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SILL STRATIGRAPHY AND SEDIMENTOLOGY IN MARINE INUNDATED BASINS SACHS HARBOUR, NORTHWEST TERRITORIES: IMPLICATIONS FOR SEA-LEVEL RECONSTRUCTION

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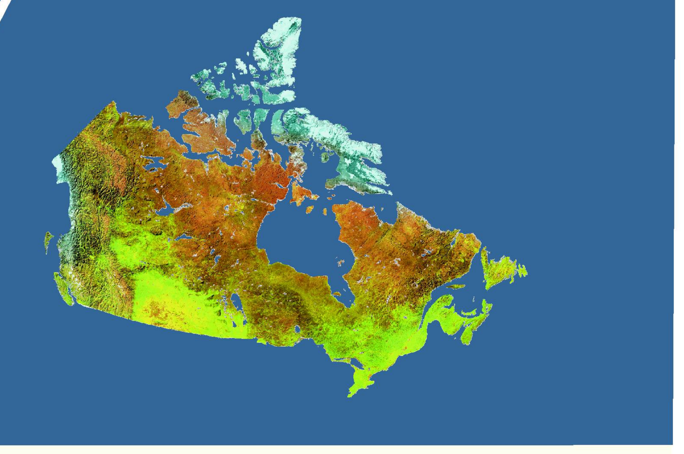


Introduction

Eroding bluffs near Sachs Harbour

Projections of sea-level rise are critical for assessing erosion and flooding impacts in the Arctic. The models used to project future sea-level changes in part rely on accurate records of past sea-levels.

This study focuses on the interpretation of past sea-level changes by studying the recent marine inundation of former freshwater basins. The inundation basin approach relies on the accurate determination of the former height of the basin sill over which the marine water flooded. This is critical as these basins have margins composed of unconsolidated material.

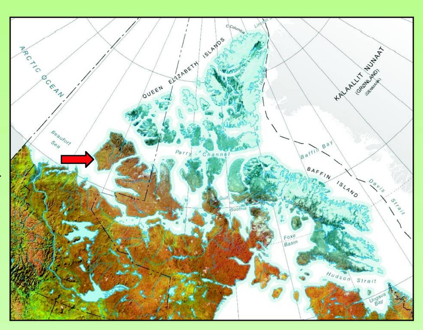
Shallow seismic profiles and core samples of the sills are being used to identify key processes in the remodeling of sill morphology following submergence. This is being used to define a range of attributes that can characterize sill reworking, and thus improve the accuracy of past sea-level records.

Study site

The former glacial outwash plain adjacent to the hamlet of Sachs Harbour is dotted with kettle and thermokarst lakes which likely formed 8000-9000 yrs BP (French and Harry 1983). These lakes are now gradually being inundated by rising sea level. The former lake margins, or sills, likely display a similar stratigraphy to the outwash plain. The outwash plain stratigraphy has been described by French and Harry (1983) and Harry (1982) from oldest to youngest:

i) Basal till associated with the Laurentide ice sheet is rarely exposed above sea level, ii) 1-5 m of laminated fine sand and silt with poorly defined and irregular cross-bedding deposited in a submarine outwash, iii) 1-6 cm horizon of detrital roots and stems (10,600±130 yrs BP), iv) 1-4 m of medium well-sorted sand deposited as a sandur plain, v) ~1 m of peaty organic material (6490±60 BP),and vi) various amounts of aeolian sand.

The submerged basin sills (2.9-4.8 m depth for basin A, 1.9-5 m for basin B) are in places incised by channels interpreted to be former lake outlets and possibly the location of initial lake breaching by rising sea level. The marine basins A and B have depths of 45 m and 14 m, respectively.



Study site location (red arrow) on map of northern Canada. Core locations (below) focused on sill morphology depicted on satellite image. Water depths varied from 2.0-9.4 m at coring sites. White lines indicate the approximate location of submerged sills, which outline the extent of former freshwater basins.

