Evolution of the Ebb-Tidal Delta St. Jean Estuary
Gaspe Peninsula, Quebec, Canada

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Introduction

Ebb and flood tidal deltas occur on the seaward and landward sides, respectively of an inlet between barrier spits of the St. Jean estuary Gaspe Bay, Quebec, Canada. The St. Jean estuary inlet is between the Douglastown and Halimand spits at the mouth of the estuary (Lenz, 1992). An accumulation of sediments deposited primarily by ebb tidal currents has created a conspicuous ebb tidal delta on the seaward side of the estuary mouth which is typical of such systems (Davis,1991). The shape and position of the ebb-tidal delta as well as the spits changes over time because of tidal and or longshore current influences. It is the goal of my research to describe the morphology of the ebb-tidal delta of the St. Jean estuary. My study focused on an area approximately 2,000 meters along the coast and up to 600 meters east into the seaward side of the estuary.

Methods

The primary method used in study of the morphology of the ebb-tidal delta was the comparison of air photographs that date back to 1948. Air photos taken in 1948, 1961, 1962, and 1976 were compared and contrasted at a scale of 1 in = 200 meters. Because air photographs were not available for years since 1976 a contour map was constructed using a laser theodolite to plot points used to form the contour map. The Surface III program for the Macintosh computer was used to construct the map. Oblique photographs were taken from a private airplane were used to constrain recent morphology. Spanning the inlet of the St. Jean estuary is a railroad bridge. This bridge, as well as the railroad itself, is often used as a reference point when comparing the air photos. In addition a contour map was constructed using a laser theodolite to plot points used to form the contour map. The Surface 3 program for the Macintosh computer was used to construct the map.

Results

The primary results of my field study are summarized by the topographic map of Fig. 1. To constrain topography 458 points were used. Analysis of the contour map revealed that in 1992 the main ebb channel turned north in a single channel that gradually decreased in depth. The terminal lobe of the estuary arcs around the main channel extending further north than the end of the channel. The arm like appearance of the terminal lobe is unprecedented suggesting substantial changes since 1976.

Discussion

A comparison of the map of Fig. 1 with air photos as far back as 1948, shows evolution of deltaic features including terminal lobes, sand bars and lateral channels as affected by northerly directed longshore currents and wave energy.

Ebb Channel

The main ebb channel in 1948 flowed slightly south eastward straight through the barrier island inlet with only a slight bearing to the south (Figure 2). By 1961 the main ebb channel had made a stronger shift to the south. The main channel extended out to a distance approximately 240 meters beyond the railroad bridge. By the following year the channel had lost some depth. This is evident in the fact that the greater depths of the main channel do not extend much farther that the bridge (only about 100 m). Drastic changes had occurred in the position and strength of the main ebb channel by 1976. In 1976 the main ebb flow was no longer contained in a single channel but instead branched into three channels (Fig. 2). The three channels tended southeast, east, and northeast, but the largest channel moved northeast, loosely following

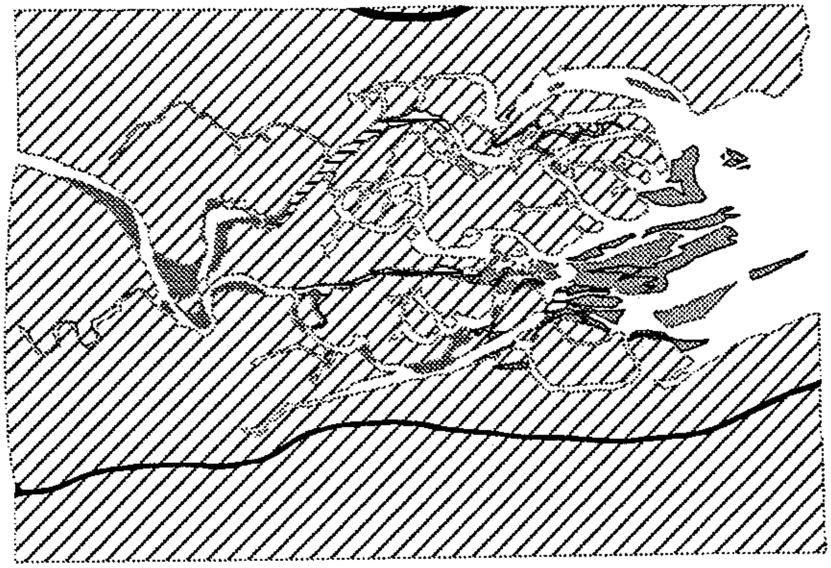


fig. 4 The modern river delta.

