THE ORIGIN AND EVOLUTION OF PENOUILLE SPIT, FORILLON NATIONAL PARK, GASPÉ PENINSULA, QUEBEC

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INTRODUCTION

Penouille spit is located in Forillon National Park on the northern shore of Gaspé Bay (Fig. 1). The purpose of this study was to obtain information about the developmental history of the spit by studying the positions and orientations of beach ridges, sediment transport directions relative to the offshore bars, grain size distribution along each shore, the soil profile of a four-foot erosion scarp on the west side of the spit, bedding in two trenches dug on the south and west shores, and measurements of accretion and erosion made from comparison of 1989 and 1978 data.

GEOMORPHIC FEATURES

Seven north-south transects were surveyed with a tape and compass to locate the positions of the major ridges in the field (Fig. 2). These measurements were plotted on a map of Penouille made in 1978 (Allard and Germain, 1979) and compared with the ridges shown on a blow up of a 1970 aerial photograph. Each ridge represents a former shoreline of the spit.

Ten transects across the offshore bars on the south side of the spit recorded the relative locations and sizes of the bars close to low tide. These measurements and aerial photographs taken in 1989 were used to draw a contour map of the bars. The resultant pattern was compared to aerial photographs from 1948, 1961, 1966, 1970, and a map of the spit made in 1978 (Allard and Germain, 1979) to determine growth and movement of the bars. From 1970 to 1989 the bars grew to extend further west, parallel to the south shore. This growth is due to changes in topography and sediment transport along the south shore.

One change in topography was the development of a hook on the southwest corner of the spit (Fig. 2). The shape and orientation of this feature is indicative of the sediment transport directions. The path of transport runs from north to south along the west side of the spit, around the hook to the offshore bars. From there, sediment accretes onto the south shore. One source of sediment for this system is the eroding area marked by a scarp on the west side of the spit, which is continually being worked by the waves.

SPIT SEDIMENTS AND STRATIGRAPHY

Two trenches were dug to analyze the stratigraphy of the spit on the south and west shores (Fig. 3). At station C (Fig. 2), the trench showed the accretion of sediment onto the south side of the spit. The layers of sand in the trench were parallel to the surface indicating that layers of sediment were being deposited by the waves. The second trench dug on the west side between stations H and I showed erosional features and evidence of sediment that had been reworked by the waves. The layers within the trench were truncated by erosion of the foreshore. The bedding in these trenches proved the hypothesis that the west shore was being eroded back while the south shore was being built out.

A four foot erosional scarp on the west side of the spit was cleared off to reveal a soil profile . The horizons present in the profile included a dark organic horizon which would have taken a minimum of hundreds of years or as many as several thousand years to form (Birekland, 1974; Press and Siever, 1974).

FACIES	Thickness	Convoluted Lamination	Climbing Ripple Lamination	Planar/ Undulatory Lamination	Flute Casts	Psuedo-nodules	Mud Drapes	Rip-ups	
								Top	Mid.
A (n:19)	R: 18-150cm x: 43.7 s: 36.1	79%	16%	68%	37%	53%	47%	-	-
B <20cm (n:50)	R: 1-15cm x: 4.7 s: 4.3	22%	42%	14%	12%	10%	4%	-	-
B' >20cm (n:30)	R: 20-56cm x: 34.1 s: 24.9	70%	27%	40%	37%	20%	17%	-	-
C (n:54)	R: 3-85cm x: 26 s: 18.3	7%	7%	-	-	14%	24%	87%	3%

Table 1. Type and abundance of sedimentary structures, average bed thickness, and sample size for each of the facies in the study. Note: Facies B was split into two thickness populations, greater than or less than 20cm.

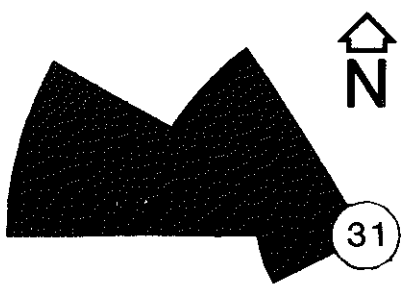

Figure 2. Flute mark paleocurrent rose diagram. Data is from all three facies in the study.