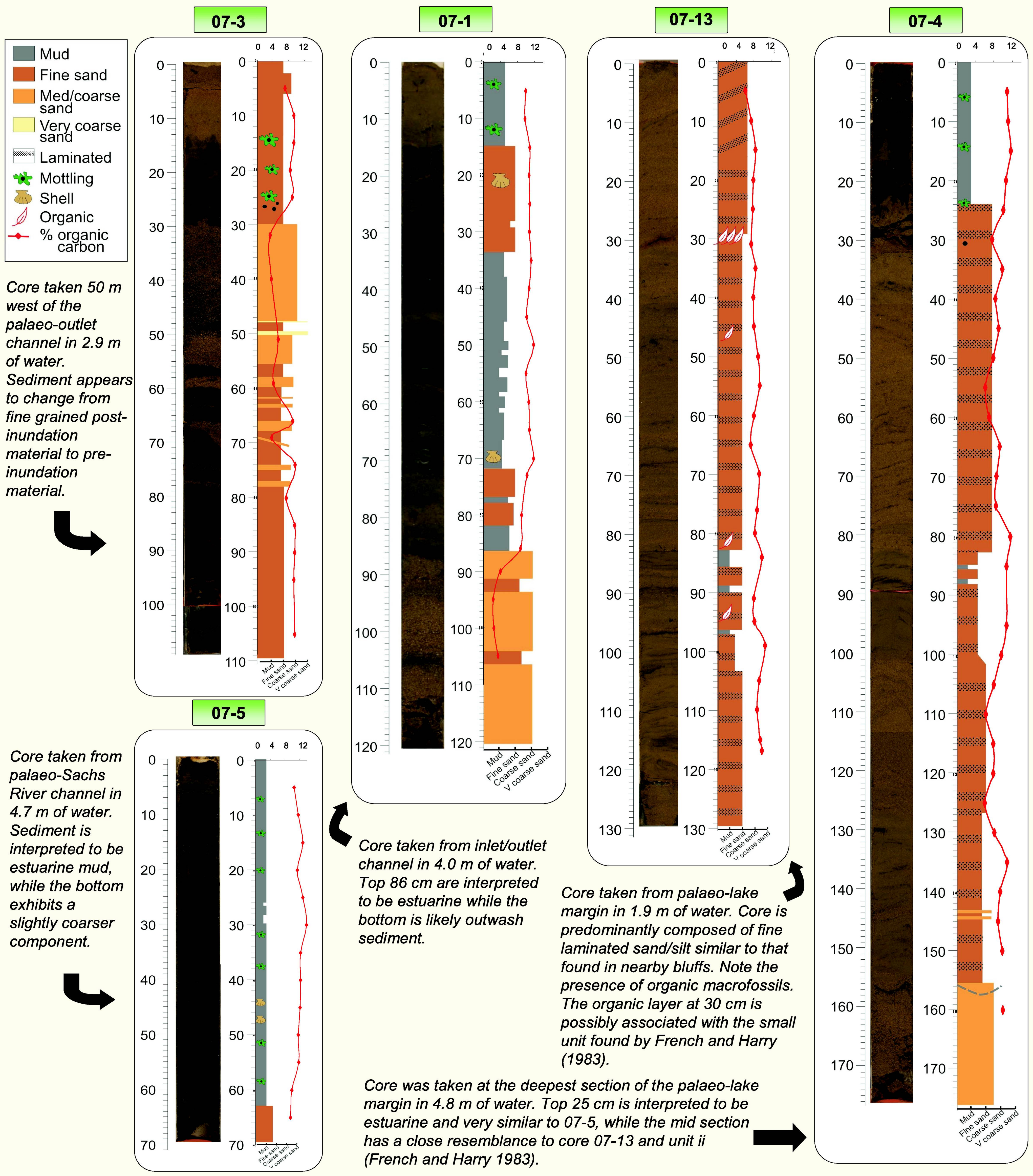
Methods

•To sample sill sediments, a vibracoring device deployed from a sea ice platform was used.

•X-ray and visual examination were used to discriminate and characterize sedimentary units.

•Particle size and loss-on-ignition analyses provided information on textural and organic carbon.

Photos: drilling through sea ice, setting up vibracore, and lab work



Core taken 50 m west of the palaeo-outlet channel in 2.9 m of water. Sediment appears to change from fine grained post-inundation material to pre-inundation material.

Core taken from palaeo-Sachs River channel in 4.7 m of water. Sediment is interpreted to be estuarine mud, while the bottom exhibits a slightly coarser component.

Core taken from inlet/outlet channel in 4.0 m of water. Top 86 cm are interpreted to be estuarine while the bottom is likely outwash sediment.

Core taken from palaeo-lake margin in 1.9 m of water. Core is predominantly composed of fine laminated sand/silt similar to that found in nearby bluffs. Note the presence of organic macrofossils. The organic layer at 30 cm is possibly associated with the small unit found by French and Harry (1983).

