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CONTENTS

NOTES ON THE KINGS MOUNTAIN BELT IN LAURENS COUNTY, SOUTH CAROLINA[1]

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During the course of road traverses in Laurens County, South Carolina, in May 1960, we observed a belt of rocks with striking similarities to the Battleground schist of Precambrian (?) or Paleozoic (?) age of the Kings Mountain belt in Cherokee and York Counties, South Carolina (Keith and Sterrett, 1931, maps). The outline of this belt of probable Battleground schist in Laurens County is shown on figure 1.

The belt of rocks consists of fine-grained sericite phyllite, muscovite-quartz schist, biotite-muscovite schist, garnet-muscovite schist and some hornblende schist. The foliation of the schist is conformable with that of fine-grained feldspathic gneiss, gneissic granite, and hornblende schist to the southeast and northwest of the belt. The foliation trends northeastward and dips 15° to 40° toward the southeast. Linear features such as elongate clusters of muscovite or sericite on the foliation planes and the axes of small folds strike toward the southwest or south-southwest and plunge about 30° in that direction. Between Clinton and Laurens the belt of schist and adjacent rocks trends more easterly and the foliation strikes N. 60° E. to N. 80° E. with southward dips that rarely exceed 35°. Southwest of Laurens the belt again strikes northeast as do the rocks on either side. Several diabase dikes cut across the schist. Figure 1 shows three of these dikes and a mass of granite near the center of the belt. Other granite bodies, small dikes, sills and lit-par-lit layers intrude the schist, particularly southwest of Laurens and at the Saluda River, but none were separately mapped by us.

This belt of rocks appears to have been originally pelitic sediments with sparse interbedded thin layers of mafic volcanic rocks and very thin discontinuous lenses of carbonate rock. The sediments have been metamorphosed to different degrees in different parts of the belt and little of their sedimentary structure can now be seen. A distinctive sedimentary feature, however, is preserved as several layers of manganese-rich muscovite schist. This manganese-rich schist is discontinuously exposed along the three lines marked by Mn on figure 1. In the abundance of manganese these layers resemble the manganese schist member of the Battleground schist (Keith and Sterrett, 1931, p. 4-5) in

1/ Publication authorized by the Director, U. S. Geological Survey

Cherokee and York Counties, but in Laurens County the layers are higher in metamorphic grade.

The manganese schist in Laurens County consists of medium-to coarse-grained garnetiferous muscovite-quartz schist in layers from 1 to 2 inches to $2\frac{1}{2}$ feet thick. In deeply weathered exposures the garnets, which are the manganese-rich variety, have altered to clots of manganese oxides. These clots project slightly above the surface of the rock and resemble scattered pepper-corns. In and about the garnet-rich layers, manganese oxides, apparently derived locally as the schist weathered, have penetrated fractures, joints, pores, and openings. These weathered garnet-rich layers have a conspicuous distinct dull black sooty appearance. The total number of manganese-rich layers is not known, but along the three lines of manganese schist shown on figure 1 from two to five garnet-rich layers were seen at each exposure. In the northernmost line shown on figure 1 the garnets are weathered to black clots, but there is no extensive black-stained schist.

The association of manganese-rich layers with metamorphosed sedimentary rocks, the sheet-like occurrence, and the thin interlayering of manganese-rich layers with dissimilar rocks suggest to us that the manganese was deposited with the original sediments. During metamorphism many manganese garnets formed in the manganese-rich layers. When the metamorphic rocks were exposed to weathering the manganese was released from the garnets and formed the dense network of stains, veinlets, and pockets that now bestow the characteristic black and sooty appearance to the manganese schist.

The manganese-rich schists in Laurens County occupy a nearly central position in the belt of muscovite schist. The strikes of the three lines of manganese-rich schist shown on figure 1 are not quite parallel. The lines of schist appear to be merging toward the southwest and opening toward the northeast as if the schist is folded into a southwestward-plunging anticline. If the manganese-rich schist occupies an anticline, it is then part of the lower sediments in the belt of muscovite schist that passes through Laurens County. However, interbedded rather than folded relations may produce the distribution observed for the manganese schist. Its actual stratigraphic position is unknown.