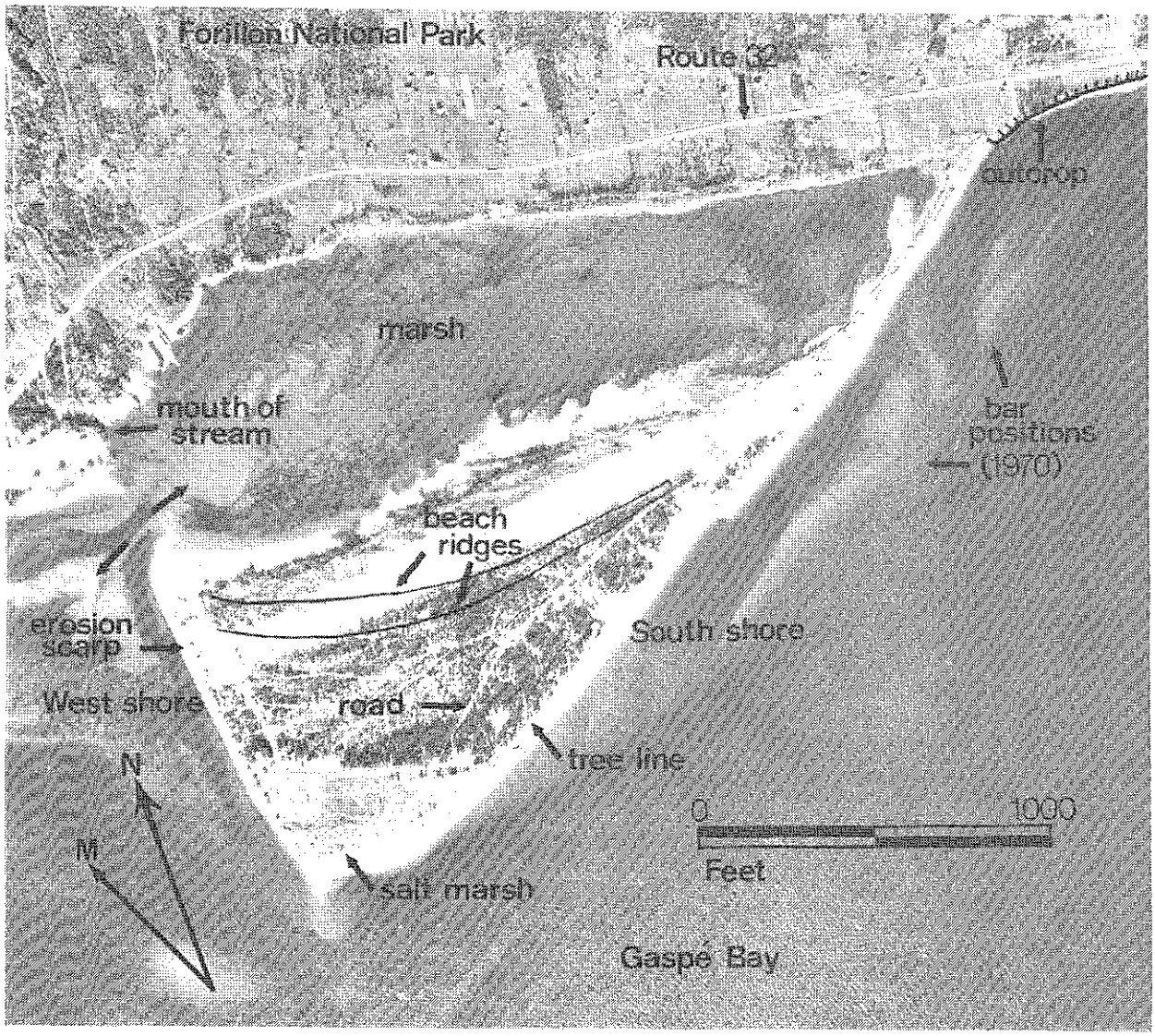

Fig. 1 Aerial photograph of Penouille Spit (1970, scale 1:12,000) with significant features labeled.

Two rock samples were collected from the Battery Point Formation of Lower Devonian age (McGerrigle, 1985) that crops out east and west of the spit (Fig. 1). The samples were red sandstones and have the same bulk composition as the sediments found on the beaches of the spit. These sandstones are continually being eroded by waves entering the bay from the Gulf of St. Lawrence, generating a significant amount of material. The transport directions along the spit determine the actual pattern of input of this eroded material to the growth of the spit.

Sediment samples were collected from the upper, middle, and lower thirds of the beach on the south and west shores. Grain size analysis of these samples is being conducted to determine trends along each shore and populations of sediment relative to the offshore bars on the south side. Grain size decreases away from the source area, providing information about the transport mechanisms present on the spit. Upon completion, this analysis will be used to establish the sources of sediment for the spit.

