

INTRODUCTION

The recent great interest in the petroleum potential of the South Atlantic Continental Shelf has prompted a reconnaissance study by the U.S. Geological Survey of the subsurface Mesozoic and Cenozoic sediments of the South Carolina and Georgia coastal margins. This study has significantly increased the available stratigraphic data for this area by providing lithologic data from cores and cuttings, fossils, and (or) geophysical logs from a number of previously undescribed water wells, oil tests, and stratigraphic tests. The purpose of this study is to provide a generalized stratigraphic framework that can serve as a starting point for more detailed stratigraphic studies of both the emergent and submerged parts of the South Atlantic Coastal Plain.

This report describes the distribution of Cretaceous sediments along the South Carolina coastal margin. Cross sections employing in-hole geophysical logs have been used to illustrate the distribution of the major stratigraphic units. The units described are of approximately equivalent rank. Formational names have not been used, however, to avoid discussions of stratigraphic nomenclature and to avoid the necessarily tenuous correlation of subsurface and outcrop units. Ages of the units shown on the cross sections are given where they are known in specific boreholes.

Locations of samples containing stratigraphically significant planktonic foraminifers, calcareous nanofossils, and (or) pollen are shown for each well log. The locations of studied samples containing other fossil groups in boreholes 6 are not shown. Fossiliferous samples shown in borehole 9 were not examined during the present study. Mollusks were examined from the samples shown in borehole 5. Names, locations, and similar data for each borehole are given in table 1.

STRATIGRAPHIC UNITS

The Cretaceous System in the subsurface of the South Carolina coastal margin consists almost entirely of Upper Cretaceous (Gulfian) sediments. The data from the 10 studied wells indicate that sediments of late Cenomanian to middle Maastrichtian (Anguliferian to Navarrian) Age occur in the subsurface across South Carolina from southern North Carolina to the Georgia border. Within this sequence, sediments of Turonian and Coniacian Age are conspicuously absent. No Early Cretaceous or older fossils were found in the studied wells. Although unit K<sub>1</sub>

is unfossiliferous within the study area, all of the stratigraphic units described in this report have been assigned a Late Cretaceous age. The upper Cretaceous sediments thicken about 30 percent from borehole 1 on the Cape Fear Arch to boreholes 9 and 10 located closer to the axis of the Southeast Georgia Embayment.

**Unit K<sub>1</sub>**  
Unit K<sub>1</sub> was encountered only in borehole 6, where it overlies pre-Cretaceous basalt, and in borehole 9. Thicknesses of K<sub>1</sub> in these two holes suggest a southwest-thickening of the unit. Unit K<sub>1</sub> primarily consists of red or brown, moderately to poorly sorted, feldspathic, fine- to very coarse grained quartzose sand and red-, gray-green-, or brown-mottled sandy or silty clay. Sand and clay are interlayered in 1-3 m beds in the upper half of the unit in borehole 9 and are more thinly bedded in the bottom half of K<sub>1</sub> in borehole 6. Unit K<sub>1</sub> contains common basalt clasts in borehole 6.

No fossils were found in unit K<sub>1</sub> in the boreholes studied for this report, and fossils have never been reported from this unit in South Carolina. The sediments from borehole 9 included here in unit K<sub>1</sub> were assigned by Applin and Applin (1947) to the lower member of their Atkinson Formation; these sediments were redefined as the lower part of the lower member of the Atkinson Formation by Applin (1955) and by Applin and Applin (1967). Applin and Applin (1967) correlate the beds of unit K<sub>1</sub> in South Carolina and eastern Georgia with fossiliferous beds of their lower member of the Atkinson Formation, which they consider to be middle Cenomanian (Woodbinian) in age, in southern Georgia and peninsular Florida. However, Hazel (1969) has pointed out that the lower part of the Atkinson contains microfossils that indicate an early Eocene age. On the basis of the tentative correlation of unit K<sub>1</sub> with at least part of this fossiliferous section in Georgia and Florida, unit K<sub>1</sub> is assigned a late Cenomanian (early Eocene) age.

**Unit K<sub>2</sub>**  
Unit K<sub>2</sub> is a relatively thin but laterally persistent unit encountered in boreholes 6, 8, and 9. K<sub>2</sub> has been tentatively identified in boreholes 2 and 4 solely on the basis of electric log signature. Unit K<sub>2</sub> contains a variety of lithologies including gray, glauconitic, fossiliferous, quartzose limestone or calcareous sand; gray, sandy or silty, calcareous, fossiliferous clay; and thinly interbedded fine-grained sand and clay. Mollusks,

benthonic and planktonic foraminifers, ostracodes, lignite fragments, mica, and pyrite are common constituents of all these lithologies. Planktonic foraminifers (61<sup>1</sup>), benthonic foraminifers (9), and pollen (6, 8) indicate a late Cenomanian (early Eocene) age for unit K<sub>2</sub>.

