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Chapter V. Barrier islands

ORIGIN AND DEVELOPMENT OF ANCLOTE KEY, WEST-PENINSULAR FLORIDA

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ABSTRACT

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The morphology of barrier system elements on the west coast of peninsular Florida is atypical for microtidal coasts because it includes numerous drumstick-shaped barriers and large ebb-tidal deltas. Anclote Key in Pinellas County, is the most northern island of the system. It was investigated in detail in order to determine its origin and developmental history. Extensive vibracoring and shallow seismic sub-bottom profiling demonstrate that a Miocene limestone platform underlies the area and is covered by only a few meters of Pleistocene and Holocene strata. Shoreward of Anclote Key, the irregular limestone surface slopes very gradually toward the Gulf whereas the gradient on the Gulf side is two to three times greater. A subtle but well-defined limestone ridge with relief of approximately 1 m is present beneath Anclote Key.

Stratigraphic analysis of 24 vibracores has identified nine Quaternary facies above the Miocene limestone. A Pleistocene muddy sand unconformably overlies the limestone and is unconformably overlain by Holocene units. As sea level rose to within a few meters of its present position beginning about 4200 yrs B.P., extensive shallow sub-tidal grass flats and inter-tidal to supratidal mangrove swamp and salt marsh environments were present in this area. Wave action near the break in slope of the limestone surface caused concentration of sand and shell to be deposited as a shallow subtidal shoal. Continued wave and tidal action accompanied by slowly rising sea level caused vertical accretion and spillover as the shoal became intertidal and eventually supratidal. Once the sand body became subaerially exposed as a barrier island, processes typical of such environments gave rise to the deposition of well-defined beach, dune, and mangrove-covered washover facies. The configuration of the shallow limestone platform was instrumental in controlling the location of Anclote Key as it developed during the late Holocene.

INTRODUCTION

The barrier island system of west-peninsular Florida extends for about 200 km south from Anclote Key. The morphology of several elements of this Gulf coast barrier chain is atypical for standard microtidal Gulf barrier models presented by Hayes and Kana (1976) and Hayes (1979). Typical microtidal barrier systems are characterized by long, narrow islands with numerous washover fans and widely spaced tidal inlets such as those on the

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Texas coast. Such barrier systems are commonly referred to as wave-dominated. The west-peninsular Florida system actually more closely resembles that of a mesotidal barrier coast which experiences subequal influence by waves and tides. Such coastal systems tend to be characterized by short, drumstick-shaped barriers with numerous tidal inlets, many of which have prominent ebb-tidal deltas.

A particularly interesting section of this Florida barrier system is in Pinellas County, along the northernmost portion of the barrier chain (Fig.1). In addition to having many characteristics of mesotidal systems, this barrier section is markedly dissimilar to the typical shore-parallel, straight to gently curving trend of microtidal barrier systems (Hayes and Kana, 1976; Hayes, 1979). Both the morphology and stratigraphy of these barriers indicate that they had multiple origins; some apparently developed as spits where littoral transport diverged at the Indian Rocks headland (Fig.1), whereas others originated as subtidal shoals which eventually became supratidal (Brame, 1978; Davis et al., 1979).

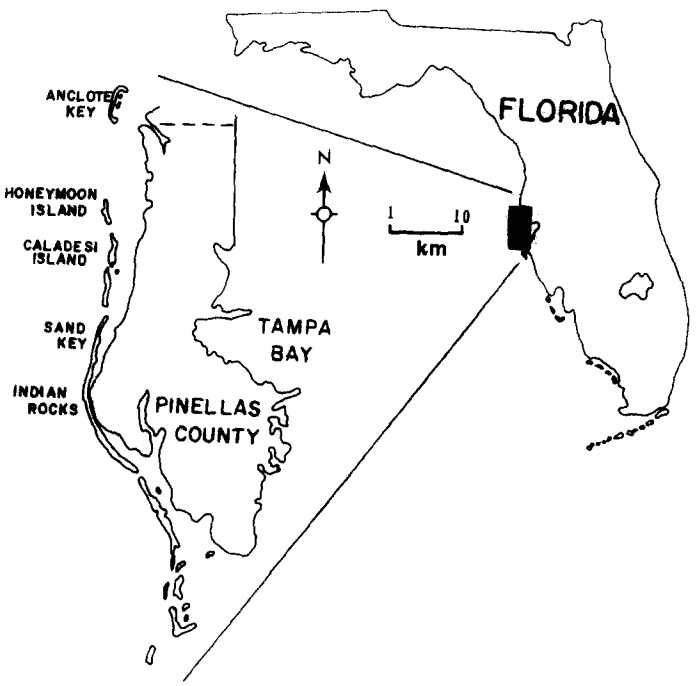

Fig.1. Index map showing location of study site.

Because of the unusual nature of this barrier system and its apparently complex origin, a long-term study of its stratigraphy and development was undertaken. This investigation has concentrated on the northern half of Pinellas County (Lynch-Blosse and Davis, 1977; Brame, 1978; Davis et al., 1979, 1982; Evans et al., 1985, this volume) although two small barriers at the southern tip of the county have also been studied (Davis et al., 1979).

Primary objectives of this effort have been: (1) to develop an understanding of the morphodynamics of the barrier system; (2) to predict future trends in the morphology of this system; and (3) to determine the history of development of these barriers through Holocene time. This will focus on the last of these objectives.

