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RADIOCARBON DATES FROM BOTANY BAY ISLAND, SOUTH CAROLINA[1/]

By

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INTRODUCTION

Marine invertebrate specimens collected from wave-cut foredunes along Botany Bay Island, South Carolina, were recently radiocarbon dated by Meyer Rubin of the Isotope Geology Branch of the United States Geological Survey. The sample locations are shown in Figure 1 and derived dates are listed below:

U. S. G. S. Lab. No.	Description	Radiocarbon Age (Years B. P.)
W-1041	Pelecypod Shells	1,550 ± 300
W-1042	Pelecypod Shells	2,100 ± 300

The spatial occurrence of this shell material as horizontal bands in stable wave-cut foredunes along an eroding shoreline is unique for the South Carolina coast, and radiocarbon dating of these shells affords correlation with eustatic oscillation of sea level data in Recent time. It is inferred that the pelecypod shells, which occur approximately 3.7 feet above the present MHW mark, became part of the accretion material in the normal beach building process at a time when the sea level stood near or slightly above the present sea level. It will be shown that the accretion of the shells by water agencies into bands along the upper beach probably occurred during the marine transgression following the "Florida Emergence".

DESCRIPTION OF SAMPLE LOCATIONS

Botany Bay Island occurs along the southern South Carolina coast and is about 5 miles long, up to 200 yards wide, and separated from Edisto Island by a half-mile tidal marsh area (Figure 1). The tidal beach area is generally 250 feet wide with gentle slope and contains a hard surface locally interrupted by mud flats and tree stumps. Shell fragments, ferruginous and phosphatic pebbles, and an occasional mammal bone occur admixed with the quartz sand and characterize the beach area.

1/ Publication approved by U. S. Army Corps of Engineers

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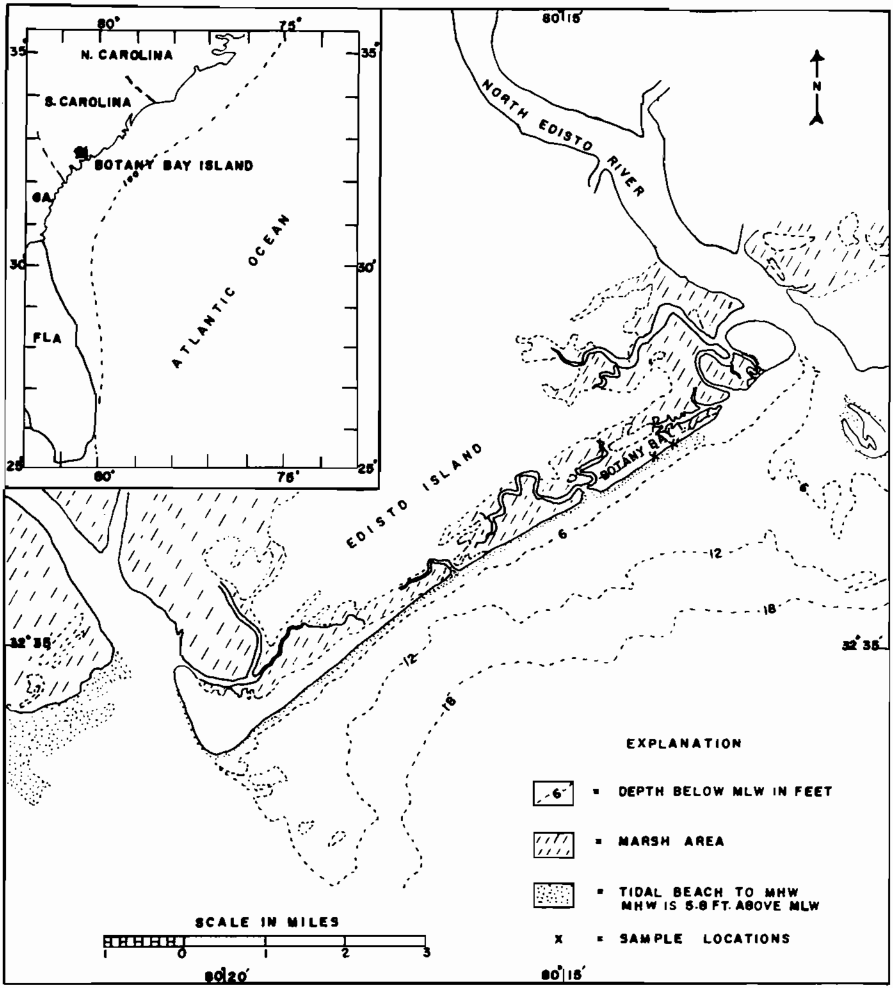

FIGURE 1. INDEX MAP AND LOCALITY CHART OF BOTANY BAY ISLAND, SOUTH CAROLINA, SHOWING LOCATIONS OF RADIOCARBON DATED SHELL SAMPLES.