**Unit K<sub>3</sub>**  
Unit K<sub>3</sub> is a readily identifiable sequence of sparingly fossiliferous, red- or brown-mottled sand and clay that occurs between the fossiliferous gray-colored sediments of units K<sub>2</sub> and K<sub>4</sub>. Unit K<sub>3</sub> was identified in 9 of the 10 boreholes. Unit K<sub>3</sub> consists of moderately to poorly sorted, feldspathic, noncalcareous, red-, green-, and brown-mottled quartzose sand and silty clay, and glauconitic, calcareous, muddy fine- to medium-grained quartzose sand. Units K<sub>3</sub> and K<sub>4</sub> could not be differentiated in either the cuttings or on the geophysical logs from boreholes 1-4. In these holes the sediments above unit K<sub>3</sub> are generally more typical of unit K<sub>4</sub> than unit K<sub>3</sub>.

Sparse planktonic foraminifers in borehole 6 indicate a late Cenomanian (early Eocene) age for unit K<sub>3</sub>. Very sparse planktonic foraminifers in borehole 2 questionably indicate the same age. This age is compatible with the ages found for unit K<sub>3</sub> and K<sub>4</sub>.

**Unit K<sub>4</sub>**  
Unit K<sub>4</sub> is a lithologically heterogeneous sequence of fossiliferous sediments that was penetrated by all the studied boreholes. Typical lithologies in unit K<sub>4</sub> include gray, calcareous, silty clay, in some instances thinly interbedded with fine-grained quartzose sand; gray, poorly sorted, calcareous, muddy, macrofossiliferous, fine- to medium-grained sand; well-sorted, medium- to coarse-grained quartzose sand; and fine-grained calcareous sand or quartzose limestone. Mollusks, microfossils, lignite, glauconite, phosphate, and mica are common constituents of these lithologies.

Foraminifers (2, 3, 6, 8, 9), pollen (1, 2, 3, 6, 8), ostracodes (6), mollusks (5, 6), and dinoflagellates (6) indicate a Turonian to possibly earliest Campanian (Austinian) Age for unit K<sub>4</sub>. Specific fossil evidence for Turonian and Coniacian (middle Eocene) ages from lower Austinian sediments was not found in any of the studied boreholes. As noted by Hazel and others (1977, fig. 3), the Turonian and Coniacian Stages are typically missing throughout most of the Atlantic Coastal Plain. Accordingly, the boundary between units K<sub>3</sub> and K<sub>4</sub> represents a major unconformity within the Upper Cretaceous section.

**Unit K<sub>5</sub>**  
Unit K<sub>5</sub> is characterized by relatively thick sequences (about 15-45 m) of sediments that are internally homogeneous with respect to lithology and bedding types. The sediments in some of these thick sequences also tend to be textural "end-member" types such as well-sorted quartzose sand or silty clay. This sediment packaging is in contrast to unit K<sub>4</sub> in which very different lithologies are interlayered in thin to moderately sorted. Typical sediments in unit K<sub>5</sub> include: well-sorted, calcareous, fine- to medium-grained quartzose sand; calcareous silty clay; and glauconitic, calcareous, muddy fine- to medium-grained quartzose sand. Units K<sub>5</sub> and K<sub>6</sub> could not be differentiated in either the cuttings or on the geophysical logs from boreholes 1-4. In these holes the sediments above unit K<sub>4</sub> are generally more typical of unit K<sub>5</sub> than unit K<sub>4</sub>.

Foraminifers (2, 3, 6, 8, 9), calcareous nanofossils (3), ostracodes (6), mollusks (6), pollen (3, 6), and dinoflagellates (6) indicate a Campanian, probably early Campanian (late Austinian to early Taylorian) Age for unit K<sub>5</sub> and for part of combined unit K<sub>5</sub>-K<sub>6</sub>.

