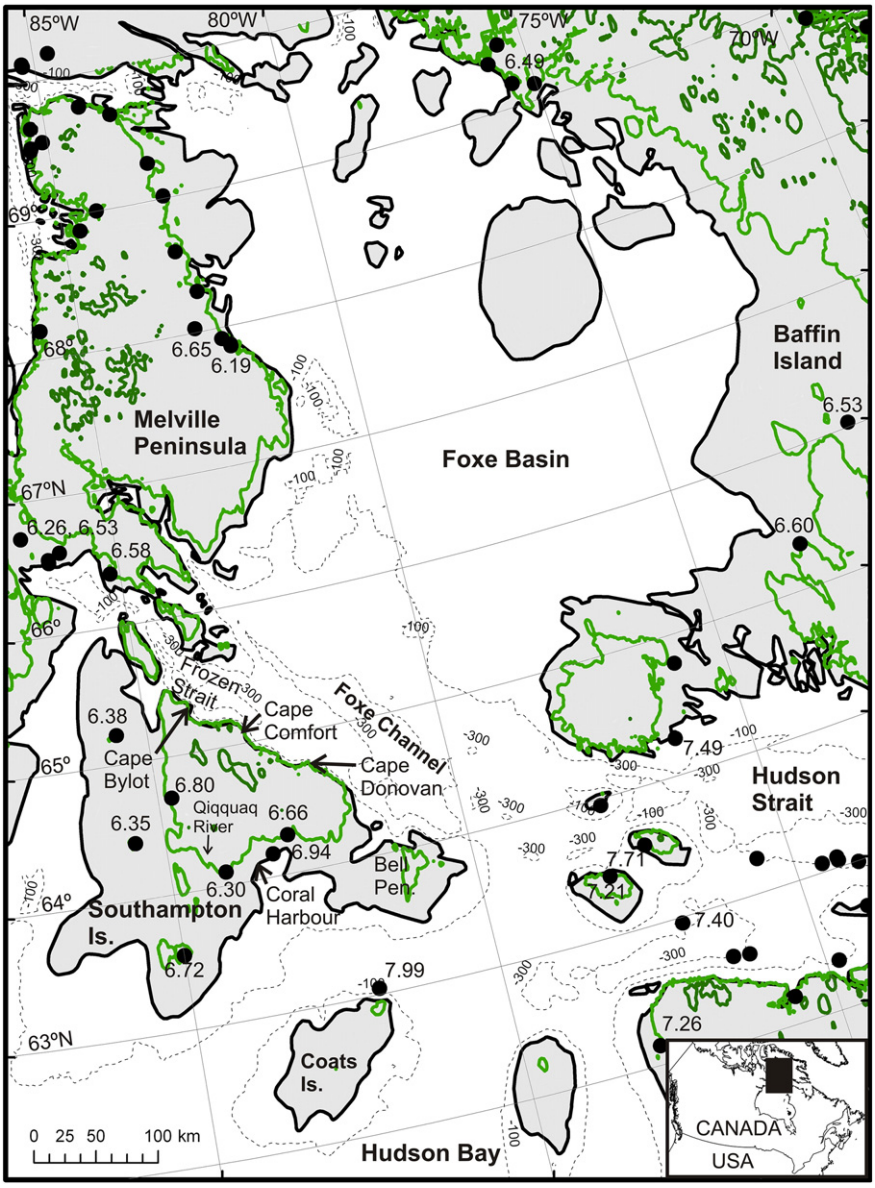

Figure 1. Southampton Island in northern Canada and the location of features discussed in the text including archival corrected radiocarbon ages in thousand years or *kilo annum* (ka) BP (cf. Dyke et al., 2003 for the complete database). The dashed lines represent bathymetric contours. The 100 m (light green) and 400 m (dark green) contours are also shown.

that large region must thus be further tested for different time intervals and in different parts of the basin. One of the goals of this paper is to determine the marine reservoir correction(s) for the early to mid-Holocene around Southampton Island. This is done using new terrestrial/marine age pairs and by comparing the results with previously proposed regional corrections.

The second objective is to increase the chronological control on the deglaciation of the southern Foxe sector and around Southampton Island. The deglaciation chronology of Foxe Basin is constrained by only eleven radiocarbon ages (cf. Dyke et al., 2003) scattered along a coastline of over 2000 km extending across northern Southampton Island (Bird, 1970), eastern Melville Peninsula (Dredge, 2001) and south-central/western Baffin Island (e.g. Ives, 1964; Andrews and Drapier, 1967). Most of the ages were obtained by gas proportional counting techniques (e.g. Dyck, 1967) and are thus from sites that contained relatively abundant fossil shell material. Many of these sites are located several meters below marine limit because marine limit sites are often characterized by coarser material with only traces of shells. The deglaciation chronology of the southern portion of the Foxe sector (Foxe Channel and northern Southampton Is.) is particularly poorly constrained with only one dated site ~50 m below marine limit in the northwest lowlands of Southampton Island (Bird, 1970), and one recent but erroneously reported calibrated age from the uplands along the northern coast (Rolland et al., 2008). This is for ~400 km of coastline, which is clearly insufficient in an area so critical for understanding the evolution of the ice margin prior to the final breakup of the marine-based Foxe ice dome. There is thus a need to improve the chronological control in the southern part of Foxe Basin, by increasing the number of robust calibrated ages, especially from sites located close to or at marine limit and to examine the impact on the chronological framework, as well as on the local relative sea level (RSL) curve; Southampton Is. is considered one of the primary RSL sites for constraining geophysical models of past ice sheet evolution (Peltier, 2004; Tarasov and Peltier, 2004). This work in turn allows placing the deglacial sediment-landsystems of Southampton Island in a revised chronological framework, and to test and refine previously proposed ice–margin retreat models for the region (e.g. Dyke et al., 2003; De Angelis and Kleman, 2007).