The manganese schist member is the topmost unit in the Battleground schist in Cherokee and York Counties (Keith and Sterrett, 1931, map). The similarity in lithology of the manganese-rich schists in Laurens County to the lithology of the manganese schist member of the Battleground schist in Cherokee and York Counties favors the interpretation that

THE MUSCOVITE SCHIST IN LAURENS COUNTY IS THE EQUIVALENT OF THE BATTLEGROUND SCHIST, BUT THE STRATIGRAPHIC POSITION OF THE MANGANESE SCHIST IN LAURENS COUNTY IS NOT KNOWN.

AT THE ENOREE RIVER THE GRADE OF METAMORPHISM OF THE BELT OF SCHIST IN LAURENS COUNTY CORRESPONDS TO THE BIOTITE-CHLORITE SUBFACIES OF THE GREENSCHIST FACIES (TURNER, 1948, P. 94), BUT THE GRADE INCREASES TO THE SILLIMANITE-ALMANDINE SUBFACIES OF THE AMPHIBOLITE FACIES (TURNER, 1948, P. 85-87) BETWEEN LAURENS AND THE SALUDA RIVER.

SERICITE PHYLLITE, MUSCOVITE-QUARTZ SCHIST, AND BIOTITE-MUSCOVITE-QUARTZ SCHIST ARE EXPOSED IN THE BELT BETWEEN THE ENOREE RIVER AND DUNCAN CREEK. SOUTHWEST OF DUNCAN CREEK THE SERICITE PHYLLITE IS ABSENT.

GARNET-FREE MUSCOVITE-QUARTZ SCHIST AND BIOTITE-MUSCOVITE-QUARTZ SCHIST ARE COMMON WITHIN THE BATTLEGROUND SCHIST BETWEEN DUNCAN CREEK AND CLINTON. CALC-SILICATE LAYERS, AS MANY AS FIVE IN ONE SMALL ROAD CUT BUT NONE MORE THAN 2 INCHES THICK, ARE EXPOSED ON S. C. 46 WEST OF CLINTON. ALONG THE SAME ROAD JUST NORTH OF THE INTERSECTION OF S. C. 265 A MASS OF VERMICULITE AND PEGMATITE IS EXPOSED IN AN OPENING IN HORNBLENDE SCHIST.

GARNETS APPEAR IN THE MUSCOVITE SCHIST EXPOSED ALONG U. S. ROUTE 76 BETWEEN CLINTON AND LAURENS (GARNET LOCALITIES ARE INDICATED BY G ON FIGURE 1). WITH THE FIRST APPEARANCE OF GARNETS THERE IS AN INCREASE IN THE ABUNDANCE OF THIN STRINGERS OF PEGMATITE AND THIN DIKES AND SILLS OF GRANITE IN THE SCHIST. GRANITOID ROCKS BECOME INCREASINGLY ABUNDANT TOWARD THE SOUTHWEST.

KYANITE IS A COMMON CONSTITUENT OF THE MUSCOVITE AND BIOTITE SCHISTS SOUTH OF LAURENS (KYANITE LOCALITIES ARE SHOWN BY K ON FIGURE 1). THE COARSEST KYANITE WE FOUND OCCURS IN 2 TO 3 INCH THICK LAYERS OF MUSCOVITE SCHIST AND BIOTITE SCHIST IN THE CUT ALONG THE CHARLESTON AND WESTERN CAROLINA RAILROAD WEST OF S. C. 42, ON THE SOUTHERN OUTSKIRTS OF LAURENS. THE KYANITE FORMS TRANSLUCENT TO OPAQUE, GRAY BLADES, SHEAVES, AND RADIAL AGGREGATES WITH INDIVIDUAL BLADES AS LARGE AS 1/16"x1/4"x3/8". ALTERATION OF THE KYANITE TO SERICITE IS QUITE MINOR.