Heavily vegetated wave-cut foredunes with aprons of sand and shell admixtures comprise the backbeach area which extends into the tidal marsh. The Botany Bay beach area, containing these unique assemblages of materials, is unlike any other area of the South Carolina coast and presents a bleak desolate appearance.

Botany Bay Island is currently undergoing rapid erosion as shown by historic survey charts and as observed by trees extending into the littoral zone. Historic charts and measured shoreline changes, shown in Figure 2, graphically portray these changes since 1785. The mean high water shoreline changes, compiled by Beach Erosion Board, May 1948, are more accurate than the historic charts of earlier dates. From this survey, it is apparent that a considerable portion of the island has been eroded since 1851; indeed since that time portions of beach have been completely obliterated with intervening stretches of tidal marsh and mud flats.

Sample location W-1041 occurs about 2.4 miles from the North Edisto River and sample location W-1042 is about 600 yards northeast of this site (Figure 1). The pelecypod shell bands at both locations occur in the lower third of wave-cut foredunes. The shells in these 3 to 5 inch thick bands are well preserved, average about 3 inches in length, and occur both in concave-up and concave-down positions with long dimensions parallel to bedding. The sands below the shell layer and several inches above contain thin, black, laminations of heavy minerals in essentially horizontal attitude. From the densely vegetated dune crest to several inches above the shell bands, heavy-mineral laminations dip at various degrees of inclination from the horizontal indicating that aeolian agencies are responsible for the upper portion of the dune; the horizontal attitude at dune base would appear to indicate water deposition along the upper beach area.

Sample W-1041 was collected by the writer in the summer of 1958 and sample W-1042 was collected in 1959. Elevation measurements on sample W-1041 are not accurately known since hurricane waters of 26 September 1958 removed most of this dune prior to the second collection period when accurate elevation control techniques were employed. The elevation to the base of the pelecypod shell band at sample location W-1042 is 9.5 feet above the mean low water mark.

The nearest known U. S. Coast and Geodetic tide recorder to the area is situated in Bohicket Creek about 3 miles above the mouth of North Edisto River. Records of this tidal gauge indicate a mean tide range of 5.8 feet and a spring tide range of 6.8 feet above mean low water.

