

TERRACES AND SHORELINES OF FLORIDA

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INTRODUCTION

This report presents a map showing the extent and distribution of identified terraces and shorelines in Florida. The map represents a compilation of the results of the work done on shorelines and terraces in the State by many authors. The map was prepared after a review of the literature and a careful examination and evaluation of all data on terraces in Florida.

The topography of Florida is the result of different erosional and depositional processes that have sculptured the landscape through thousands of years. One of the most striking features in Florida as well as in many areas along the eastern seaboard is the presence of terraces, or terraces, associated with the advance and retreats of the sea during the Pleistocene Epoch or the Pleistocene Age. The changes of sea level associated with the repeated retreat and growth of continental glaciers have left their imprint with such physiographic features as terraces, wave-cut steps of shorelines, beach dunes and offshore bars. The terraces and shorelines are well preserved in many parts of the State, particularly along the Atlantic coast, in some parts of the State the results of erosional processes that occurred during and since the last retreat of the ice have been modified and obscured the remains of these shoreline and marine features that are unrecognizable.

Mineral deposits associated with terraces, shore, and nearshore features are of economic importance. Vernon (1943, p. 156) states that phosphate deposits are confined beneath 170 feet above sea level, and possibly a third at approximately 212 feet above sea level. MacNeil (1950) investigated the distribution of shorelines in Florida in connection with investigations of land pebble phosphate deposits of southern Florida. Although MacNeil (1950, p. 106) found no relationship existed between phosphate deposits and Pleistocene terraces, the marine deposits associated with water shores of coastal bars deposited during the Pleistocene Epoch are important sources of heavy minerals and are of economic importance. Terrace deposits contain mineral resources such as common clay used in manufacturing cement and building bricks; kaolin used in the manufacture of china and dinnerware; kyanite used as refractory porcelain, and sand used in the manufacture of glass and by the construction industry. Heavy minerals produced from ancient beach deposits include limonite and leucocite, sources of titanium, zircon concentrates, and the rare-earth mineral monazite used in the manufacture of incandescent gas light mantles.

Terraces also play an important role in hydrologic regimes of ground water in many areas. The altitude of the terrace relative to adjacent land and the size of sorting of sediments underlying the terrace are factors that affect the occurrence and movement of ground water. Because the configuration of the potentiometric surfaces of the shallow artesian aquifer generally reflect contours of the land surface, terraces are to a large degree involved in a significant role in determining the configuration of the potentiometric surface of the shallow artesian aquifer system in Duval County (Fairchild, 1972, p. 8) and in Escambia and Santa Rosa Counties (Masgrove and others, 1965, p. 27).

In those areas where well sorted permeable sands underlie the terrace, recharge from rainfall occurs by infiltration into the shallow sand aquifer, into the Floridan aquifer and the Biscayne Aquifer in southern Florida.

In Volusia County, the most productive recharge areas are the eastern part of the Talbot terrace and ridges. According to Knochenmus and Beard (1971, p. 13), a relatively good hydraulic connection exists between the classic deposits and the Floridan aquifer under most of the Talbot terrace.

In southeast Palm Beach and northeast Broward Counties, in the lower Hillsboro Canal area (8.5 mi²) recharge to the Biscayne aquifer through sands underlying the Palmetto terrace has been estimated to be about 70 Mgal/d (McCoy and Hardee, 1970, p. 12).

Terraces are also important sources of water in those coastal areas in which water from deeper lying aquifers is too salty for use (Wyrick, 1960, p. 23).