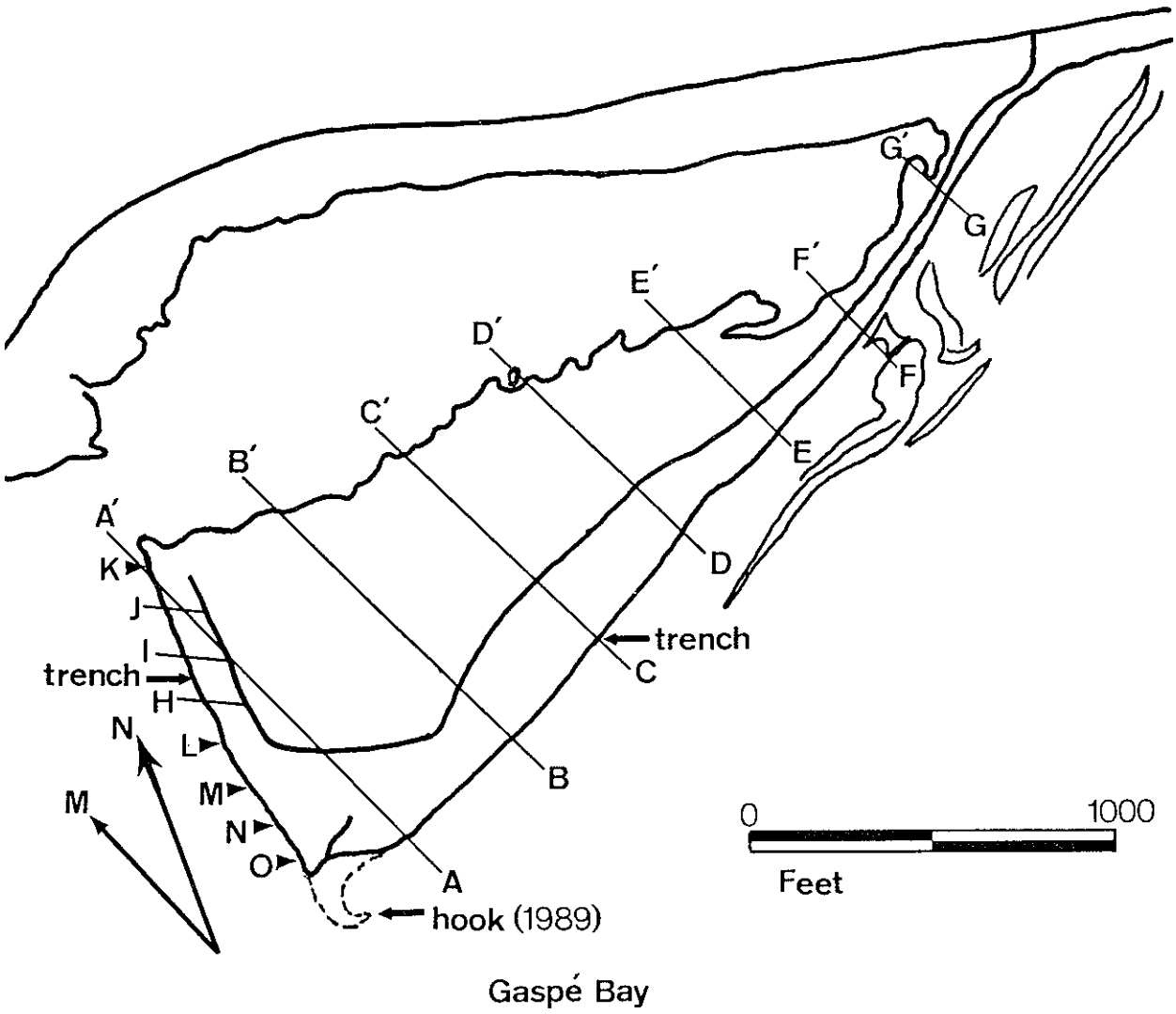

Fig. 2 Line drawing of Penouille Spit from aerial photograph in Fig. 1 showing transects, sample stations, trench locations, and hook observed in 1989.

ABSOLUTE TIME DATA

Wooden posts were installed in 1968 as part of a structure to prevent further erosion of the scarp on the west shore. In 1989 these posts were no longer in the scarp, having been exposed by erosion of the west shore. The posts showed that nine feet of erosion has occurred in the past eleven years, for an erosional rate of 1.22 ft/yr.

Estimates of erosion and accretion were made for the east and west shorelines based on measurements taken along the seven north-south transects surveyed in 1989 (Fig. 2). These measurements were compared with a map of the spit made in 1978 (Allard and Germian, 1979), to determine average rates of accretion and erosion over the past eleven year period. The greatest accretion occurred at station B (Fig. 2), where the average rate was 11.64 ft/yr. Stations A, C, D, and F also experienced net accretion with rates of 1.82 ft/yr, 0.64 ft/yr, 3.64 ft/yr, and 2.27 ft/yr respectively. Stations E and G, however, experienced net erosion, with removal rates of -3.73 ft/yr and -1.09 ft/yr.