SILLIMANITE NEEDLES, COMMONLY ALTERED TO SERICITE, REPLACE MUSCOVITE IN EXTENSIVELY PEGMATIZED GARNETIFEROUS MUSCOVITE SCHIST WEST ALONG S. C. 6 FROM COLD POINT TO THE SALUDA RIVER (SILLIMANITE LOCALITIES ARE SHOWN BY S ON FIGURE 1). LAYERS OF HORNBLENDE SCHIST IN AND WEST OF SILLIMANITE SCHIST ON S. C. 6 JUST SOUTH OF THE REEDY RIVER CONTAIN SPINDLE-SHAPED MASSES OF SERICITE, MUSCOVITE, AND PINNITE (?) PSEUDOMORPHIC AFTER CORUNDUM CRYSTALS. THE SPINDLE-SHAPED MASSES

ARE UP TO AT LEAST 24 INCHES IN LENGTH AND ARE SLIGHTLY FLATTENED IN THE PLANE OF FOLIATION OF THE SCHIST. THE CROSS-SECTIONAL DIMENSIONS OF A MASS $2\frac{1}{4}$ INCHES LONG ARE 3/4" x 1/2". RATHER COARSE MUSCOVITE APPEARS TO BE THE DOMINANT REPLACING MINERAL. THE PRESENCE OF SILLIMANITE IN THE SCHISTS DERIVED FROM PELITIC SEDIMENTS OR DERIVED FROM DEEPLY WEATHERED RESIDUUM ON THE TOPS OF BASALTIC FLOWS, AND CORUNDUM IN SCHISTS DERIVED FROM MAFIC VOLCANIC ROCKS ATTESTS THE HIGH METAMORPHIC GRADE OF THE BELT IN SOUTHERN LAURENS COUNTY. EXTENSIVE RETROGRESSIVE METAMORPHISM, EVIDENT IN THE SERICITE REPLACING SILLIMANITE AND MUSCOVITE REPLACING CORUNDUM, IS A WIDESPREAD CONDITION IN THE SOUTHEASTERN PIEDMONT AND NOT UNIQUE TO THIS BAND OF SCHIST.

FROM LAURENS COUNTY THIS BELT OF SCHIST CAN BE TRACED ACROSS GREENWOOD AND ABBEVILLE COUNTIES, SOUTH CAROLINA, INTO GEORGIA. THE METAMORPHIC GRADE DECREASES TOWARD GEORGIA TO A SERICITE PHYLLITE AT THE SAVANNAH RIVER. FROM THE ENOREE RIVER TO THE SAVANNAH RIVER, THEREFORE, THE METAMORPHIC GRADE OF THE BELT APPEARS TO INCREASE ALONG STRIKE FROM GREENSCHIST TO UPPER AMPHIBOLITE FACIES AND TO DECREASE AGAIN TO GREENSCHIST FACIES. WE INFER THAT FROM LAURENS TO ABBEVILLE COUNTIES REGIONAL METAMORPHIC ISOGRADS ARE STRONGLY DEVELOPED ACROSS THE STRIKE OF THE BATTLEGROUND SCHIST AND THAT THE KINGS MOUNTAIN BELT CAN BE TRACED THROUGH SUCCESSIVE LEVELS OF METAMORPHISM.

SHOULD THOROUGH TEST PROVE THIS INTERESTING AND RARE GEOLOGIC SITUATION, THEN THE APPARENT ABSENCE OF THE KINGS MOUNTAIN BELT BETWEEN CATAWBA AND YADKIN COUNTIES, NORTH CAROLINA (STUCKEY AND CONRAD, 1958, MAP), AND THE DISAPPEARANCE OF THE LITTLE RIVER SERIES SOUTHWEST OF PUTNAM COUNTY, GEORGIA (STOSE AND SMITH, 1939, MAP), MAY BE DUE TO SIMILAR DISCORDANCE BETWEEN REGIONAL METAMORPHISM AND STRATIGRAPHY.