Coastal setting and morphology

Anclote Key is the northernmost barrier in the west-peninsular Florida barrier chain. To the north is the zero-energy coast of Tanner (1960) which

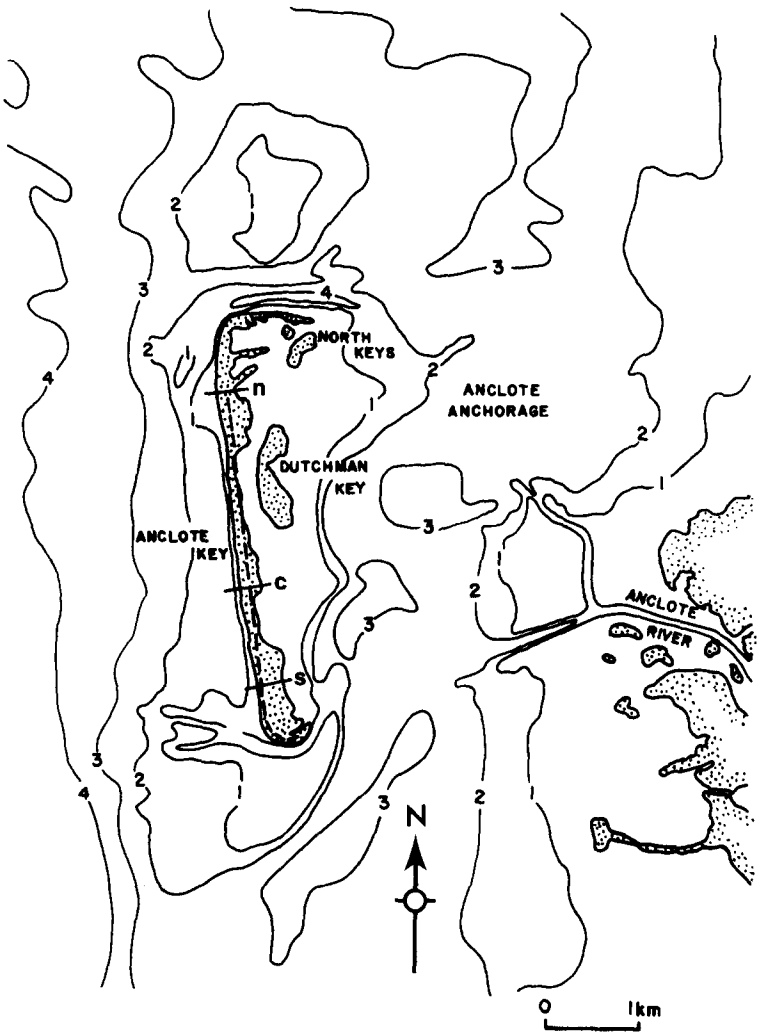

Fig.2. Map of Anclote Key area showing bathymetry and location of stratigraphic cross-sections. Solid east—west lines on Anclote Key are locations of transverse sections and the dashed line is the location of the longitudinal section shown in Fig.7.

not only lacks barriers but also lacks well-developed beaches. Anclote Key is separated from Honeymoon Island to the south by about 6 km of subtidal sand shoals and small recently developed supratidal sand islands. The general trend of the barriers in northern Pinellas County shows a marked divergence northward from the mainland shore beginning at Indian Rocks where only a narrow channel separates the barrier from the mainland (Fig.1). Anclote Key is more than 5 km from the mainland with depths averaging 2 m in the landward anchorage (Fig.2).

Anclote Key is a straight, narrow barrier, 5 km long with widths ranging from less than 100 to nearly 400 m. Dutchman Key and North Key are located just landward of the northern half of Anclote Key (Fig.2). The development of these islands is not considered in this report. Tidal channels reaching depths of 4 m are present at both ends of Anclote Key. They are bounded by subtidal to intertidal sand shoals (Fig.2) which are similar to tidal deltas except that spillover lobes mask the tidal delta configuration.

A series of discontinuous, mobile, subtidal sand bars occurs on the Gulf side of Anclote Key (Figs.3 and 4). The beach is broad and well-developed with small foredunes about a meter in height located just landward of the beach. The landward or east side of the island is characterized by washover fans which are presently inactive and covered extensively by mangroves. The island has not been breached by storms during historical time, and significant overwash has not taken place at least since the hurricane of 1921. Numerous accretionary beach ridges are present on the southern end of the island

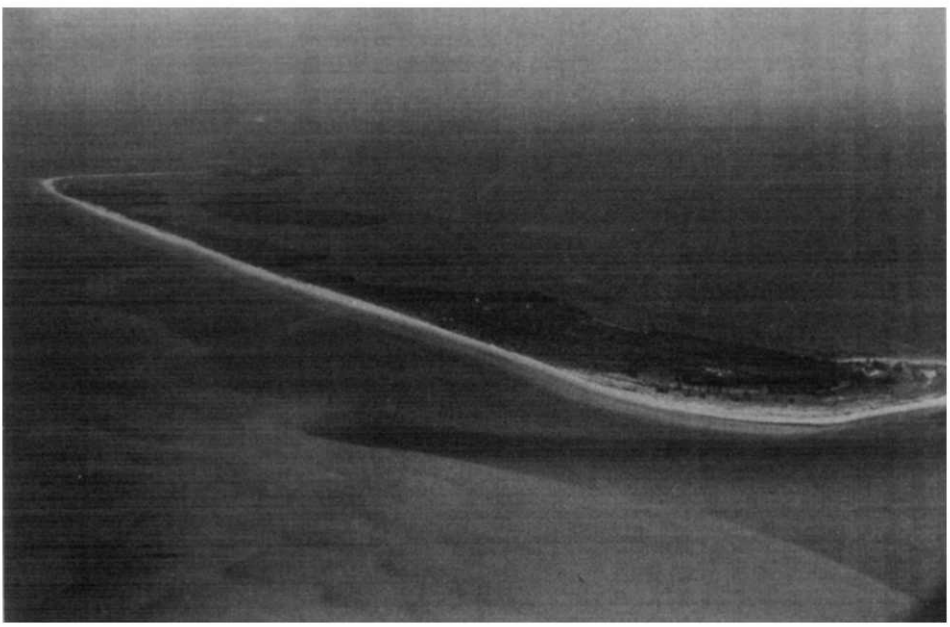

Fig.3. Oblique aerial photograph of Anclote Key looking northeast. Note large subtidal shoals and accretion ridges in the foreground at the south end of the island.