fig. 5 complete estuary image with highlighted flood tide channel the coast of the Haldimand Spit. The middle and southern channels were deeper, appearing dark on the air photos. By 1992 the main ebb channel again appears as a single channel but unlike previous years it turns strongly to the north (Fig 2).

Terminal Lobe and Swash Bars

The ebb tidal delta of 1948 had a terminal lobe that averaged 420 m from the railroad bridge (Fig. 3). The terminal lobe had four secondary lobes (A, Fig. 3) with three swash bars present at the southern edge of the delta starting at 40 m and reaching as far as 220 m from the shore of the Douglastown Spit (E, Fig. 3). By 1961 the terminal lobe take on a smoother edge that has a southern trend, losing the secondary lobes of 1948. The terminal lobe of 1961 extends up to 110 m farther at its farthest point but is 70 m closer at its closest point.

Off the shore of the Douglastown Spit in 1961 are numerous shallow areas and sandbars (F, Fig. 3). the sandbars located at the tips of the spit are swash bars, while the bar and shallow area that follow the form of the main channel is the channel margin linear bar (G, Fig. 3). The swash bars are formed by the waves' swash action, while the channel margin linear bar is formed form the interaction between ebb and flood tidal currents. The forms of 1961 are unusual in that most bars flank the main ebb channel (which is the case here) yet there are many sand bars along the coast of the Douglastown Spit as well as a few, closer to shore, along the Haldimand Spit. The most notable example of this is the small island off shore of the Douglastown Spit (H, Fig. 3). The Haldimand Spit also has an island off its southern tip but because it is located along the main channel it is an unusually large swash bar (J, Fig. 3). Just one year later the numerous sandbars present along the shore of the Douglastown Spit have virtually disappeared. The general trend of the terminal lobe did not change from 1961 to 1962 but in 1962 it had gained a lobed appearance similar to that of 1948, but not as pronounced. To the south of the main channel there remains a channel margin linear bar that is a small remanent of the bar of 1961.

In 1976 some of the bars of 1961 were reformed. The coast line of the Douglastown Spit as compared to both 1961 and 1962 has migrated more eastward giving it a more humped shape. The slope of the beach on the Douglastown Spit is much gentler than that of the Haldimand Spit. At the tip of the Douglastown Spit there is an island bounded on one side by a lateral channel and on the other, the main ebb channel (K, Fig. 3).

In 1992 the terminal lobe does not resemble those of previous years. There is a strong northward trend of the lobe that stretches several hundred meters. In previous years the terminal lobe resembled a fan but in 1992 it resembles an arm that stretched several hundred meters from the tip of the Douglastown Spit to a quarter of the way across the Halimand Spit.

Interpretations and Conclusions

Analysis of air photos and comparison of various features such as terminal lobes, shorelines, and ebb current placement reflects the processes that form them. The terminal lobes of 1948, 1961, and 1962 all have the same general lobed shape characteristic of a wave dominated ebb-tidal delta (Boothroyd, 1985). In the case of wave domination high wave energy keeps the ebb-tidal delta close to the spits and gives it a "blunted" appearance. The hooked form of the 1992 terminal lobe suggests that domination by waves gave way to domination by longshore currents from the south (Boothroyd,1985).

