Abstract

Sediment Delivery and Retention in a High-Latitude Coastal Delta: A Study of the Great Whale River, Hudson Bay, Canada

Peter Hülse[1] and Samuel J. Bentley, Sr.[2]*

[1]CASP, University of Cambridge, Cambridge, UK
[2]Coastal Studies Institute and Dept of Geology and Geophysics, Louisiana State University, Baton Rouge LA 70803
*email sjb@lsu.edu

For decades, it has been recognized that river-delta hydrodynamics and morphology may be characterized in terms of three fundamental suites of forces, provided by riverine flow, tides, and waves. For high latitude deltas, the presence of ice both on land and sea provides an additional control on both sediment/water delivery to the delta, and subsequent dispersal by marine processes. For example, the presence of sea ice greatly dampens or eliminates the effects of wind waves, whereas control of tidal flow by sea ice may be less effective. Because waves are generally considered to be very important factors in resuspension and dispersal of sediment delivered to the coast, the seasonal presence of sea ice, by reducing wave energy, can likely alter both the morphology and capacity for retention of sediments within coastal river deltas (both subaerial and subaqueous). These effects may be expressed latitudinally, in comparing different deltaic systems, or locally, as a function of climate change over time within one deltaic system.

To explore the interactions among such climatic effects, and sediment delivery and dispersal within a high latitude fluvial-marine dispersal system, a field study of sediment cores and seabed geoacoustic mapping was undertaken offshore of the Great Whale River, on the Hudson Bay shores of Quebec, Canada (Fig. 1). Seabed bathymetry and subbottom stratigraphy were mapped from the Canadian research ice breaker *CCGS Amundsen*. Core sites were selected based on results of seafloor mapping. Box- and gravity cores were collected to determine sediment properties and sediment accumulation rates (SARs), using ^{137}Cs, ^{210}Pb, and ^{14}C geochronology. These geochronological methods allow contraining sediment accumulation over both decadal-centennial timescales (with ^{137}Cs and ^{210}Pb) and centennial to millennial timescales (with ^{14}C).

Sediment accumulation in the study area appears to be a relatively steady process over time-scales of the last 50 – 100 yr. Subtle differences between ^{137}Cs and ^{210}Pb SARs suggest an offshore shift in the locus of fine sediment deposition during the past ~150 yr, which may be a result of ongoing climatic warming leading to decreasing sea-ice coverage and a more energetic marine environment. Grain diameter frequency analyses suggest that environmental processes controlling sediment transport and deposition vary over decadal time scales. Although, we cannot define an exact cause for this pattern, these shifts may be related to variations in river discharge, wave climate, possibly due to windier conditions or less sea-ice dampening, bioturbation or a combination of all. This also suggests that longer term river discharge signals are preserved in the marine sedimentary record offshore of the Great Whale River.