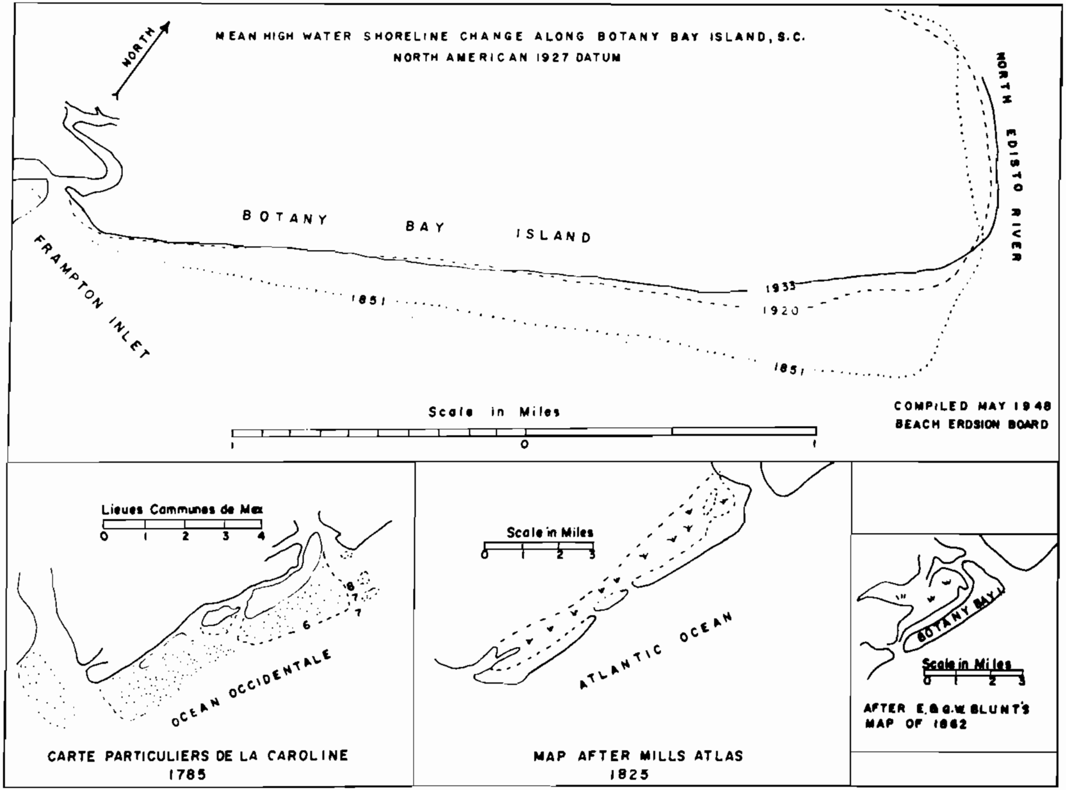

FIGURE 2. HISTORIC AND SHORELINE CHANGES OF BOTANY BAY ISLAND, SOUTH CAROLINA.

Since the shell bands at sample location W-1042 occur 3.7 feet above mean high water, it is suggested that the shells were deposited by water agencies along the upper beach at a time of (a) slightly higher mean sea level or (b) during storm conditions attended by higher than normal tidal range. Absolute correlation of sea level elevation at the time of deposition is speculative; however, it will be shown that the shell deposits appear to be in accord with available data on the eustatic oscillation of sea level.

CORRELATION TO EUSTATIC RISE OF SEA LEVEL

The eustatic changes of sea level are directly related to the total volume of ice on the continents and thus provide a reliable means for world wide correlation of techtonically stable shorelines. According to McFarlan (1961, p. 147), radiocardon dating of late Quaternary Formation deposits in Louisiana show clearly that ice sheets of the last major glaciation not only reached their maximum development but began to retreat before 35,000 years ago. His data indicates that the final stage of retreat began about 18,500 years ago and virtually ended 5,000 years ago. McIntire (1962) cites radiocarbon dates of 3,000 to 5,000 years B.P. for accretion ridges inland from the coast; on the basis of peat assays from Plum Island, Massachusetts, he interprets 3400 B.P. as the approximate time of sea still stand in Recent time.

Fairbridge (1958, p. 477) has compiled a correlation chart and graph of sea level oscillations of the last 12,000 years based on radiocarbon dates. Part of this graph for the last 2700 years is depicted in Figure 3. The radiocarbon dates from Botany Bay Island (1,550 and 2,100 B.P.) appear to correlate with the time of the Florida Emergence if analytical error of 300 years is applied to radiocarbon dating techniques.

According to Per Bruun (1962, p. 5), the Florida Emergence had sea-level elevations approximately 2 meters below present sea level and probably added 1/8 mile to 1 mile to the general Florida shores depending on offshore bottom slope. The Florida Emergence is so named because of excellent examples found there. Roman coastal structures in the Mediterranean also suggest a low sea level at that time and, climatically, the Florida Emergence coincides with a universal cool phase.

The radiocarbon dates of Botany Bay Island appear to coincide with the Florida Emergence when the sea level stood at a lower elevation. The pelecypod shells were probably formed offshore at that time within their 3 meter depth ecologic range. The shells were probably transported to the beach by water agencies during the marine transgression, shown on the chart, which occurred between 945 and 1400 B. P. Figure 3 also