PREVIOUS INVESTIGATIONS

Numerous reports have been prepared on the terraces of Florida. Mason (1913, p. 31) was the first to recognize marine terraces in Florida. Three terraces were identified, mapped, named, and described as "marine terraces of deposition with estuarine and fluvial detritus into stream valleys." The terraces—Pensacola, Tallapoosa, and the Newberry—were named by Mason from the localities in which they were originally mapped. Cooke (1939, 1942) identified seven "coastal terraces in Florida." Eight shorelines were identified as interglacial marine terraces and named (Cooke, 1939, 1942, p. 248): 1. Vernon (1942, p. 18) recognized five "coastwise terraces," four interglacial marine terraces and a high-level detritic plain. Parker and Cooke (1944, p. 24) identified the Miami beach later to be named the Silver Bluff terrace (Parker and others, 1955, p. 146). MacNeil (1950, p. 99) recognized four Pleistocene terraces in the detailed study of topographic maps. Altschuler and Young (1960, p. 202-205, fig. 8-2) established that terrace sands in central Florida upland, in the Lake Ridge area, in west-central Polk County contain a residual weathering product of the underlying Bone Valley Formation rather than being the result of wave deposition during the Pleistocene sea.

According to Altschuler and Young (op. cit., p. 203) there is a definite relation between sand size distribution and present-day topography and sand differentiation is discordant to any of the proposed Pleistocene shorelines and to absolute altitude.

As shown on Table 1, there is little agreement among geologists on the number of terraces and their origins, particularly of those terraces about 70-100 ft (Wicomico terrace).

There is growing evidence (Altschuler and Young (1960, p. 202-207), Al and Brooks (1965, p. 406-411) and Lichtler (1972, p. 15-16), that suggests that much of the higher terrain above 100-170 ft, at least in Florida, does not consist of deposits associated with the advance of Pleistocene sea, but represent older deposits of Pliocene and upper Miocene age. Stringfield (1966, p. 64-71) presents a complete summary discussion of the marine terraces and their related history. Areal investigations that have detailed terrace maps available are shown on Figure 1.

DEFINITIONS OF TERRACE

Garner (1974, p. 708) defines a marine terrace as a surface of erosion or deposition formed along a coast by wave erosion and deposition.

Marine terraces are the former bottoms of shallow seas, usually floored with deposits of sand, clay, silt and shells, and are bounded along their inner margin by shoreline features such as relict beach ridges, swales, or inner lagoons, seaward facing wave-cut scarps or sea cliffs, and offshore and bay bars.

METHODS OF MAPPING

Several methods have been used to identify and delineate terraces and shorelines in Florida. Most old shorelines and terraces have been identified from topographic (Cooke, 1942; MacNeil, 1950) and physiographic or geomorphic evidence (White, 1958, 1970). More modern evidence suggested by lithology and stratigraphy has been used to delineate the relationship between terrestrial or beach sediments and lagoonal, deltaic or marine deposits (Parker, 1970). Dyer (1943, p. 63) suggested that the identification of terraces by features of soils, drainage and vegetation associated with particular terraces might be feasible. Geomorphic features were used by White (1970) to distinguish surfaces that had been inundated by the sea from those that were not. Parker and others (1955, p. 146) states that field mapping of the Silver Bluff terrace shorelines and associated islands was greatly facilitated by recognition of the fossil assemblages associated with the Silver Bluff terrace and areas that were dry land, mostly islands, during the Silver Bluff transgression. Al and Brooks (1965) used fossils to determine the ages of at least five terraces.

The method of delineating terraces used in the present study was based on contour elevations and topographic expression of land forms. The terrace features and relief were identified from 1:50,000 scale 1:5 minute topographic quadrangles and transferred to U.S. Geological Survey maps, scale 1:250,000 for comparison of the maps from published reports on Florida terraces were then compared to the base map. Although reduction of the maps for comparison of the maps of some detail, major features have been retained, however, with sufficient detail to show the general relief and distribution and relations of terraces and shorelines. The terrace terminology used is that of Cooke (1939, 1945).

MODIFICATIONS OF MARINE TERRACES AND SHORELINES

Along the Atlantic coast, the shoreline scarps of the Pamlico and Wicomico terraces maintain their altitude for hundreds of miles—from Virginia to Georgia, generally with little change by erosion.