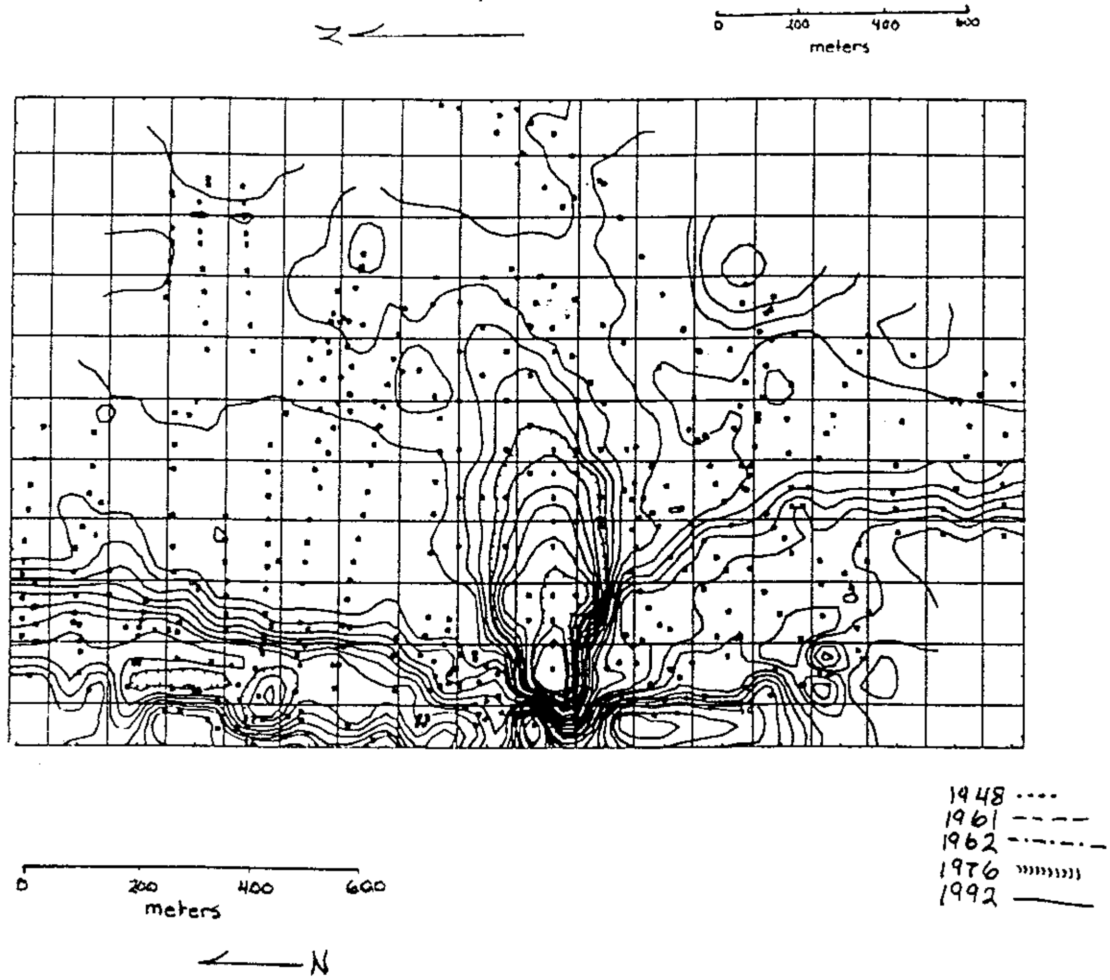
References Cited

Boothroyd, J. C., 1985, Tidal Inlets and Tidal deltas, in, Davis, R. A. , Jr., Coastal Sedimentary Environments, New York, Springer, 2nd Ed., p. 445-532.

Davis, R. A., Oceanography : An Introduction to the Marine Environment, Dubuque, Iowa, Wm. C. Brown, 434 p.

Lenz, E. K., 1992, Deposition and Evolution of the Douglastown-Halimand Spits, Gaspe, Peninsula, Quebec, Canada, in, Wilson, M. A., 5th Ed. Beloit College, Wisc., p. 56-60.

Figure 1: Contour map of the ebb tidal delta; data collected June, 1992. Note the bend in the east trending ebb current channel as well as the shape of the terminal lobe.



