NORTH CAROLINA
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
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INFORMATION CIRCULAR 8

WHITE RESIDUAL CLAYS OF THE VOLCANIC SLATE BELT IN NORTH CAROLINA

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DIVISION OF MINERAL RESOURCES
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FOREWORD

North Carolina, for many years, has been an important producer of heavy clay products, such as are manufactured from red burning clays and shales, and of residual kaolin. As early as 1897 and again in 1925 kaolin was mentioned in Montgomery and Richmond counties. However, these clays attracted little or no attention until recently.

It is now known that deposits of white to buff burning clays occur along the eastern edge of the Piedmont plateau from Richmond to Nash counties. This report contains information on the distribution, size, mode of occurrence and general character of these deposits. It is believed that these clays are sufficiently promising to justify further investigation and research.

Jasper L. Stuckey
State Geologist

December 30, 1950

C O N T E N T S

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WHITE RESIDUAL CLAYS OF THE VOLCANIC SLATE BELT IN NORTH CAROLINA

By: Sam D. Broadhurst*

INTRODUCTION

The occurrence of white residual clays or kaolins along the eastern border of the Piedmont in North Carolina has long been recognized. As early as 1897[1] chemical and firing tests were made on samples from Montgomery and Richmond counties, while further testwork and brief descriptions of a few deposits were published in 1925.[2] During the early part of the century clay was mined on a small scale near Ellerbe, Richmond County, and used principally in cotton and paper goods manufacture, and as late as 1940 deposits in Moore County were opened and some clay obtained for the filler trade. However, little has been known as to the size and extent of the deposits, nor has systematic research been carried out to fully determine the potentialities of these clays for commercial uses. Similar clays in Georgia have been utilized in the manufacture of fire brick.

Results of firing tests published in Bulletins 13 and 29 of the North Carolina Department of Conservation and Development and preliminary

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1 & 2References are at end of circular

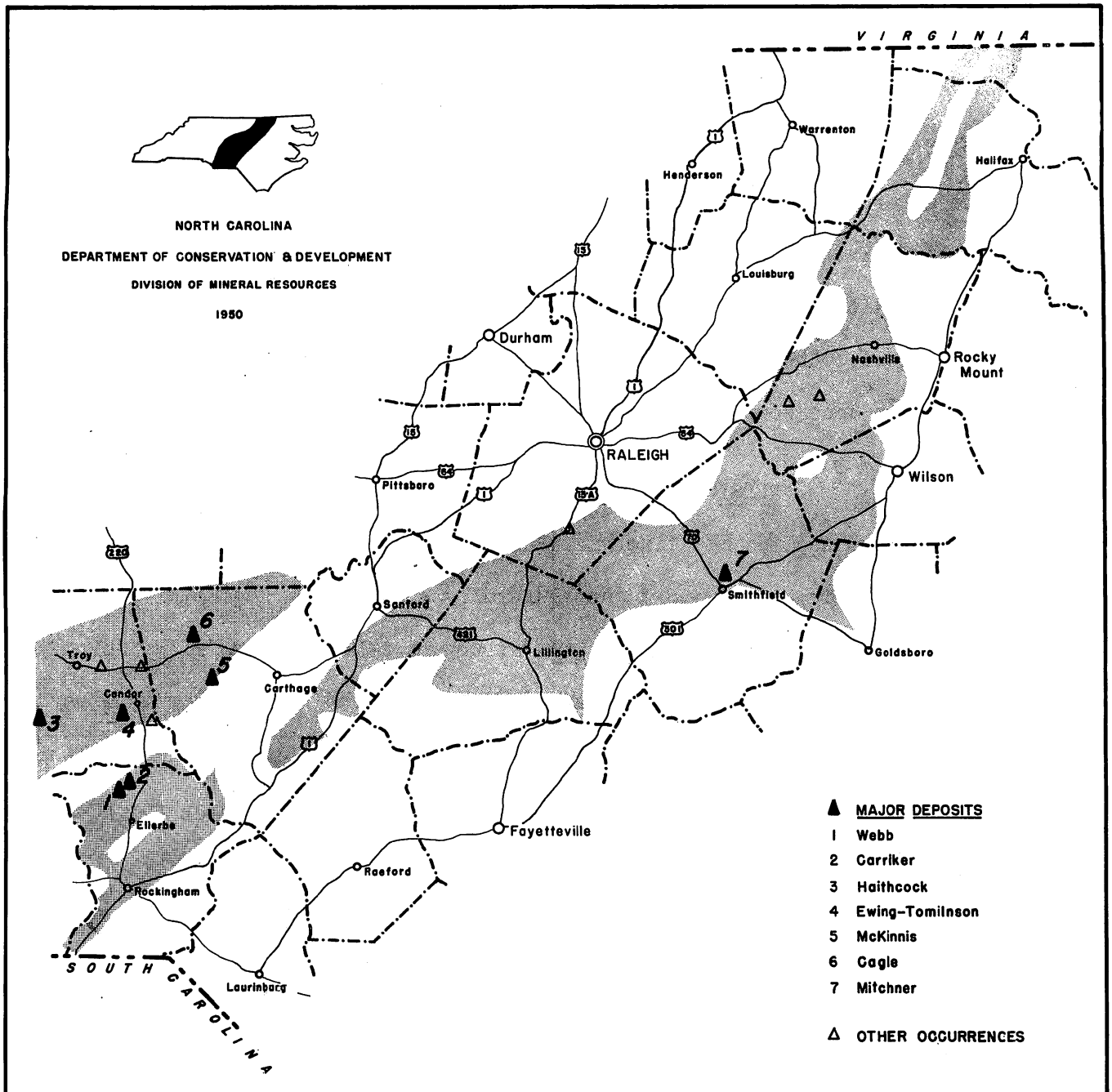
testwork by the Department of Engineering Research at North Carolina State College show that the kaolins fire a light yellow to buff color, and reach incipient fusion at about 2200° F and vitrification at approximately 2450° F. Indications are that the kaolins, if present in sufficient quantities, may have possibilities in the manufacture of certain ceramic products.