Although shoreline scarps and terrace surfaces are well preserved in many parts of Florida, scarps and terraces, particularly the older ones, have been modified by erosional processes throughout much of the State.

Shoreline scarp modification by solution of underlying limestone is believed to be a contributing factor, according to Vernon (1942). In many cases, linearity of the scarp has been destroyed by collapse of underlying limestone or by being breached by streams.

Several authors report post-depositional modifications of the terrace surfaces caused by different processes. Bishop (1956, p. 20) reported that in northern Highlands and southern Polk Counties, Von and Puri (1962, p. 679) stated that Wicomico shorelines stand at 70 feet in Gilchrist County and 50 feet in Levy County rather than the 100 feet, because it has been lowered by solution of underlying limestones.

According to Von (1966, p. 14) the Wicomico terrace in Jefferson County occurs at 40-45 feet and coincides with the Cody Scarp in central Jefferson County. The Cody Scarp is a persistent topographic feature which represents a relict marine terrace that extends regionally through the East and Gulf Atlantic Coastal Plain (Puri and Vernon, 1964, p. 11, fig. 5). Hendry reported (1966, p. 29) the Pleistocene Okefenokee shoreline is represented by the Cody Scarp at elevations of 140-150 feet in Leon County. Von (op. cit., p. 14) states that "the anomaly in elevation of this apparently similarly related feature is not uncommon in Florida where limestone lies near the ground surface and is readily susceptible to solution." White (1958, p. 38), in discussing terrace surface subsidence, reports that the extent of the Wicomico and Okefenokee terraces was differentially reduced by subsidence over a large area in central peninsular Florida.

HAZLEHURST TERRACE

The name Brandywine was used by Clark (1915) to describe deposits in Prince Georges County, Maryland. Cooke (1939, p. 595) restricted and redefined the Brandywine to those sediments deposited in the Brandywine sea and also established the upper limit of the Brandywine shoreline at 170 feet above sea level. According to Cooke (1945, p. 273) scattered remnants of an eroded surface of a terrace and shoreline exist in a bar 6 to 8 miles wide from the Perdido River on the Alabama-Florida State line eastward to northern Gadsden County. Cooke identified scattered remnants of the Brandywine surface as far south as Polk County.

There is not complete agreement among the many authors as to how far sea level rose above 170 feet elevation in western Florida. The "high terrace" of MacNeil (1930, p. 18), the delta plain surfaces of Von (1966, p. 9), Hendry (1966, p. 24) and Vernon (1942, p. 25) do not have scarps at the upper edges, therefore are not considered to be of Pleistocene marine origin but rather to represent Miocene or Pliocene deltaic deposits by these authors. Although March (1966, p. 93) found no evidence of a Brandywine shoreline from topographic maps in Escambia and Santa Rosa Counties, he did identify a ridge in Santa Rosa County as a possible former offshore bar from a time when sea level rose above 150 feet. Correlation of terraces by different authors is presented in Table 1. Stringfield (1966, p. 68) reported that Cooke included in his interpretation the Okefenokee terrace at 150 feet and that Cooke renamed the Brandywine Terrace as Hazlehurst terrace. The generalized map includes the Hazlehurst terrace with the Brandywine terrace.

COHARIE TERRACE

The name "Coharie" was applied by Cooke (1931, p. 506) to those Pleistocene deposits formed while the sea stood at an altitude of 212 feet above sea level, which is the height of the shoreline of the Coharie terrace.

The Coharie terrace, at altitudes of 170 to 215 feet, extends along the middle of the northwestern part of the State from the Perdido River in Escambia and Santa Rosa Counties, he did identify a ridge in Santa Rosa County as a possible former offshore bar from a time when sea level rose above 150 feet. Correlation of terraces by different authors is presented in Table 1. Stringfield (1966, p. 68) reported that Cooke included in his interpretation the Okefenokee terrace at 150 feet and that Cooke renamed the Brandywine Terrace as Hazlehurst terrace. The generalized map includes the Hazlehurst terrace with the Brandywine terrace.