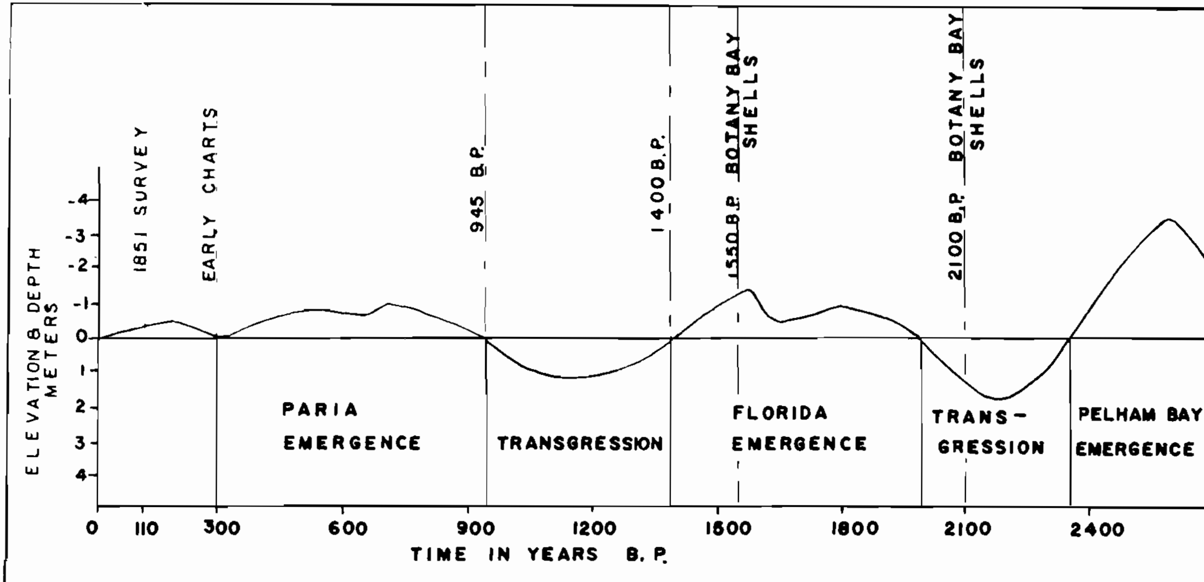

Figure 3. Eustatic oscillation of sea level curve showing correlation of radiocarbon dated samples from Botany Bay Island, South Carolina. Curve after Fairbridge (1958).

shows a rise of sea level of more than 1.5 meters which would appear to correlate with a slightly higher elevation of sea level during deposition of the Botany Bay shell samples. The graph shows no transgression period after 945 B. P.; since then the fluctuations have been minor with near present sea level conditions again during the early colonization period of America.

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SOUTH CAROLINA BENTONITE AS AN EXTRUSION AID

By

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INTRODUCTION

Recent years have seen a very large increase in production of light colored face brick in the Southeastern States. This region does not have the plastic fire clays that are common in the Mid-west and in Pennsylvania, and it has therefore been necessary to develop new compositions for the Southeast. Combinations of kaolin and sericite, raw materials which are relatively abundant in the Southeast, have produced light colored face brick. The kaolin-sericite composition has the disadvantages of low plasticity, low dry strength, and high maturing temperatures. The industry would benefit greatly from additives that would correct these deficiencies. Needless to say, such an additive would have to be very low in cost.

Discovery of bentonite in South Carolina made available a new raw material which might serve as an additive to face brick materials. Bentonites from other districts are well known for their high plasticity, high dry strength, and low maturing temperatures. Bentonites are such potent clay materials that they are seldom used in excess of 5 percent by weight as an additive for ceramic products. Amounts greater than this will introduce new troubles that are characteristic of the bentonite.

Cost is a major deferrent in use of bentonite for brick manufacture in the Southeast. Shipping cost and processing cost inhibit the use of Western bentonite. The South Carolina bentonite is attractively situated from the standpoint of transportation cost. However, the bentonite contains 20 to 70 percent water as mined and the removal of this water followed by pulverization of the bentonite would be troublesome. Costs would be less if the bentonite could be used in the wet lumpy condition as mined.

It was desired to evaluate the South Carolina bentonite as an additive to light colored face brick compositions. Also, it was desired to evaluate the bentonite in the "as mined" condition rather than in the pulverized condition.

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PROCEDURE

A base composition was selected for this work made up of 50 percent South Carolina kaolin and 50 percent -14 mesh kaolin grog. This composition was selected because it represents one that is very poor in plasticity, dry shrinkage, and fired properties other than color. It should be remembered that this composition is a very poor one and badly in need of help. It offers a great opportunity for assistance by bentonite whereas a composition that already has good plasticity or dry strength would not offer such an opportunity. Grog was selected for this composition instead of sericite because the grog has a better color than the sericite and thus offers a better means of evaluating coloring characteristics of added bentonite.

A shipment of Carolina bentonite was received during July from Mr. J. S. Newlin of Ridgeland, South Carolina. It is understood that this bentonite was obtained from a railroad cut in the bentonite deposit.

The kaolin and grog were pre-mixed to a plastic consistency in a muller type mixer for all compositions except composition S4. After pre-mixing, the plastic base composition was then mixed with the desired bentonite in a ribbon type mixer. The mixing time was less than one minute. It was hoped that this type of mixer and short mixing time would give a mixing action comparable to that obtained in the pug mills.