This report is concerned with investigations made during the summer of 1950 by the Division of Mineral Resources of the North Carolina Department of Conservation and Development. Its purpose is to present data concerning the location, geologic occurrence, general characteristics and other information pertinent to the deposits of residual kaolins associated with the Volcanic Slate Belt in North Carolina. The report is of a preliminary nature in that deposits, other than the ones here described, are expected to be uncovered if a suitable market for the clay is developed.

Field work was carried out by Sam D. Broadhurst, Assistant State Geologist, aided by Freeman L. Russell and Walter G. Wells, Student Assistants. The project was under the general direction of Jasper L. Stuckey, State Geologist.

LOCATION

The area described in this report forms a long northeasterly trending belt passing through parts of Richmond, Montgomery, Moore, Harnett, Wake, Johnston, and Nash counties. In general it constitutes the irregular contact zone between the Volcanic Slate Belt rocks of the Piedmont and sediments of the Coastal Plain. The most prominent occurrences are in the southwestern part of the belt. (See Location Map).



MAP OF

PRINCIPAL CLAY-BEARING AREAS

SHOWING

DISTRIBUTION OF DEPOSITS

10 0 10 20 30
MILES

The area is characterized by gently rolling interstream areas capped with sands and gravels. Underlying the sediments and exposed along the major drainage systems are the crystalline rocks from which the kaolins were derived.

Although field investigations were largely restricted to this contact zone, other occurrences are known. However, deposits inspected outside the zone were usually small.

PHYSICAL AND CHEMICAL PROPERTIES OF THE CLAY

The kaolins are fine grained, often somewhat blocky, relatively free from excessive grit, and do not generally show a high degree of plasticity. Some are very soft and show little structure, whereas others are quite hard and retain many of the characteristics of the rock from which they were derived. In general the clays have a rather dull appearance, although they occasionally display a slight sheen, possibly indicating the presence of sericite.

The texture is variable, however the grain size is usually small. Some clays are very fine-grained, most of the material passing 200 mesh. Others have a fine-grained groundmass but contain hard angular fragments of feldspar and quartz which average less than 1/16 inch in diameter.

Colors generally range from white to brown, iron oxides being the chief cause of discoloration. Where unstained, the kaolin is a greenish to dead white, however some staining is usually present. The clays may be white, white with brown spots of limonite, white with iron stain along cracks and fractures, light cream with brown streaks, tan, brown, and in some cases blue. The bulk of the material is a light cream or white with brown spots and streaks scattered throughout. Clay from the

lower portions of a deposit may contain cubes and nodules of pyrite.

During early geological investigations of the clays in North Carolina, chemical and physical tests were made on samples of these residual kaolins from deposits in Richmond and Montgomery counties. Results of some of the tests on three samples are given below.

ANALYSES OF CRUDE KAOLIN, RICHMOND COUNTY, NORTH CAROLINA

	Sample 20	Sample 21	Sample 22
Silica	70.63	68.15	73.70
Alumina	21.81	19.99	16.03
Ferric Oxide	1.49	1.86	1.57
Lime	0.20	0.13	0.38
Magnesia	0.29	0.16	0.47
Alkalies	1.45	2.85	1.90
Ign. Loss	4.04	4.70	4.33

CALCULATED MINERALOGICAL COMPOSITION

	Sample 20	Sample 21	Sample 22
Clay Substance	47.14	49.30	36.05
Feldspar	16.13	9.20	
Quartz	36.73	41.50	62.33