SUNDERLAND TERRACE

The Sunderland terrace is found in northern Okaloosa and Walton Counties at altitudes of 100 to 170 feet and at an altitude of 170 feet. The terrace forms a band several miles wide in these counties and shows evidence, according to Cooke (1939, p. 41) of at least two erosional cycles. The terrace extends from Escambia County eastward through Gadsden County and then northeastward through Jefferson and Madison Counties, then southward through Suwannee, Columbia, Bradford, and Alachua counties. The terrace extends as far south as Polk and Highlands Counties in central peninsular Florida. The generalized map includes the Okefenokee terrace with the Sunderland terrace.

WICOMICO TERRACE

The Wicomico shoreline stands at 100 feet above sea level and the lower limit of the terrace stands at 70 feet above sea level. The terrace and shoreline are well developed in the northeast in Clay, Duval, Nassau, and Putnam Counties (Cooke, 1945, p. 284-285). In northwest Florida in Calhoun, Okaloosa, Santa Rosa, and Walton Counties the Wicomico terrace forms a narrow band dissected by stream erosion. This terrace and shoreline have been modified by subsidence in many places in Jefferson County (Von, 1946) and in Duval and Gilchrist Counties (Puri, Von, and Oglesby, 1967).

PENHOLWAY TERRACE

According to Cooke (1945, p. 287) the Penholway terrace forms a narrow belt abutting the Wicomico. The shoreline stands at approximately 70 feet and the terrace stands at 42 feet above sea level. Both the Penholway and the next lower terrace were formed during pauses in the retreat of the sea from 100 to 25 feet.

The Penholway terrace, which occupies much of the Florida peninsula, is best developed in central Florida. In northern Florida, in Walton County, the Penholway terrace is a much dissected narrow band between 50 and 70 feet above sea level. In central Florida, in Marion County (1945, p. 291), further west, in Escambia County, Marsh (1966, p. 90) identified the Penholway terrace with a shoreline at an altitude of 70 feet. The seaward boundary of the Penholway terrace is generally better defined than the inland boundary. In many places, however, particularly in Pasco, Hernando and Levy Counties the Penholway terrace and shoreline are obscure.

TALBOT TERRACE

The Talbot terrace is not as well developed throughout Florida as in the northern states, particularly in Maryland. The Talbot terrace is well developed along parts of the coast, particularly in Duval and Santa Rosa Counties (Cooke, 1945; Bernes, Love and Taver, 1963), and in Volusia County (Knochenmus and Beard, 1971). According to Cooke (1945) the Talbot terrace is best developed in parts of northwest Florida (Bay, Leon, Volusia, and Walton Counties) and in central Florida (St. Johns and Volusia Counties). He identified the terrace as occurring between 25 and 50 feet and the shoreline at 100 feet from studies in other States, at about 42 feet above sea level. The Talbot shoreline is rarely well developed because it does not abut against terraces higher than the Penholway, except where the Penholway was cut away by the Talbot Sea (Cooke, 1939, p. 49). Other land-sea marine terraces with shorelines at 100 feet such as lagoons, bars and barrier islands are in Duval, Flagler, Okaloosa and Santa Rosa Counties (Cooke, 1945, pp. 295-296).

MIAMI COAST TERRACE

The Pamlico terrace and shoreline are two of the best developed land-form features of the peninsula because they have been least modified by erosional processes. The Pamlico terrace and shoreline extends continuously for a distance of 200 miles north along the valley wall of the St. Johns River in northern Martin County to northern Marion County where it is breached by the Oklawaha River (White, 1958, p. 54). On the west coast, the Pamlico terrace extends to Pompano Beach in Broward County. The terrace ranges in width from several hundred yards at Miami to about 2 miles in southern Duval County.

