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Research Paper

Aminostratigraphy of surface and subsurface Quaternary sediments, North Carolina coastal plain, USA

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ABSTRACT

The Quaternary stratigraphy and geochronology of the Albemarle Embayment of the North Carolina (NC) Coastal Plain is examined using amino acid racemization (AAR) in marine mollusks, in combination with geophysical, lithologic, and biostratigraphic analysis of 28 rotasonic cores drilled between 2002 and 2006. The Albemarle Embayment is bounded by structural highs to the north and south, and Quaternary strata thin westward toward the Suffolk paleoshoreline, frequently referred to as the Suffolk Scarp. The Quaternary section is up to ~90 m thick, consists of a variety of estuarine, shelf, back-barrier, and lagoonal deposits, and has been influenced by multiple sea-level cycles. The temporal resolution of the amino acid racemization method is tested statistically and with the stratigraphic control provided by this geologic framework, and it is then applied to the correlation and age estimation of subsurface units throughout the region. Over 500 specimens (primarily *Mercenaria* and *Mulinia*) from the subsurface section have been analyzed using either gas chromatographic (GC) or reverse-phase liquid chromatographic (RPLC) techniques. The subsurface stratigraphic data are compared with AAR results from numerous natural or excavated exposures from the surrounding region, as well as results from NC beach collections, to develop a comprehensive aminostratigraphic database for the entire Quaternary record within the NC coastal system. Age mixing, recognized in the beach collections, is also seen in subsurface sections, usually where major seismic reflections or core lithology indicate the presence of stratigraphic discontinuities. Kinetic models for racemization are tested within the regional stratigraphic framework, using either radiocarbon or U-series calibrations or comparison with regional biostratigraphy. Three major Pleistocene aminozones [AZ2, AZ3, and AZ4] are found throughout the region, all being found in superposition in several cores. Each can be subdivided, yielding a total of at least eight stratigraphically and statistically distinct aminozones. Kinetic modeling, supplemented with local calibration, indicates that these aminozones represent depositional events ranging from ~80 ka to nearly 2 Ma. Three prominent seismic reflections are interpreted to represent the base of the early, middle, and late Pleistocene, respectively, roughly 2 Ma, 800 ka, and 130 ka. The large number of samples and the available stratigraphic control provide new insights into the capabilities and limitations of aminostratigraphic methods in assessing relative and numerical ages of Atlantic Coastal Plain Quaternary deposits.

1. Introduction

Over the past three decades, amino acid racemization (AAR) has been employed to assign both relative and numerical ages to Quaternary coastal units of the U.S. Atlantic Coastal Plain (Fig. 1; see reviews in Wehmiller and Miller, 2000; Muhs et al., 2004). Based on measured extents of amino acid racemization (reported as the ratio of the dextro [D] form of an amino acid to its levo [L] counterpart, or *D*/*L*), these studies often have been successful in