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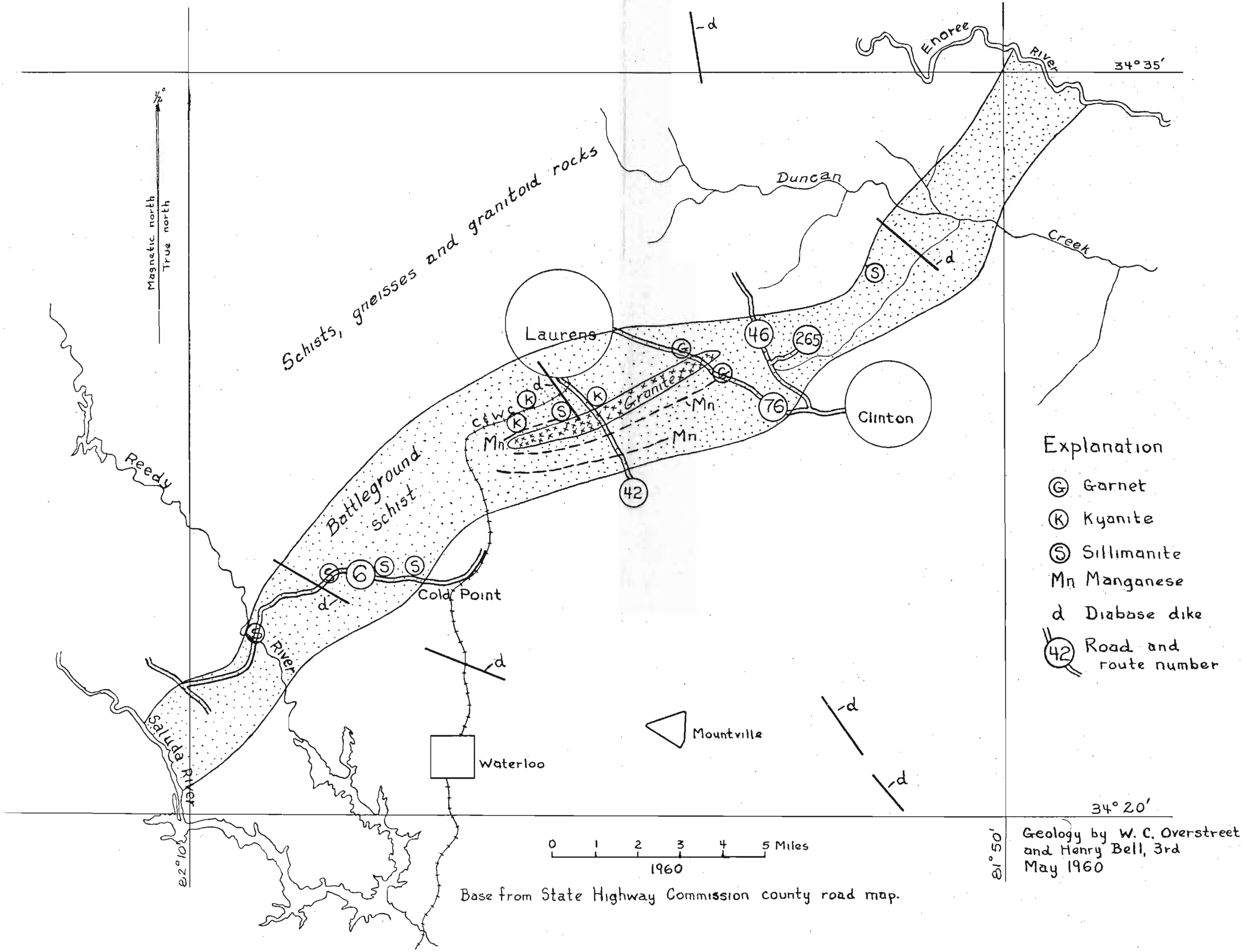

FIGURE 1. SKETCH MAP SHOWING THE LOCATION OF THE BATTLEGROUND SCHIST IN LAURENS COUNTY, SOUTH CAROLINA

NOTES ON THE CALCIUM CARBONATE CONTENT OF THE SANTEE LIMESTONE

By

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The Santee Limestone is the most important lime-bearing formation in South Carolina. It contains the largest tonnage of uniform high-quality limestone that is readily available for mining. This article is intended as a brief summary of the chemical character of the formation. More detailed information will be presented in a bulletin now being prepared.

The Santee Limestone occurs near the surface or at shallow depth in parts of eight South Carolina Coastal Plain counties (Figure 1).