Fig.4. Oblique aerial photograph of north end of Anclote Key showing recently developed recurved spits in the foreground.

(Fig.3). Although there has been a few hundred meters of accretion in this area during the last century, strong tidal currents in the adjacent southern channel (Fig.2) restrict southerly growth. In contrast, since the 1940's, the north end of the island has been extended by nearly a kilometer in the form of recurved spits (Fig.4) which accumulated on the shallow subtidal platform. The northernmost of these spits is now connected to one of the North Keys. Additional northward extension of the island appears to be restricted by the northern tidal channel (Fig.2).

Coastal processes

Compared to most other barrier island systems of the world, the west-peninsular Florida system is subjected to rather low-energy processes except for those associated with infrequent hurricanes. Waves are typically 30—50 cm or less except during the passage of easterly moving frontal systems that are common during winter months. Wave heights of 80—100 cm occur for short periods as these systems pass across the Florida coast at nearly weekly intervals during winter. Wave period is generally 3—4 s although it may be longer during storms or if low swell waves reach the coast. Although prevailing winds change seasonally, wave approach is generally from the southwest. Immediately after the passage of frontal systems the wind shifts, blows strongly from the north and causes relatively large waves to approach from the northwest.

The littoral drift in northern Pinellas County is from south to north. There are, however, local reversals in direction. One such reversal occurs at the south end of Anclote Key where waves refract around a large gulfward protruding sand shoal causing north to south littoral drift which results in the prominent and numerous recurved beach ridges (Figs.2 and 3). The dominant northerly littoral drift has resulted in extensive recurved spit development at the north end of the island (Fig.4).

Coasts along the eastern Gulf of Mexico are subjected to low tidal ranges. Spring tides at Anclote Key are 90 cm with mean tides of 60 cm (NOAA, 1982a). Tides are mixed with both semidiurnal and diurnal tides during the lunar cycle. Maximum tidal currents in Anclote Anchorage are 30 cm s^{-1} to the north during flood and 40 cm s^{-1} to the south during ebb (NOAA, 1982b). Tidal currents in the channels at each end of Anclote Key may exceed 1 m s^{-1}.

Hurricanes generate great increase in the magnitude of coastal processes on this coast. West-peninsular Florida is not subjected to direct attack by these storms as frequently as other portions of the Gulf Coast. During the past century only three severe hurricanes have made landfall on the west-central Florida peninsula. Even those which pass northward over the Florida shelf at distances of 100—200 km have little direct effect on the Pinellas County barriers. Hurricanes during the 1970's which had landfall on the northeastern Gulf Coast generated breakers only 1.0—1.2 m in height and storm tides of less than 1 m. The hurricane of 1921 considerably modified the west-peninsular barrier system in that numerous inlets were cut and many of the islands were washed over. The closest of these changes to Anclote Key was the cutting of Hurricane Pass between Honeymoon and Caladesi Islands immediately to the south (Fig.1).

Modern environments and sediments

Anclote Key and adjacent areas contain all of the sedimentary environments typically associated with barrier islands. However, only a narrow spectrum of sediments is present. Terrigenous sediment is a sorted polycyclic fine quartz sand with small amounts of mud. Plant debris is common as is biogenic skeletal carbonate which ranges in size from very fine sand to gravel.

Gulfward of Anclote Key, a shallow, gently sloping, inner shoreface is periodically subjected to wave action. The fine shelly quartz sand is commonly rippled but bioturbation is abundant. The nearshore zone is characterized by sub-parallel, discontinuous, ephemeral bars of moderately well-sorted fine, shelly quartz sand. Ridge and runnel morphology is common, especially during summer months when wave energy is low. Runnels typically have rippled surfaces; biogenic pellets in the ripple troughs commonly produce incipient flaser bedding.

The beach generally displays an accretional-type profile with a typical foreshore and broad, sub-horizontal backshore. Sediments of the foreshore are rather poorly sorted and bimodal due to an abundance of coarse shell

material and well-sorted quartz sand. Eolian ripples and thin discontinuous heavy-mineral laminae are common on the backshore. A poorly developed low-lying foredune complex occurs landward of the backshore. Vegetation rapidly colonizes and stabilizes foredunes which rise approximately 1 m above the beach. Highest elevations on the island are about 2 m above mean sea level.

Palms and pines are present on the relatively high elevations on Anclote Key. The dominant trees, however, are mangroves which are present throughout the lower supratidal and intertidal zone on the mainland side of the island. Although present morphology and stratigraphy of the island indicate that washover fan deposits are common, recent washover activity has been confined to the rapidly prograding northern end of the island where dunes are absent or very low.

Beach-ridge accretion on the south end of the island is similar to that previously described on drumstick-shaped barriers (Hayes and Kana, 1976; Hayes, 1979). Elongate cat's eye ponds are common on this portion of the island; one large pond has persisted for several years (Fig.3). The pond experiences tidal fluctuations and the bottom is covered with biogenic pellets. In contrast, accretion on the north end of the island has been rapid. Elongate cat's eye ponds do not form due to the greater exposure to waves and longshore currents.