Core was taken at the deepest section of the palaeo-lake margin in 4.8 m of water. Top 25 cm is interpreted to be estuarine and very similar to 07-5, while the mid section has a close resemblance to core 07-13 and unit ii (French and Harry 1983).

Results and Discussion

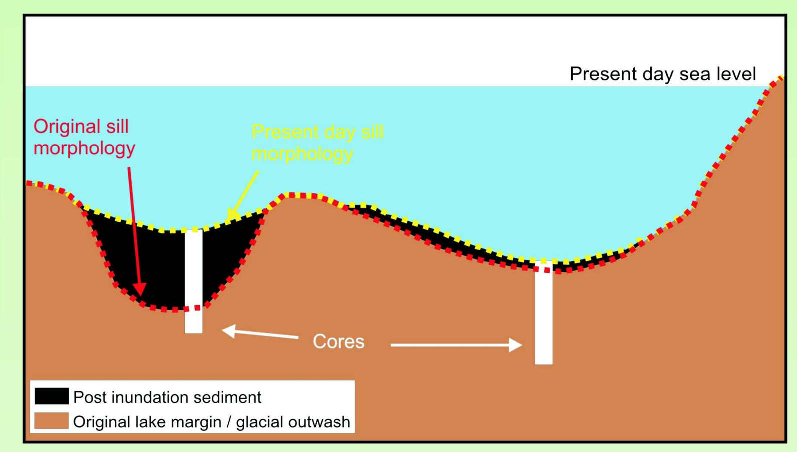
Main sediment types in cores include:

1. Silty black mud having abrupt contacts above and transitional contacts below.
2. Fine sand occurring with abrupt contacts above and below with no visible unconformity.
3. Fine sand occurring with irregularly cross-bedded fine laminations typically having abrupt contacts above and transitional below.
4. Medium to coarse sand having undulating or abrupt contacts.

These beds can be combined into three recurring units:

1. Unit 1 is dominated by silty black mud with minor amounts of fine sand and typically has a conformable contact with the underlying unit that in certain cases is disturbed by burrow tracks. This unit normally caps cores found in or near channels and is presently thought to represent post-inundation sediment deposited in the Sachs estuary. Radiocarbon dates will further help to confirm this assumption.
2. Unit 2 is dominated by laminated fine sand and is similar to submarine sediment described by French and Harry (1983) (unit ii). It occurs either underlying unit 1 or indicates a truncated surface. It is presently thought to represent pre-inundation material.
3. Unit 3 is dominated by varying thicknesses of interbeded medium to coarse sand and non-laminated fine sand with abrupt contacts. It is presently thought to represent pre-inundation material.

The identification of units interpreted to be deposited post-inundation help identify the location of pre-inundation sill surfaces, the lowest point of which records the sea-level rise that breached the basin.



The yellow line indicates the top of the present sill while the red line indicates the location of the sill as it underwent submergence. In the absence of sub-bottom information the lowest point of the present sill surface could be misinterpreted as the height of sea-level when it breached the basin. Instead, the sea-level is recorded by the base of the buried channel.

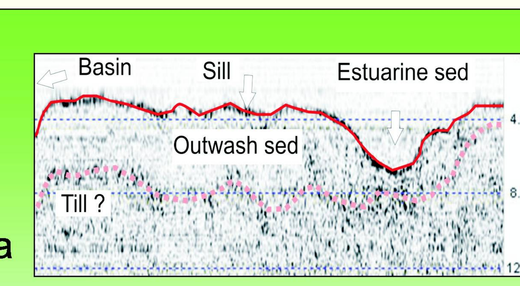
Concluding thoughts

Cores have shown that as sea-level rose, the basin margins have undergone deposition and erosion. Channel cores are composed of silty black estuarine mud overlying sub-aqueous outwash while non-channel cores are composed solely of sub-aqueous outwash. Although non-channel cores are important in understanding the sill morphology, it is likely that only channel cores are crucial to reconstructing sea-level.

We can use the stratigraphy to identify the original sill surface which in places is concealed by post-inundation. It is the original sill surface that must be mapped in order to determine past sea-level positions.

Upcoming work

The next stages of the project are to correlate the acoustic and core stratigraphy to reconstruct the broad architecture of the sills and formulate a depositional and erosional history for the observed sedimentary sequences. It will also enable us to determine if till is underlying the known sill sediments, as in other areas of the outwash.



Red line represents sill surface which dips down under the Sachs River. Pink line is a strong acoustic reflector

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