More than 175 chemical analyses are available from many different locations within the outcrop area. Some of the analyses are given by Sloan (1908, p. 378-379) but the majority come from private reports in the files of the Division of Geology, S. C. State Development Board.

The calcium carbonate content of the Santee Limestone is uniform over a wide area and even through much of the thickness of the formation. Calcium carbonate contents from four widely scattered localities (Figure 1) are as follows:

Sample No.	Location	Elevation of Sample	$CaCO_3$ (%)
2	Jenkins Hill, 6 mi. NE of Orangeburg	Near 200'	96
3	Webb's Creek on Lake Marion	45'-65' zone	90-95
4	Carolina Giant Cement Co. pit at Harleyville	0-45'	96
5	Average of 1 mile of Santee River bluff, north of Jamestown, Berkeley County	15'	94

Only a moderate vertical variability in the calcium carbonate content of the limestone is shown by the many samples obtained from drill holes. Near the base of the formation the carbonate content decreases as the formation becomes a little more glauconitic, but there is not necessarily a general steady decrease of carbonates

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at depth. For example, the samples from the many holes drilled at Webb's Creek (located near Milligans in Orangeburg County) show an increase and then a decrease in calcium carbonate with depth. An average analysis from 6 widely spaced holes within the Webb's Creek area that passed through a total of 306 feet of limestone (51 feet per hole) is as follows:

Fe_2O_3	Al_2O_3	CaO	MgO	SiO_2	$CaCO_3$
1.49	0.80	48.98	0.78	8.84	87.39

However, at an elevation above 65 feet the limestone has a rather constant composition of 84% $CaCO_3$, in the 45-65 foot elevation zone the $CaCO_3$ content is 90 to 95%, and below 40 feet elevation the calcium carbonate falls rapidly to as low as 67% in the 26-16 foot elevation zone.

Near the top of the formation in the Holly Hill-Harleyville area the carbonate content appears to be the highest and perhaps the most uniform. The Santee Limestone (this includes the so-called Castle Hayne Limestone) in the pit of the Carolina Giant Cement Company averages 96% calcium carbonate. From 7 holes drilled on what was the McCoy Farm (three miles southwest of Holly Hill) 479 feet of limestone was sampled and analyzed. Each analysis represents approximately 15 feet of limestone. An average chemical composition for the 479 feet is as follows:

Fe_2O_3	Al_2O_3	CaO	MgO	SiO_2	Loss	Total	$CaCO_3$
0.71	1.04	53.1	0.85	2.92	41.05	99.66	94.73

The $CaCO_3$ content is highest in the 20-65 foot depth zone, averaging near 96%. Below about 65 feet depth it falls to a little below 90%. The overburden at this locality is less than 20 feet.

West of the town of Orangeburg the Santee Limestone changes laterally into the McBean Formation, a glauconitic sand. Drill hole data indicates the change is very abrupt with little intergradation of limestone with sand. A sample taken within 1 to 2 miles of the contact (see No. 1, Figure 1) from an auger drill hole at a depth of 50 feet (elevation 125 feet) still contained 70.6% calcium carbonate.

Impurities in the Santee Limestone are mostly quartz and clay. There is only a nominal amount of magnesium carbonate (usually less than 1-2 percent) or calcium phosphate (usually less than 1 percent).

THE SANTEE LIMESTONE IS NOW BEING USED AS A RAW MATERIAL IN THE MANUFACTURE OF PORTLAND CEMENT. IT IS POTENTIALLY A SOURCE OF HIGH-CALCIUM LIME FOR THE CHEMICAL OR FIBER GLASS INDUSTRIES.