The protected bay or sound immediately landward of the island is characterized by muddy, shelly, quartz sand which is bioturbated by both burrowing invertebrates and by sea grass. Wave action is minimal, the bottom is covered with sea grasses and tidal currents are sufficiently sluggish that physical reworking of the sediment is almost nonexistent.

The tidal channels at both ends of Anclote Key contain shelly, bimodal poorly sorted quartz sand which displays poor sorting and has a mean grain size in the medium to coarse sand range. Megaripples and plane beds predominate in these channels.

General bedrock geology

Unconsolidated Quaternary deposits of west-central peninsular Florida are underlain by Miocene carbonates and terrigenous sands. The northern portion of Pinellas County and the adjacent shelf area is underlain by the Tampa Formation; a Lower Miocene quartzitic limestone containing chert zones and some dolomitic horizons (Heath and Smith, 1954; Carr and Alverson, 1959). It can be characterized as a fossiliferous packstone although there is a range of textures and compositions.

The Tampa Formation does not crop out in the immediate vicinity of Anclote Key but small exposures are present near the Indian Rocks headland to the south (Fig.1) and a few kilometers north of Anclote Key along the mainland shore. This limestone is also exposed discontinuously on the shallow shelf, gulfward of northern Pinellas County. Beginning at depths of about 10 m the veneer of Holocene sediments is thin and patchy exposing irregular areas of the limestone.

Previous work

Although numerous studies of barrier island development have been conducted, few of these have involved high density coring. This is particularly true along the Gulf Coast; where the emphasis has been on the Texas coast. The classic studies of Galveston Island (Bernard et al., 1959; Davies et al., 1971) and Padre Island (Fisk, 1959; Dickinson, 1971) were primarily concerned with gross stratigraphic relationships and were based on a single shore-normal section of cores. Studies of Matagorda Island area of Texas (Wilkinson, 1975; Wilkinson and Basse, 1978) involved extensive drilling and determination of general depositional environments (but involved little coring). Barrier islands of Louisiana are currently being investigated by the Louisiana Geological Survey (e.g. Boyd and Penland, 1981). Even less work has been done on barriers in the eastern Gulf of Mexico although Otvos (1970, 1979, 1982) has investigated Holocene islands on the Mississippi and Alabama coasts and Schnable and Goodell (1968) considered the stratigraphy and development of barriers in the Florida panhandle.

Studies of the peninsular Florida Gulf Coast barriers have been minimal and largely restricted to their morphology (Missimer, 1973; Herwitz, 1977; Harvey, 1979) and to the radiocarbon dating of material from beach ridges (Stapor and Matthews, 1980). In the Pinellas County area, investigations of the barrier system have been concerned with the inner shoreface sediments (Winston et al., 1968; Riggs and O'Conner, 1974) and a detailed study of Caladesi Island (Lynch-Blosse and Davis, 1977; Brame, 1978). Of these only Brame's work on Caladesi Island involved a detailed coring and stratigraphic analysis.

STRATIGRAPHY

Utilization of vibracoring techniques (e.g. Lanesky et al., 1979) has enabled investigators to obtain essentially undisturbed cores from unconsolidated sequences. Using such an apparatus, 24 cores, about 7.5 cm in diameter, were obtained from Anclote Key and adjacent sedimentary environments. These cores plus continuous seismic profiles of adjacent areas provide data for interpretation of the sequence of environments which gave rise to Anclote Key.

The cores were taken from three traverses normal to the long axis of the island and one which parallels the trend of the island (Fig.2). Each of the three east—west sections includes six cores; two on the subtidal Gulf side, two on the island and two in the adjacent sound. The longitudinal section contains nine cores extending from the northern east—west section to the recurved beach ridges at the southern tip of the island. Short supplementary hand cores were taken in the mangrove areas in order to determine thickness of the mangrove peats.

The vibracores range in length from 2.5 to 4.8 m. Eleven of the 24 cores penetrated into limestone bedrock. Extreme friction caused by the dominant

well sorted and packed, fine quartz sand prevented penetration to bedrock on the island itself. Compaction was negligible due to the small amounts of mud and peat in the vibracores.

Facies

Ten facies have been identified in the cores based on their lithology, texture, structures and included biogenic material. Two of these are interpreted as being pre-Holocene in age.

Miocene limestone

Miocene bedrock, penetrated by eleven of the 24 vibracores, is a quartzose fossiliferous packstone of the Tampa Formation. A greenish, quartzitic and