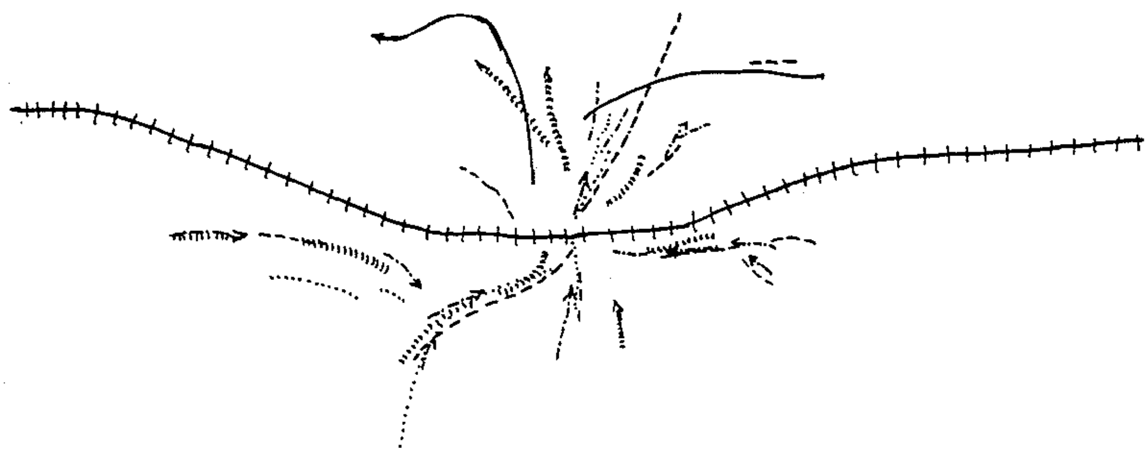


Figure 2: Compilation of the main ebb flow channels from 1948 to 1992. Note how the southeastern trend of the channels from 1948 to 1962 changes to a northeast and north trend in 1976 and 1992.