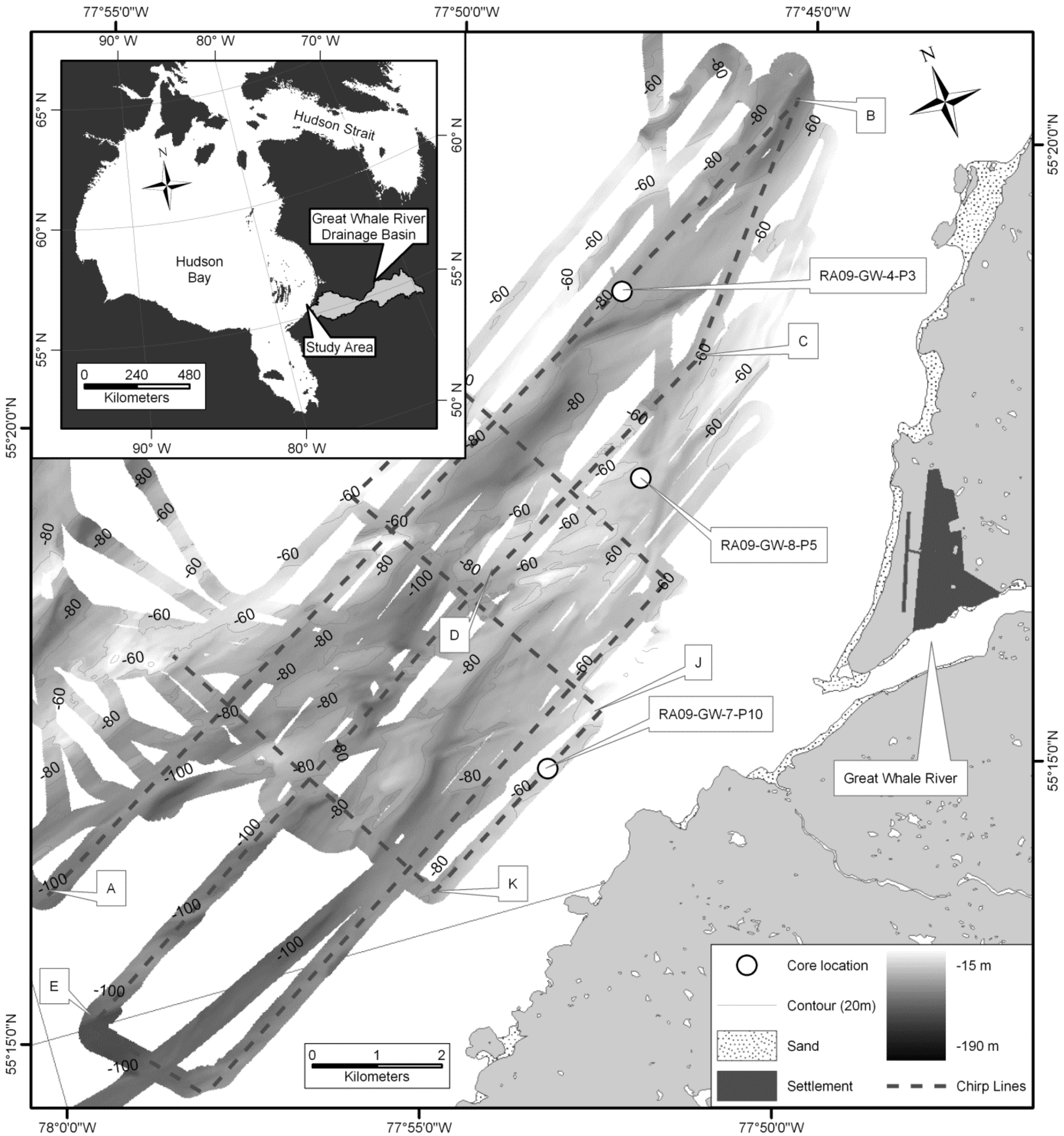

Figure 1: The small map displays the drainage basin of the Great Whale River and the location of the study area offshore the river mouth. The larger map shows bathymetry and the location of sub-bottom profiles (dashed) and selected coring locations (circles). Capital letters refer to sub-bottom profiles.

There is strong evidence that the Great Whale River responded to global climatic changes during the past 1500 to 2000 y with decreased river discharge during the colder Little Ice Age (LIA) and increased river discharge, similar to modern values, during the warmer Medieval Warm Period (MWP). This is suggested by decreasing SARs during the LIA, in contrast to increasing SARs during the MWP and Modern Optimum. SAR variations were strongest in the most distal core suggesting increased sediment retention in river proximal areas during the LIA, possibly due to increased sea-ice cover and associated wind-wave dampening. River discharge estimations are similar to modern values during the MWP but substantially lower during the LIA. A higher frequency signal is recorded in magnetic susceptibility records, suggesting river discharge variability with a period of 195-263 y, which was persistent during the past ~2000 yr. In summary, during the last ~2000y, warmer climates (including the last several decades) in eastern Hudson Bay produced increased river water and sediment discharge as well as stronger wave activity and increased sediment dispersal (due to decreased sea-ice coverage), while climatic cooling, and presumably longer and more extensive ice cover, yielded the opposite effects. These climatic effects can potentially produce more dramatic climatic shifts in the marine dispersal of fluvial sediments than are found in lower latitude systems lacking in ice cover.