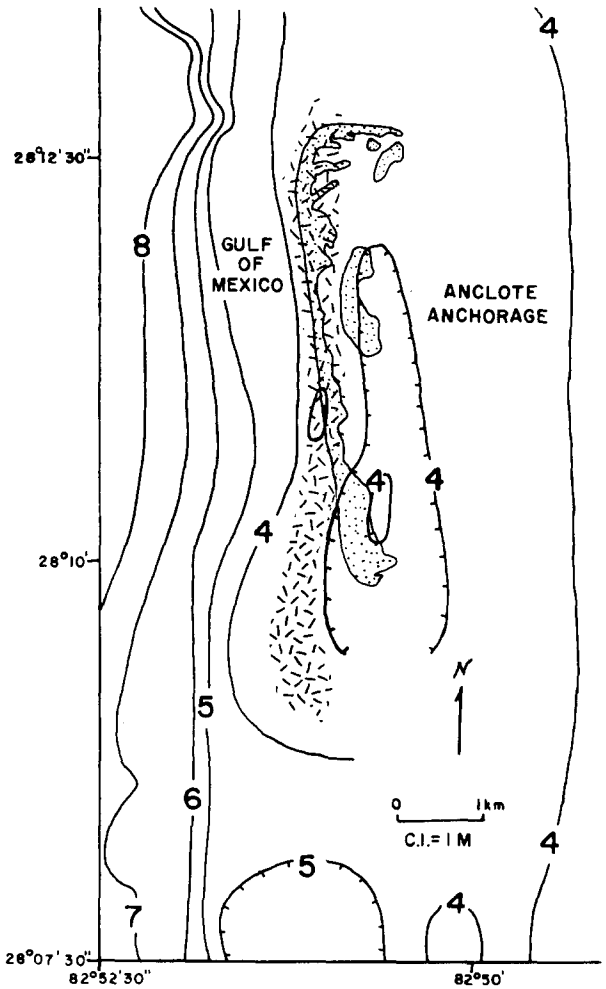

Fig.5. Isopach map of Miocene Limestone surface in vicinity of Anclote Key. Pattern indicates location of bedrock ridge.

smectitic clay unit is present above and mixed with the upper portion of the Tampa Formation. It is widespread at this horizon and has been interpreted as a weathering residuum (Wright, 1973).

Because of the shallow depth of this bedrock unit, a series of seismic profiles and numerous (15) additional vibracores were taken in order to map the limestone surface. Profiles were run both north to south and east to west adjacent to Anclote Key and cores were taken to the north, south and in the sound landward of the barrier (Davis et al., 1982). In the area of Anclote Key and throughout the northern Pinellas County barrier system, there is a very gentle gulfward slope on the bedrock surface from the mainland to the barriers or slightly gulfward of them. At this location the gradient shows a marked increase (Fig.5). There is a subtle but defined low ridge on the limestone surface beneath Anclote Key as well as the barriers to the south. This extends for more than 40 km (Davis et al., 1982). Both vibracoring data and seismic profiles show that the limestone surface is irregular, with a relief that is less than 1.5 m throughout the region (Fig.6).

Pleistocene muddy sand

Immediately above the Tampa limestone is a thin but continuous muddy sand which is present in eleven of the thirteen cores which penetrated to this horizon (Fig.7). The thickness ranges up to 52 cm. Plant debris and shell are present; mud content ranges from 8 to 32 wt.% and shell is less than 3%. Some plant debris in the upper portion of this unit has been identified as sea grasses and the shell material is from a normal marine fauna.

This unit is distinct from both overlying and underlying units by its high mud content and its relatively consolidated consistency. It occurs throughout the area in the subsurface of Caladesi Island to the south (Brame, 1978) and is exposed in the inner shoreface (Winston et al., 1968). Amino acid racemization dates on shell material from three cores in St. Joseph's sound, just southeast of Anclote Key have produced ages ranging from 100,000 to 140,000 yrs B.P.

Vegetated paralic environments

A bioturbated and mottled, peaty quartz sand unit, up to 1.1 m in thickness, overlies the pre-Holocene muddy sand unit in 20 of the 21 cores which penetrated this horizon (Fig.7). Shell and mud each range up to 2 wt.%. Plant debris, dominantly mangrove, is abundant. This unit is distinguished from the underlying muddy sand unit by a sharp contact and distinct change in sediment composition.

A radiocarbon date from mangrove fragments near the bottom of the unit is 4520 ± 70 yrs B.P.; a date from shell material near the top of the unit is 1850 ± 70 yrs B.P.

Transition

This facies is a bioturbated quartz sand containing mangrove debris and shell fragments. It is present in all 22 of the cores which penetrated to the