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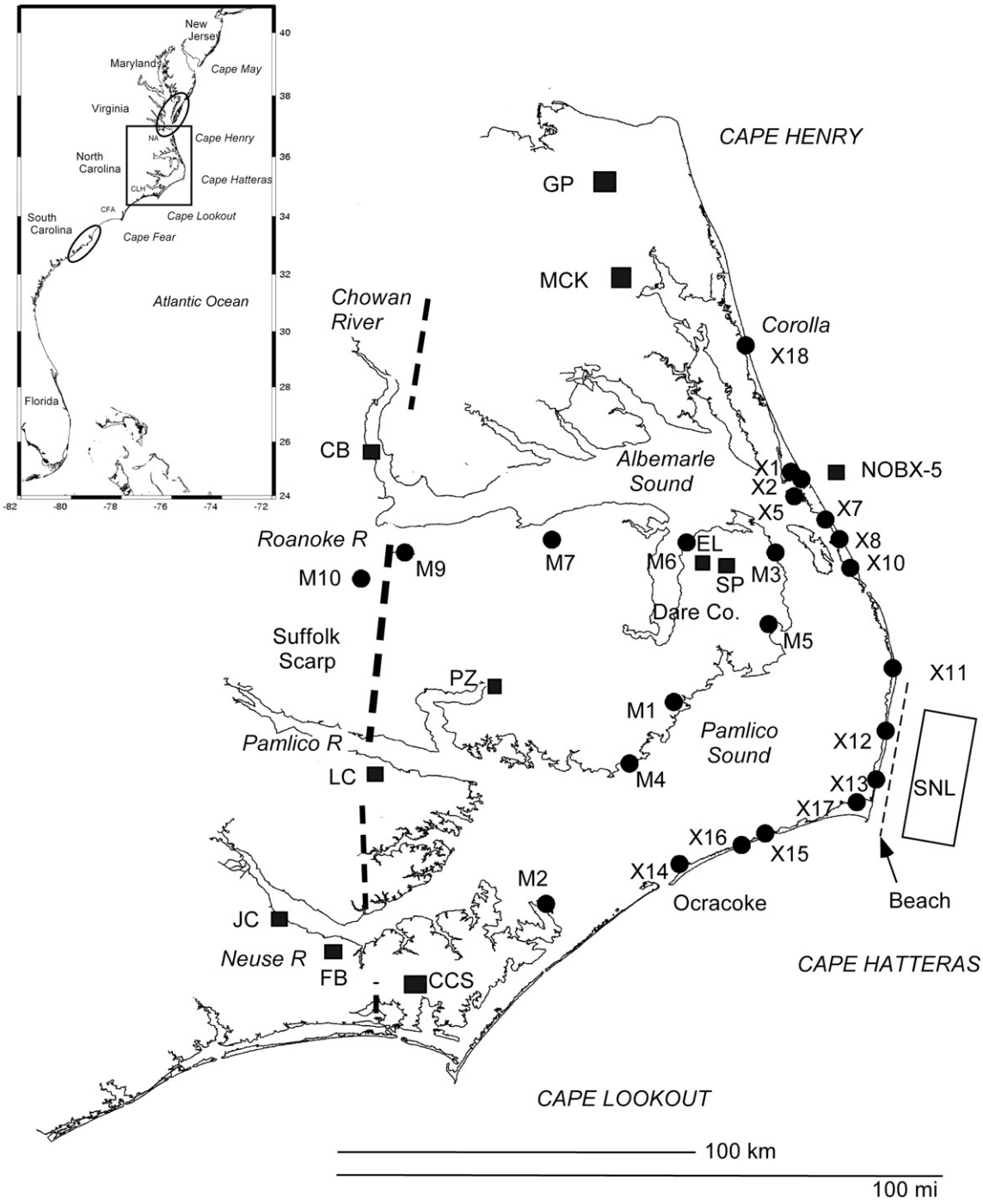

Fig. 1. Maps showing the US Atlantic Poastal Plain (inset) and North Carolina study area in detail. Localities where samples have been collected for AAR analysis are identified with filled circles (occupied for this study) and squares (occupied during previous studies). Mainland cores (MLD) are identified as "M" with the core number, and Outer Banks cores (OBX) are identified with an "X" and the core number. The dashed line indicates the approximate position of the Suffolk Scarp or paleoshoreline, which generally identifies the inland extent of Quaternary units that fill the Albemarle Embayment, which is centered in the region of Albemarle Sound. The Albemarle Embayment is bounded by east-west structures known as the Norfolk Arch, located in the region of Cape Henry, and the Cape Lookout High, located in the region of Cape Lookout. Table 1 includes locality information and references to background information for previously studied sites. Locality abbreviations: GP = Gomez Pit; MCK = Moyock; CB = Colerain Beach; EL = East Lake Pit; SP = Stetson Pit; PZ = Ponzer; LC = Lee Creek; JC = James City; FB = Flanner Beach; CCS = Core Creek Sand; SNL = offshore vibracores; "beach" = collections of Holocene and Pleistocene shells on modern beaches between Rodanthe and Cape Hatteras, NC. Inset notations: NA = Norfolk Arch; CLH = Cape Lookout High; CFA = Cape Fear Arch. Circled areas in the inset identify regions where most previous coastal plain AAR data have been obtained.

defining relative age sequences, particularly within narrow geographic regions (<~2° latitude). However, difficulties have arisen when attempting to correlate aminostratigraphic sequences over the entire latitudinal range of the Coastal Plain, from ~26° to ~42°N. (Wehmiller et al., 1992). Many of these aminostratigraphic studies were conducted between 1975 and 2000 in urbanizing areas of southeastern Virginia (VA) and central South Carolina (SC), where active commercial excavations yielded extensive fossil material for AAR study (Fig. 1). Only limited collections have been available in the intervening region of North Carolina (NC), where a complex and often thick Quaternary section is present, particularly north of Cape Lookout. Original AAR studies of the NC