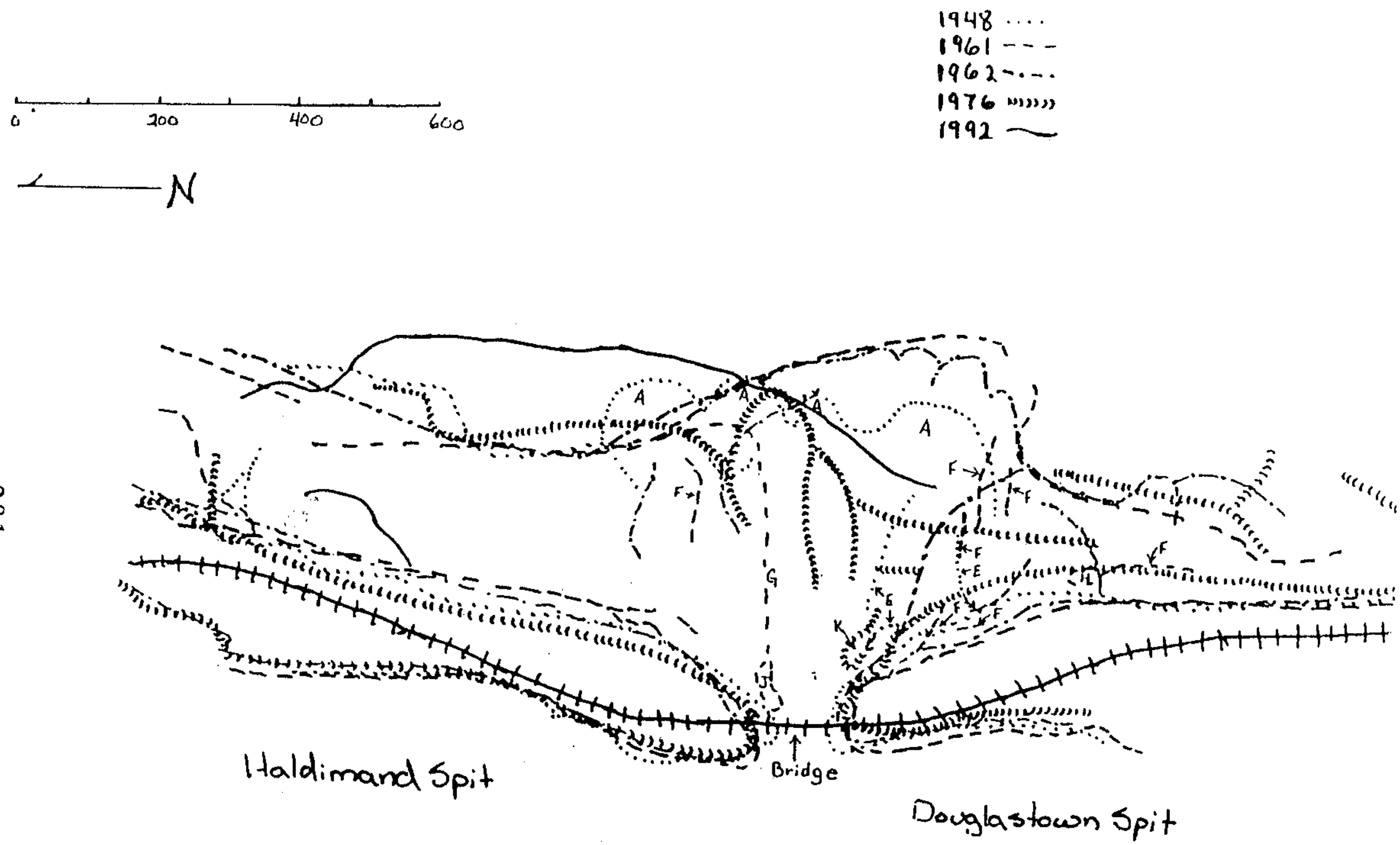


Figure 3: Compilation of the coast lines and terminal lobes of 1948 to 1992.

GRAVITY CONSTRAINTS ON BEDROCK TOPOGRAPHY BENEATH ST. JEAN ESTUARY, GASPÉ, QUÉBEC, CANADA

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Introduction

A gravity survey was undertaken to investigate possible subsurface controls on the origin of the Douglastown and Haldimand Spits near Gaspé Bay on the northeast coast of the Gaspé Peninsula. The primary focus of the gravity survey was to determine the depth and topography of the bedrock beneath the St. Jean Estuary. It was hoped that a detailed knowledge of bedrock topography and distribution of materials overlying bedrock would help constrain theories of spit formation, especially those advocating glacial control.

Methods

The estuary is separated from Gaspé Bay by the Douglastown and Haldimand Spits. One gravity traverse was located directly across these spits. Another gravity line was chosen along a highway located approximately six kilometers upstream from the spit traverse. This second traverse was chosen in order to provide additional insights into valley geometry and to provide additional information on regional variations in gravity. Thirty-eight stations were surveyed across the two spits, and twenty-seven stations were surveyed along the highway that crosses the St. Jean River at a point where bedrock is exposed. A theodolite was used to accurately determine distances and elevations for each station. Variations in gravitational accelerations were measured with a Worden gravimeter. Each two-hour segment of readings was opened and closed with a measurement at a base station so that the meter-specific drift and tidal corrections could be applied to all readings. Free-air, Bouguer, and terrain corrections were computed, and the resulting gravity values were plotted.

Data Analysis

A regional gravity trend was observed in both traverses (Figs. 1 and 2). A line was fit to both sets of data to define the regional trend which then was subtracted from the original gravity values to reveal residual anomalies (Figs. 3 and 4). These residual anomalies were analyzed using a computer program that calculates Bouguer anomaly values for subsurface models.

Various two-dimensional models of the spit region were created using a computer program from Burger (1992) with constraints supplied by regional geology (bedrock outcrops on either side of the valley), the dimensions of the spits, and seismic information (bedrock depths). The final model that most closely matches the residual data describes a broad, relatively shallow, gently sloping valley filled with saturated sand and gravel with a bedrock surface at a depth of 50 meters beneath the spits (Fig. 5). The residual gravity of the highway traverse gives no indication of a deeply-buried bedrock valley. The profile of the bedrock surface in this area is fairly flat and slopes east toward the spits.