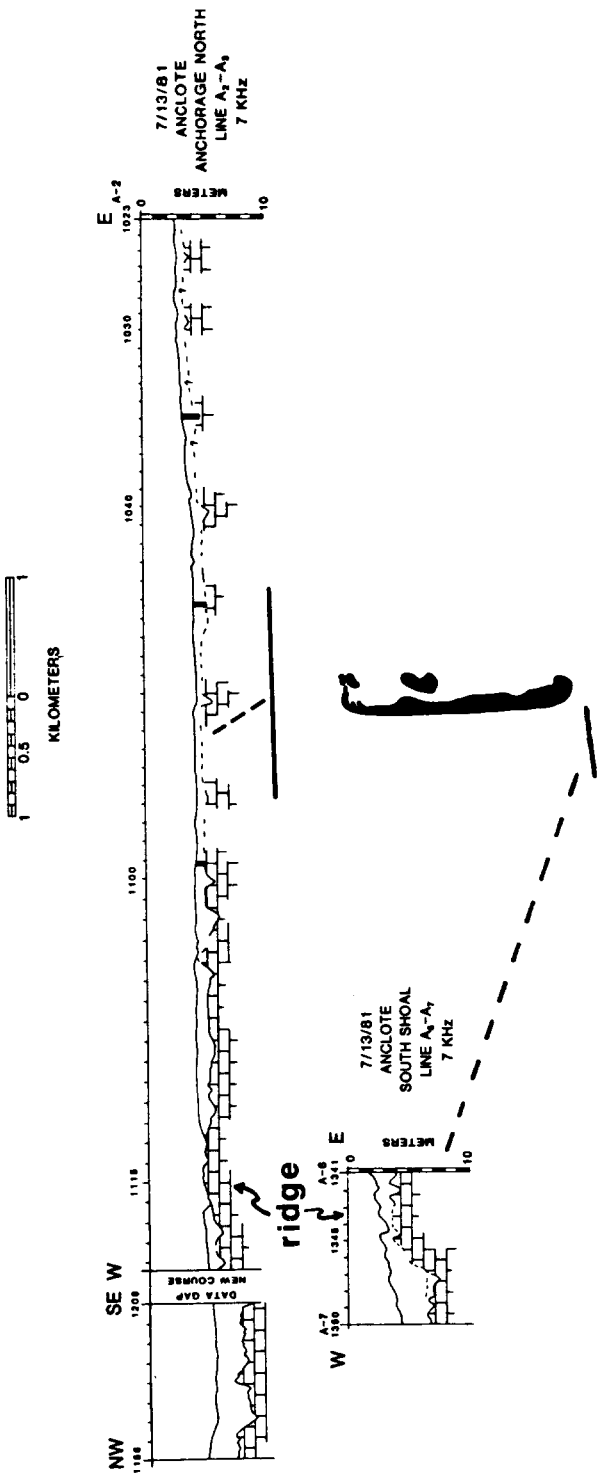

Fig.6. Seismic profiles in east—west orientation near Anclote Key. Note general irregularity of the surface and the change in overall gradient near the present position of Anclote Key.

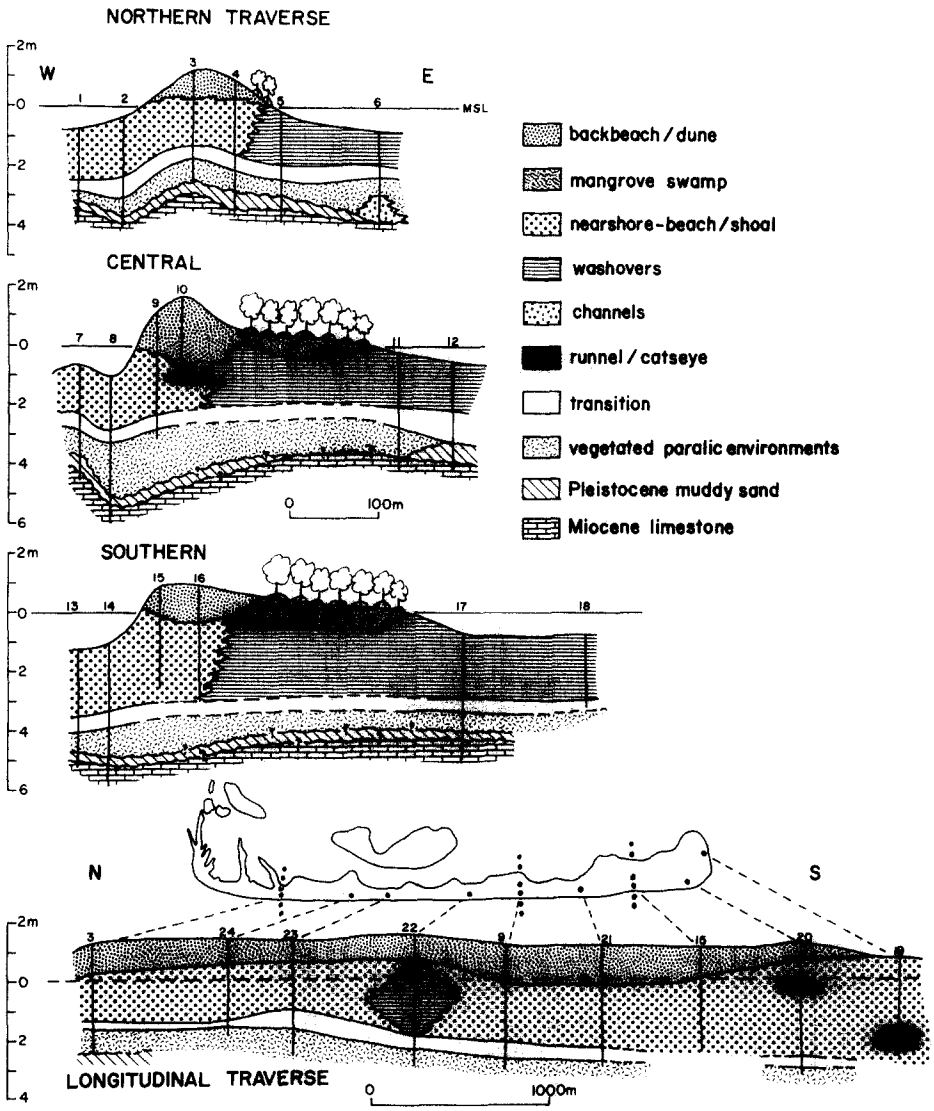

Fig.7. Stratigraphic cross-sections at Anclote Key; three are oriented east—west and one is longitudinal.

appropriate depth (Fig.7). Plant debris decreases vertically and shell material increases vertically in this unit. It represents a transition between the peaty sand of the paralic environments below and the relatively organic-free overlying sand units.

Nearshore-beach/shoal

A light-colored quartz sand containing up to 37% sand- and gravel-size shell material is present in 19 of the cores (Fig.7). This unit ranges from 1.5

to 2.6 m in thickness and only occurs immediately under and Gulfward of the island. Bioturbation is rare and there are scattered, discontinuous laminae of pellets and seagrass debris. Shell material is generally scattered but some shell layers are present.

Washovers/spillovers

Also overlying the transition sand and stratigraphically equivalent to nearshore-beach sand is a shelly quartz sand interpreted as originating from spillover or washover processes. This unit is up to 2.4 m thick and is present in seven of the cores including all of those taken from the sound side of Anclote Key (Fig.7). General textural and compositional characteristics are similar to those of the nearshore-beach sand. Mud content is less than 2% and shell gravel reaches up to 23 wt.%.

