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Geological characteristics and spatial distribution of paleo-inlet channels beneath the outer banks barrier islands, North Carolina, USA

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ABSTRACT

Nearly 200 km of high-resolution ground penetrating radar (GPR) data were acquired along the Outer Banks barrier island system of North Carolina, USA. GPR data combined with lithofacies and biofacies data reveal multiple depositional facies including inlet channel, flood-tide delta, overwash, peat and inner shelf. Previously undocumented paleo-inlet channels constitute a significant portion of the shallow geologic framework between Oregon Inlet and Cape Hatteras. GPR data reveal the complex stratigraphy associated with multiple sequences of cut-and-fill within inlet channels. Two types of paleochannels (non-migrating and migrating) were classified based on geometry and fill-patterns. Sediments and foraminifera collected from vibracores were correlated to GPR data to define the regional shallow stratigraphic framework. Channel-fill facies are characterized by clinoform packages, sometimes bounded by erosional surfaces, indicating variable sediment transport directions from the ocean and sound sides. Channels are incised into older flood-tide delta deposits corresponding to older inlet activity when barriers existed further seaward. Flood-tide delta deposits are capped with marsh peat and overwash units. Migrating inlet facies occur under the widest portions of the island, whereas narrow portions of the island are underlain by the non-migrating inlet facies or flood-tide delta/overwash facies. This geologic/geomorphic relationship is attributed to the successional stage of island evolution during transgression, and sediment transport processes associated with the different inlet types. The radar facies, lithofacies, and biofacies provide a comprehensive dataset that will permit more precise identification of barrier island facies in the geologic record.

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1. Introduction

Sea-level rise and storm patterns (e.g., intensity and frequency) are the dominant processes that work in combination with geologic controls to drive coastal geomorphic change in barrier island settings. Because of this process–response relationship, the underlying geologic framework of barrier islands provides clues to the workings of a barrier island system in response to process changes through time. Understanding the history and the process-response is becoming increasingly critical due to the imminent impacts of accelerated sea-level rise (Kemp et al., 2009) and the potential for increased storm impacts (Emanuel, 2005; Webster et al., 2005; Neu, 2008; Nyberg et al., 2008a,b; Mann et al., 2009) on coastal systems in general. Furthermore, characterizing the regional and vertical distribution of barrier island facies is significant for sequence stratigraphic interpretations of the ancient geologic record and for understanding the formative processes of ancient barrier island systems (Willis and Moslow, 1997; Nishikawa and Ito, 2000).

Flood-tide delta (FTD) and channel-fill sediments associated with inlets are commonly preserved beneath transgressive barrier islands and are an important component of island evolution during transgression (Godfrey and Godfrey, 1976; Heron et al., 1984; Inman and Dolan, 1989; Riggs and Ames, 2003; Culver et al., 2006). These deposits serve as a shallow water platform and may facilitate barrier island migration (Godfrey and Godfrey, 1976; Riggs and Ames, 2003). FTD deposits associated with inlets may be reworked and incorporated into the back-barrier shore zone, thereby increasing island width and elevation (Riggs and Ames, 2003; Culver et al., 2006; Smith et al., 2008). Numerous investigations utilizing cores, aerial photographs, and mapping techniques have demonstrated the workings of inlets and their role in barrier island evolution, however, few studies have corroborated core or geomorphic data with geophysical data, particularly on a regional scale.

Along the Outer Banks barrier islands of North Carolina (NC) (Fig. 1) only three inlets (Oregon, Hatteras, and Ocracoke) currently exist within a 200 km length of shoreline. However, additional

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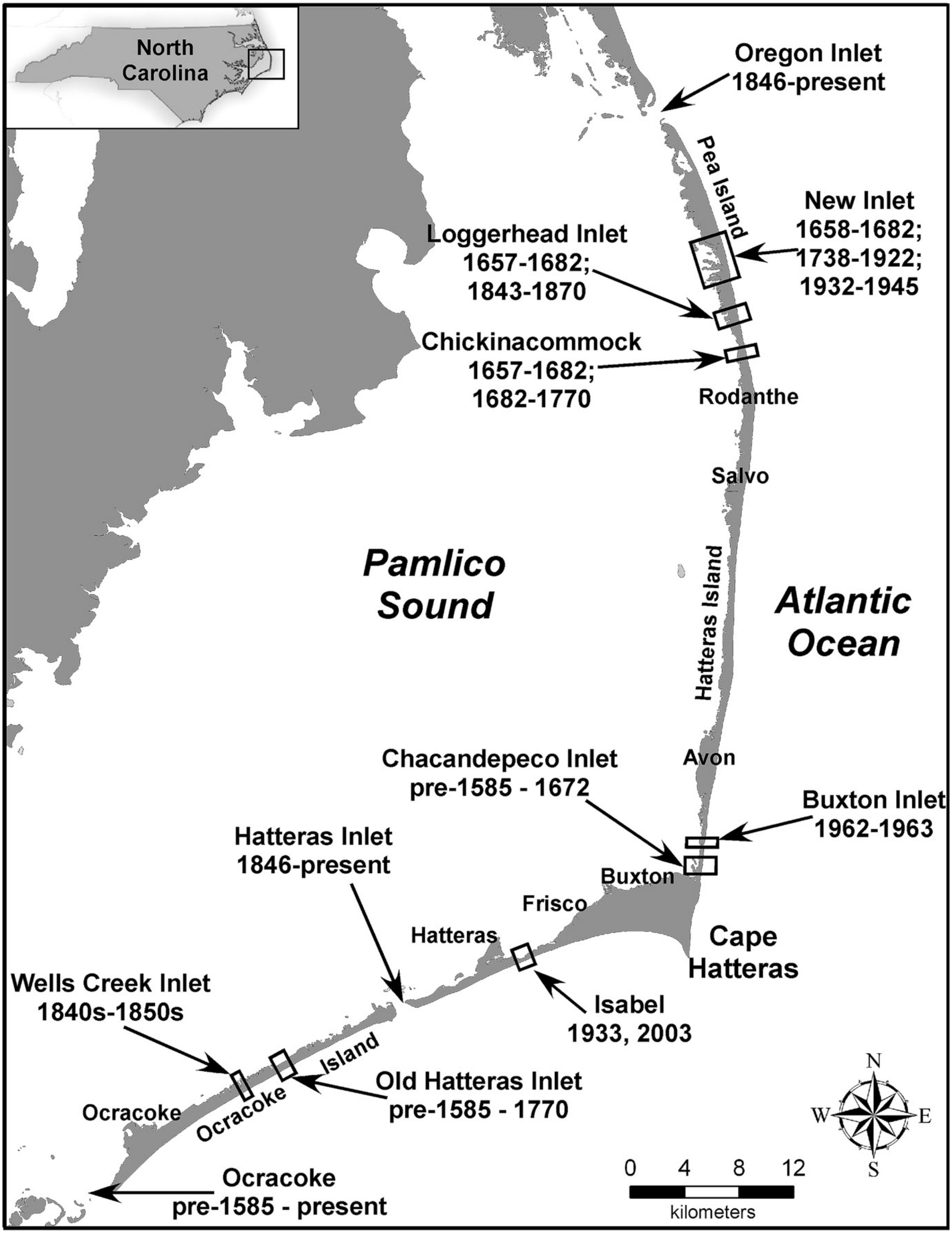

Fig. 1. Map illustrating the approximate locations and dates of existence of historic inlets from Fisher (1962) between Oregon Inlet and Ocracoke Inlet. Approximate locations are based on historical maps and records.

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