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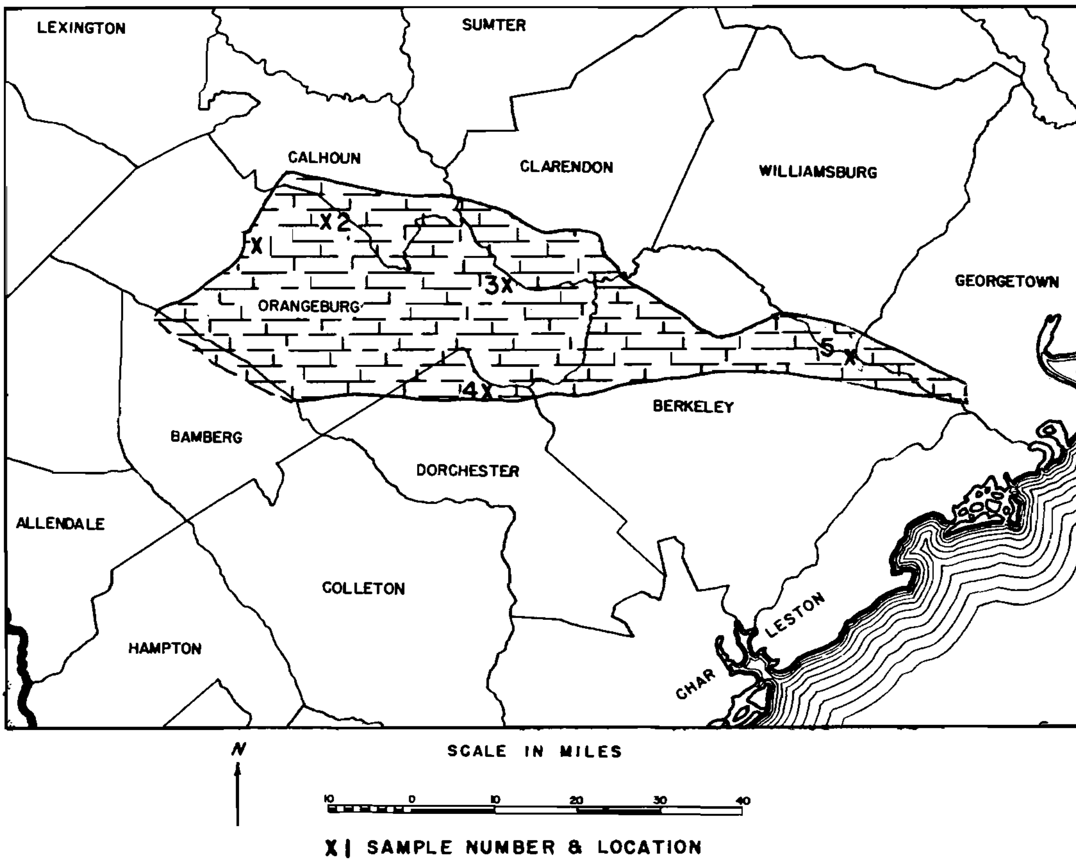

FIGURE 1. AREA UNDERLAIN BY THE SANTEE LIMESTONE AT DEPTHS LESS THAN 50 FEET.

EXPLORATION FOR HEAVY MINERALS ON HILTON HEAD ISLAND, S. C.

By

Camilla K. McCauley

ABSTRACT

In 1954 and 1955 the U. S. Bureau of Mines and the National Lead Company made independent investigations to evaluate the deposits of heavy minerals on Hilton Head Island, one of the sea islands, in Beaufort County, S. C. The island is $12\frac{1}{4}$ miles long and $5\frac{1}{4}$ miles wide at its maximum width and has an area of $42\frac{1}{2}$ square miles.

The U. S. Bureau of Mines drilled 265 holes, of which only 17 percent disclosed a heavy mineral content of 3 percent or more. Analysis revealed an average heavy mineral content of 2.19 percent to a minable depth of 11.1 feet.

The National Lead Company drilled 545 holes. Of these, 20 percent had a heavy mineral content of 3 percent or more, based on an average minable depth of 10 feet. The average percentage of heavy minerals in the top 10 feet was 2.14 percent.

Mineralogical analyses made by the U. S. Bureau of Mines on composite samples of heavy mineral concentrates revealed the following major components: ilmenite, 35.0 percent; zircon, 11.7 percent; rutile, 5.5 percent; and monazite, 1.43 percent.

It is estimated that there are at least 8,226,000 tons of heavy minerals on Hilton Head Island over an area of 18,000 highland acres. The richest deposits are along the northern half of the beach and adjacent foredune where the average heavy mineral content was 7.87 percent.