This unit contains distinct layers which exhibit shell concentrations near the base grading into bioturbation structures near the top; contacts between sedimentation units are abrupt. These characteristics distinguish it from the nearshore beach/shoal facies. The upper surface of this unit is the present substrate in the sound. It is bioturbated in the upper few tens of centimeters.

Backbeach/dune

Thirteen cores penetrated a homogenous, well-sorted, fine quartz sand which characterizes the present backbeach and foredune area of the island. Cross-stratification with local concentrations of phosphatic heavy minerals is prominent. Thicknesses are typically only 1 m but exceed 2 m in the central region of the barrier. Although shells are not common, some thin shelly layers near the base record the overwash process. In general, the base of this unit is near present sea level.

Mangrove swamp

The present mangrove swamp on the back of Anclote Key overlies a well-developed sandy peat unit which reaches a thickness of nearly 1 m. One core penetrated a thin peat layer beneath the backbeach/dune facies. The peat is very sandy with most samples containing over 50 wt.% quartz sand. Fibrous intertwined mangrove material is dominated by *Rhizophora*, the red mangrove. Thin units of the washover facies occur within the peat unit at a few locations.

Runnel/cat's eye sequence

Three cores penetrated a sequence of alternating well-sorted, shelly quartz sand and pelleted mud. Horizontal stratification is present throughout both. These sequences are up to 1 m in thickness. This facies originates when accretionary beach ridges migrate over the pelleted mud in cat's eye ponds, such as is presently taking place at the south end of Anclote Key (Fig.3).

Channels

Abundant shell gravel with some mud is present in one core in the northern east—west section (Fig.7). This poorly sorted shelly sand contains up

to 40 wt.% shell gravel and is 81 cm thick where cored. It immediately overlies the limestone bedrock and is overlain by peaty sand of the vegetated parlic facies. No stratification is recognizable and shell material decreases from the bottom upward. Its lithology and stratigraphic position suggests deposition in a tidal channel.

Facies associations

The lower four facies show a uniform and widespread distribution throughout the Anclote Key area (Fig.7). In general, these units are subparallel to, and drape over the underlying bedrock.

Above the transition sand the relatively thick nearshore/beach shoal and washover/spillover facies occur at the same stratigraphic position with the former on the Gulf side and the latter on the sound side. The sections are capped by backshore/dune and/or mangrove swamp facies. The beach ridge/cat's eye sequence and the channel deposits are the only local facies.

ORIGIN AND EVOLUTION OF ANCLOTE KEY

Pre-Holocene time

The Lower Miocene limestone bedrock of the Anclote Key area provides an excellent temporal basement upon which the origin and development of this barrier island can be reconstructed. West-peninsular Florida is unique among Gulf Coast barriers because of the proximity of this bedrock. The presence of this basement framework plus the detailed stratigraphic information on Anclote Key, allows for interpretation of the sequence of events and depositional environments which produced the present barrier complex.

The surface of the Tampa Formation was exposed for an indeterminate period of time after it was lithified. Subaerial weathering produced an irregular, karstic surface throughout this part of the Florida peninsula. Although seismic profiles reveal only a meter or so of relief in the Anclote Key area, other areas nearby have greater surface relief; sink holes, caverns, and other karst features are abundant. This surface in the Anclote Key area slopes gulfward from the mainland to the position of the barrier island at less than 1 m km^{-1}. At the barrier, the gradient increases to more than 2 m km^{-1} for at least a few kilometers under the present shoreface (Fig.5). There is also a slight but persistent southerly slope of the bedrock surface beneath Anclote Key and a slight low ridge that parallels and underlies the barrier island (Fig.5).

The origin of this bedrock configuration is presently unknown but it probably developed at some time prior to the last rise of sea level before the Holocene, possibly during Illinoisan glaciation (Fig.8A). At this time, sea level was over 100 m below its present position and the shoreline was about 200 km to the west of Anclote Key.

During the Sangamon interglacial, sea level rose rapidly to a level approxi-

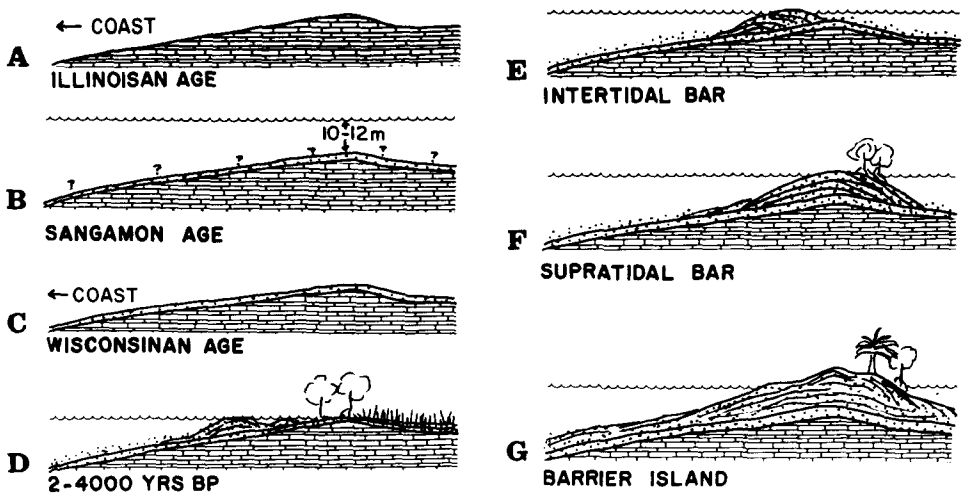

Fig.8. Schematic representation of sequence of stages in the development of Anclote Key.

mately 7 m above present sea level (Cooke, 1945). At this time, the present site of Anclote Key was a low energy, protected shelf or coastal bay with normal marine salinities. It was in this setting that the muddy sand accumulated (Fig.8B). This unit is thin and of uniform thickness in the study area. Although original thickness is unknown, it could not have been more than a few meters.