According to MacNeil (1950, p. 104), the Silver Bluff might be tentatively correlated with the "climatic optimum" a period about 5,000 to 4,000 years ago when the climate was appreciably warmer than now. During Silver Bluff time sea level was 8 to 10 feet higher than present sea level. The Silver Bluff is considered to be Pleistocene by Scholl (1963).

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EXPLANATION

Detailed terrace maps available from areal investigations. Numbers refer to "selected references."

Fig. 1 Index of available terrace maps.

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This public document was promulgated at a total cost of \$420.00 or a per copy cost of \$1.68 for the purpose of disseminating hydrologic data.

*Refer to figure 1

TABLE 1.—Correlation of Terraces and Shorelines in Florida

Mason 1913 (Escambia, Citrus, Alachua Counties)	Cooke 1939, 1945 (Statewide)	Vernon 1942 (Holmes and Washington Counties)	MacNeil 1950 (Statewide)	Marsh 1966 (Escambia and Santa Rosa Counties)	Hendry 1966 (Leon County)	Von 1966 (Jefferson County)	Bernes and others 1963 (Flagler, Putnam, St. Johns Counties)
	Hazlehurst, formerly Brandywine 215-320 ft. (Fluvial)	Coastwise delta plain 250-320 ft. (Fluvial)	High Pliocene terrace 150-280 ft. (Subaerial)	High level or upland surface 60-280 ft. (Marine)	Miocene-Pliocene delta plain 260 ft. (Fluvial)	Miocene delta plain to 260 ft. (Fluvial)	
	Coharie 170-215 ft. (Marine)	Coharie at 170-215 ft. (Marine)		70-ft-shore bar at 190-200 ft. (Marine)	Okefenokee Dunes		Coharie 170-215 ft. (Marine)
	Sunderland 100-170 ft. (Marine)	Okefenokee at 115-150 ft. (Marine)	Okefenokee at 150 ft. (Marine)		Okefenokee at 150 ft. (Marine)		Sunderland 100-170 ft. (Marine)
Newberry 70-100 ft. (Marine)	Wicomico 60-105 ft. (Marine)	Wicomico at 100 ft. (Marine)	Wicomico at 100 ft. (Marine)		Wicomico at 100 ft. (Marine)	Wicomico at 40-45 ft. (Marine)	Wicomico 70-100 ft. (Marine)
Tallahassee 0-40 ft. (Marine)	Penholway 42-70 ft. (Marine)			Penholway at 70-80 ft. (Marine)			Penholway 42-70 ft. (Marine)
	Talbot 25-42 ft. (Marine)						Talbot 25-42 ft. (Marine)
	Pamlico 5-25 ft. (Marine)	Pamlico at 25 ft. (Marine)	Pamlico 25-35 ft. (Marine)	Pamlico at 30 ft. (Marine)	*Pamlico 25-35 ft. (Marine)	Pamlico at 26-40 ft. (Marine)	Pamlico 10-25 ft. (Marine)
	Silver Bluff 0-10 ft. (Marine)		Silver Bluff 0-10 ft. (Marine)			Silver Bluff at 10 ft. (Marine)	Silver Bluff 0-10 ft. (Marine)

Note: Shorelines shown as a single figure, terraces shown as intervals.

1. See Stringfield (1966, p. 68).

EXPLANATION

- Relief of terraces, in feet
- 215-320 Includes Hazlehurst terrace (formerly Brandywine) (Cooke, 1939), Coastwise delta plain (Vernon, 1942), part of high Pliocene terrace (MacNeil, 1950).
 - 170-215 Coharie terrace
 - 100-170 Includes Sunderland terrace (Cooke, 1939), Okefenokee terrace (MacNeil, 1950).
 - 70-100 Wicomico terrace
 - 42-70 Penholway terrace
 - 25-42 Talbot terrace
 - 8-25 Palmetto terrace
 - Less than 1-10 Silver Bluff terrace

See Table 1 for topographic relief, shoreline elevations and origin for specific areas.