Composition S1 was made from the base body alone while composition S2 had 5 percent bentonite and the remaining compositions 10 percent bentonite. The quantities of bentonite were based on the "as received" bentonite. Determinations were made on this material and it was found that it contained 22 percent water of plasticity.

The mixing method for composition S4 differed from the other methods in that the kaolin and grog were not pre-mixed to a plastic condition. Instead kaolin, grog, and bentonite were all mixed in ribbon type mixer.

It was felt that the bentonite as received was considerably dryer than could be anticipated from a mining operation. Therefore, the desired amount of bentonite was pre-wet with water in a muller type mixer until it was plastic enough to extrude. This pre-wet bentonite was then blended with the base composition in the ribbon type mixer. Composition S5 used the lumpy material obtained from the mixer while composition S6 grated the bentonite prior to addition to the mixer. Such an action could possibly be obtained from certain commercial shredding machines.

Each composition was then extruded and the rate of extrusion together with the amperes required for extrusion were determined. The rate of extrusion was then calculated in inches per amp/min. The plastic modulus of rupture was determined on the bars immediately after extrusion. The water of plasticity, dry modulus of rupture, shrinkages, and fired strength were determined by conventional methods. Bars were fired to 2100° F prior to determination of fired properties.

RESULTS OF INVESTIGATION

Additions of Carolina bentonite were very beneficial to extrusion characteristics. It will be noticed from the rate of extrusion measurement in Table 1 that the bentonite was able to provide significant increases in the rate of extrusion. It also became very obvious during rate of extrusion tests that the base composition alone showed severe feather-edging while this feather-edging was completely eliminated with a composition containing Carolina bentonite. It is therefore felt that the bentonite offers promise of reducing the horsepower required to extrude a thousand brick together with increasing the speed of extrusion for a difficult-to-extrude material.

The Carolina bentonite also provided significant increases in plastic strength. Additions of 10 percent bentonite doubled the plastic strength of the base composition. The dry strength showed even greater increases through the addition of bentonite.

Fired strengths were greatly improved with additions of bentonite. There was no significant change in either the drying or firing shrinkage.

The results did not indicate any pronounced difference between the different methods of incorporating the bentonite. It was shown that the "as mined" wet bentonite could be included with the base mixture so as to give pronounced advantages in behaviour.

The Carolina bentonite caused a change in the fired color of the specimen. Composition with 5 percent bentonite showed a slight yellow cast while the compositions containing 10 percent bentonite had a very noticeable yellow color. The 10 percent composition, though, would still be classed as a very light colored face brick. All of the compositions that contained bentonite showed the development of some dark spots. These were approximately 1/16 of an inch nodules of bentonite that had not mixed in with the rest of the composition. These fused and formed a dark brown spot during firing. None of the mixing methods were effective in completely eliminating the spots. Frequency of occurrence of spots varied from about 1 per square inch of surface area to 5 per square inch. It is probable that these specks will not be eliminated without drying and pulverizing the bentonite prior to its use in the body.

Table 1.-- The influence of South Carolina bentonite on brickmaking qualities of a facebrick material

Sample	Composition	Rate of Extrusion in amp./min.	Water of Plasticity %	Plastic MOR psi	Dry MOR psi	Linear Drying Shrinkage %	Fired MOR psi	Total Linear Shrinkage %
S1	Standard*	11.7	23.5	6	17	.4	383	0.9
S2	5% bentonite	14.1	25.4	7	104	1.1	1477	2.0
S3	10% bentonite	15.7	26.1	12	174	.7	1160	2.4
S4		20.5	24.9	12	152	1.4	1458	3.2
S5	Pre-wet 10% bentonite	20.0	28.1	11	167	2.6	1754	4.8
S6	Grated, pre-wet bentonite	21.0	25.8	11	213	1.0	1468	3.1

*Standard, 50% kaolin and 50% -14 mesh grog

Bentonite as received contained 22% water.

SUMMARY

Tests have indicated that additions of South Carolina bentonite to face brick mixtures of poor extrudability will greatly improve the extrudability, dry strength, and fired strength of the mixtures. The bentonite can be incorporated in the mix in the "as mined" condition but plant results would probably be better if the bentonite were double pugged or quick shredded before mixing. Quantities of bentonite as low as 5 percent bentonite containing 22 percent water were effective in improving the processing qualities. The smaller quantities show a very slight yellowing of the fired color while 10 percent additions cause a pronounced yellow cast.