Lowering of sea level during the Wisconsinan glacial advance caused the shoreline to again retreat to a position far gulfward of its present position (Fig.8C). Subaqueous erosion by waves and currents during this regression and the subsequent transgression plus subaerial exposure during the Wisconsinan advance, did not completely remove the muddy sand unit as evidenced by its widespread occurrence not only in the Anclote Key area but throughout the northern Pinellas County coastal zone (Davis et al., 1982; Evans et al., 1982).

Holocene

As Wisconsinan glaciers melted, sea level rose rapidly but at variable rates. Considerable data from the Gulf Coast of South Florida indicate that sea level was about 4 m below present level approximately 4400 yrs B.P. (Scholl and Stuiver, 1967), a value in agreement with data from other parts of the Gulf of Mexico (Shepard, 1964; Coleman and Smith, 1964).

Stratigraphic data from the Anclote Key area indicate that during the period of 4000—5000 yrs B.P., sea level was just at or slightly below the bedrock ridge and the adjacent landward platform of the Tampa Limestone. Although the tidal range was probably similar to the present range, the very gentle slope on this surface landward of the ridge gave rise to a broad intertidal to slightly supratidal zone which, in conjunction with a slow rise in sea

level from about 4400 to 2000 yrs B.P., allowed for the extensive development of mangrove swamp and/or salt marshes throughout this area (Fig.8D). The Big Cypress Swamp and the Everglades of South Florida are attractive analogs for such settings. The widespread distribution of the peaty sand, throughout not only the area beneath Anclote Key but the surrounding area as well, supports such a reconstruction. As in modern swamps and marshes, tidal channels were present. This is evidenced by the channel deposit in core 6 which cuts through the muddy sand unit and rests directly on the limestone (Fig.7).

This environment appears to have persisted for a relatively long period of time as evidenced by radiocarbon dates from the peaty sand. Mangrove material from near the base of this unit yielded a date of 4250 ± 70 yrs B.P. Shell material from the top of this unit was dated at 1850 ± 70 yrs B.P. These data suggest that mangrove swamp or salt marsh communities persisted in this area, and also suggest that sediment accumulation rates during this internal were low in comparison to more recent rates.

The outer or gulfward fringe of the mangrove swamp was subjected to some wave energy but probably not enough to produce a well-developed beach. The combination of wave action and slowly rising sea level over the mangrove and salt marsh communities eventually caused destruction of this depositional environment, probably about 2000 yrs B.P. when the area at, and just landward of the bedrock ridge, became subtidal (Fig.8E). This produced the peaty sand unit of the vegetated paralic environments (Fig.7).

Following the development of shallow subtidal conditions, the focus of wave energy was over the limestone ridge where the gradient of the bedrock surface changes. Breaking of waves over this shoal area caused development of a subtidal sand bar slightly gulfward of Anclote Key (Fig.8F). Normal wave conditions supplemented by storm activity resulted in the reworking of the upper portion of the peaty sand, in the deposition of the transition sand, and in the upward accretion of shelly sand. Shelly sand accumulated as two distinct facies: (1) one on the Gulf side which was subjected to wave action (nearshore/beach sand); and (2) the other which resulted from subtidal spillover caused by waves and wave-generated currents (washover/spillover sand). As accretion accelerated during the slow rise of sea level from 2000 yrs B.P. to present (Scholl and Stuiver, 1967), the sand bar became intertidal and migrated landward (Fig.8G). Wave-generated processes caused continued accumulation of the nearshore/beach and washover/spillover facies.

Upward accretion eventually produced supratidal conditions and the ancestral Anclote Key. Inundation and accompanying washover took place only during storm conditions. Breaking waves produced the uprush and backwash process generating a typical Gulf beach profile and sediment accumulation (nearshore/beach lithosome). Longshore currents became prominent causing longitudinal extension of the initial island. Eolian processes on the supratidal island produced foredunes and mangroves began to establish a community on the intertidal landward side of the island. The present island profile became established (Fig.8H).

Present dynamics of the island are now typical of those on other barrier coasts. Washover has been a rare event since development of the foredunes except under extreme energy conditions; none are known at least since the hurricane of 1921. Longitudinal accretion of the barrier has been slow during historical time due to restrictions imposed by the tidal channels on both ends of the platform. The only significant longitudinal accretion is on the north end of the island where numerous spits have extended Anclote Key about a kilometer since 1943. Washover takes place annually along this portion of the island due to the absence of well-developed foredunes.

SUMMARY AND CONCLUSIONS

Several conclusions can be drawn about the origin and development of Anclote Key. They are:

(1) The shallow Miocene limestone displays a distinct change in slope a few kilometers from the mainland shore and also contains a well-defined ridge near the break in slope.

(2) The configuration of the underlying limestone surface was instrumental in the stabilization of Anclote Key at its present location.

(3) Initial Holocene sediment accumulated about 4200 yrs B.P. in a shallow grass flat or intertidal vegetated environment about 4 m below present sea level.

(4) Upward shoaling, caused primarily by waves, developed a shallow subtidal sand body which migrated slightly landward by spillover phenomena.

(5) Initial formation of the sand bar/shoal was only slightly gulfward of the present position of Anclote Key. Total landward migration was no more than a few hundred meters.

(6) The shoal complex became supratidal and eventually developed typical barrier environments similar to those present today. This took place between 2000 and 1500 yrs B.P.

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