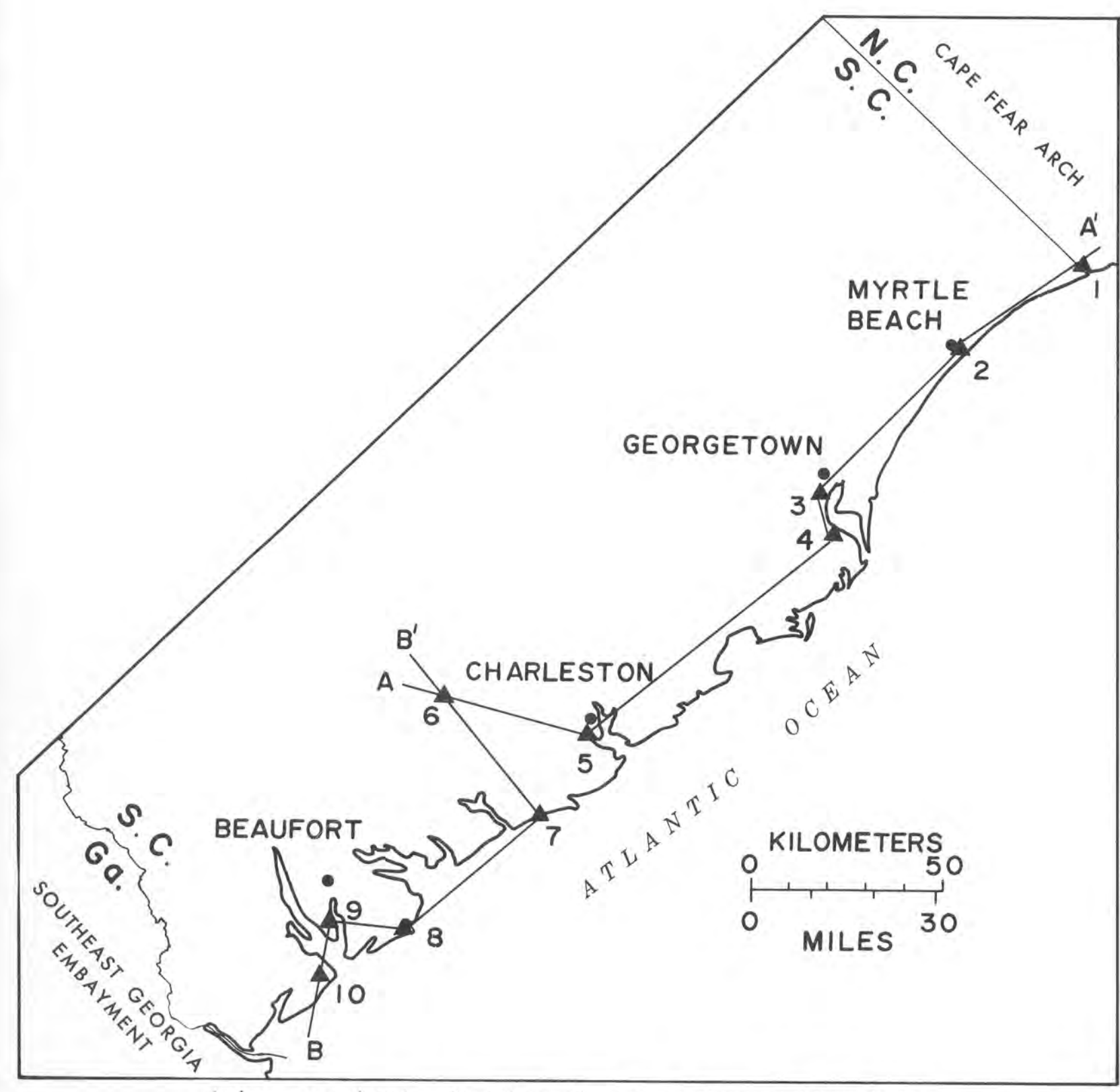
**Unit K<sub>6</sub>**  
Unit K<sub>6</sub> is a homogeneous sequence of poorly sorted marine sand and clay encountered in all of the boreholes. Typical lithologies include gray, calcareous, fossiliferous clay and gray, glauconitic, calcareous, fine- to medium-grained muddy sand that locally contains sufficient megafossils to warrant the use of the term quartzose fossiliferous limestone. Bedding in unit K<sub>6</sub> is typically thick or absent, and the unit as a whole is massive and lithologically uniform.

Foraminifers (2, 3, 6, 8, 9), calcareous nanofossils (3), ostracodes (6), mollusks (5, 6), pollen (3, 6), and dinoflagellates (6) indicate a Campanian, probably late Campanian, to middle Maastrichtian (late Taylorian to Navarrian) Age for unit K<sub>6</sub> and part of combined unit K<sub>5</sub>-K<sub>6</sub>.

1/ Numbers in parentheses indicate boreholes in which fossils were found.

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Index map showing locations of cross sections and boreholes

Borehole number and name	Approximate location	Total depth (ft)	Approximate elevation (ft)	Source of log data	Published data
1 Calabash	33° 13' N, 79° 13' W	4070	48 (14.6)	G.S.C.	
2 Myrtle Beach 18th Avenue	33° 42' N, 79° 24' W	1428 (436)	25 (7.6)	G.S.C.	
3 Penny Royal	33° 02' N, 79° 04' W	1441	15 (4.6)	G.S.C.	
4 Esterville Plantation	32° 52' N, 79° 10' W	1835 (561)	18 (5.5)	G.S.C.	
5a Charleston Consolidated Railway and building	32° 50' N, 79° 10' W	1612	5 (1.5)	F	Stephenson (1914). Data combined with log from nearby (5b)
5b Charleston Medical Center	32° 50' N, 79° 10' W	2078 (634)	10 (3.0)	G.S.C.	
6 N.E.C.R. Clubhouse Crossroads No. 1	32° 52' N, 79° 10' W	2599 (792)	20 (6.1)	G.S.C.	Hazel and others (1977). See and others (1977)
7 Elsieh Island	32° 52' N, 79° 10' W	2287 (694)	10 (3.0)	G.S.C.	Zupan and Abbott (1976)
8 Fripp Island	32° 52' N, 79° 10' W	2168 (666)	5 (1.5)	G.S.C.	Zupan and Abbott (1976)
9 Myrtle Island No. 2	32° 52' N, 79° 10' W	3454 (1053)	10 (3.0)	F	Wise (1961), Slig (1965, 1969), G.S.C. data files
10 Hilton Head Island	32° 52' N, 79° 10' W	2900 (885)	5 (1.5)	G.S.C.	Zupan and Abbott (1976)