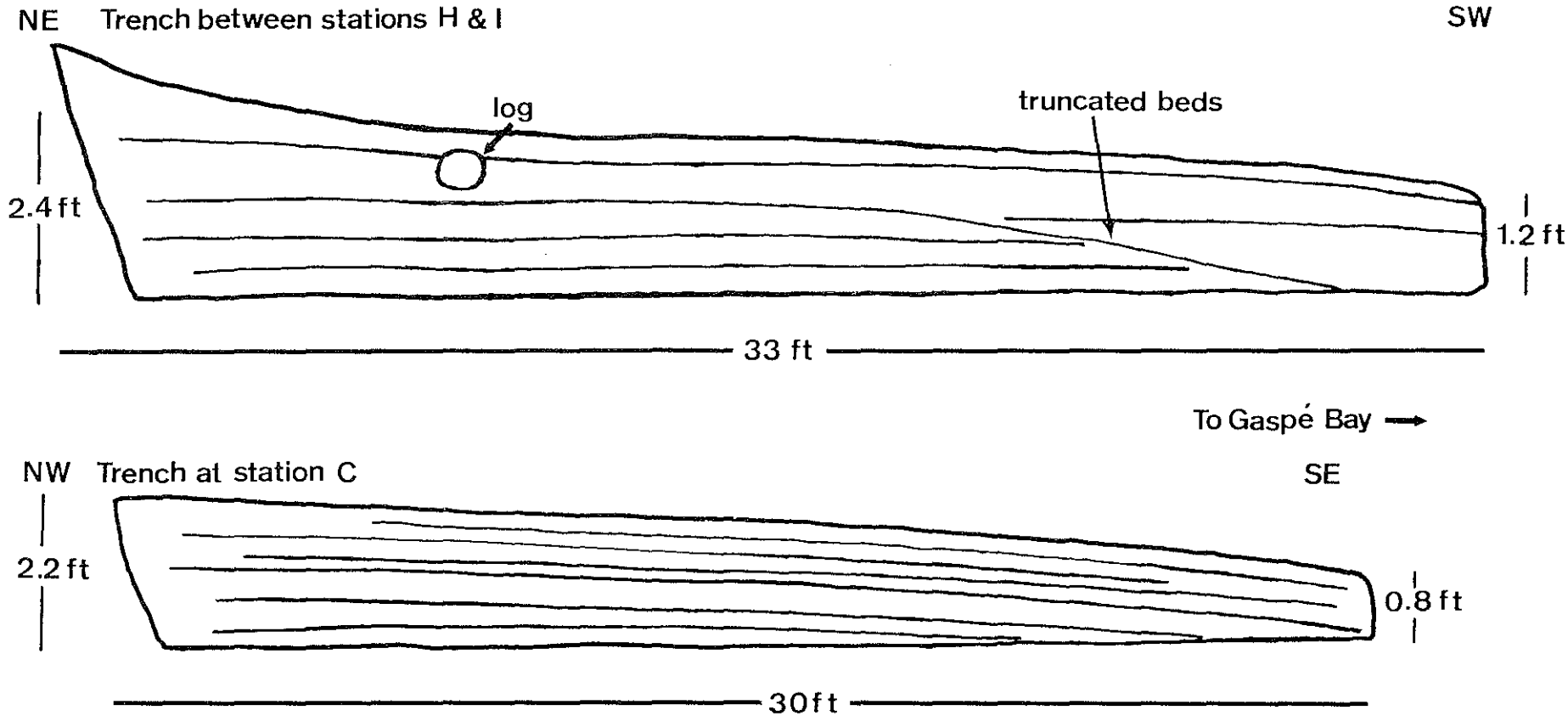

Fig. 3 Sketch of the trench between stations H and I, showing truncated beds indicative of past erosion and the trench at station C showing layers parallel to the beach face indicating accretion.

CONCLUSIONS

The dynamic processes which have influenced the developmental history of Penouile spit are exemplified by the erosion of the west shoreline, the beach ridges which record the growth of the spit, the topographic changes in the offshore bar pattern relative to the geomorphology of the south shore, and the growth of a hook on the southwest corner which shows sediment transport direction.

Based on the rates of erosion and accretion for the past eleven year period, an estimate of the age of Penouille spit can be calculated. The minimum age for the spit is 154 years based on the maximum calculated accretion rate. The average age is 463 years based on an average of the accretion rates, and the maximum age is 2,891 years using a minimum accretion rate.

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