PHYSICAL PROPERTIES	Sample 20	Sample 21	Sample 22
Water Added %	27.7	26	27.7
Plasticity	lean	lean	lean
Air Shrinkage %	4	3.5	4
Fire Shrinkage %	9	8	8
Total Shrinkage %	13	11.5	12
Ave. Tensile Strength lbs./sq. inch	10	13	15
Max. Tensile Strength lbs./sq. inch	14	16	16
Character of Slaking	Slow	Slow	Slow
Texture of Clay	Fine	Fine	Fine
Incipient Fusion F^{o}	2250	2300	2250
Vitrification F^{o}	2500	2500	2450
Viscosity F^{o}	2700	2700	2700
Total Fluxes	3.43	5.00	4.32
Color when burned	Yellow White	Yellow White	Yellow White
Specific Gravity	2.41	2.52	2.43

Samples 20, 21 and 22 represent high-grade unstained kaolin from one locality as described by Ries (pp. 144, 148).[1]

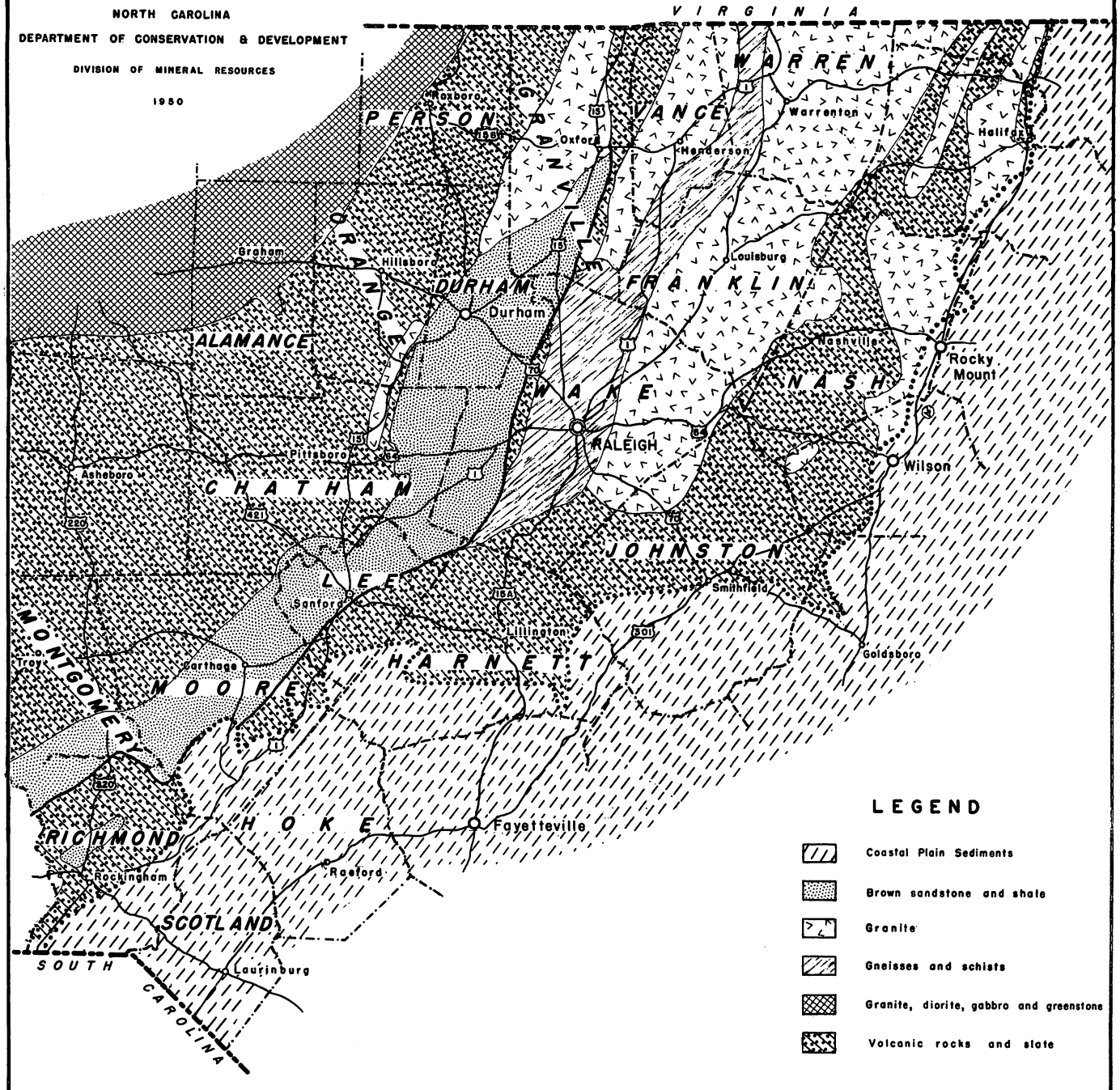
During the present investigation samples of various types and grades of kaolin were obtained throughout the area. These were submitted to the Department of Engineering Research at North Carolina State College where detailed tests are being made, and economic possibilities of the materials studied.

GEOLOGIC OCCURRENCE

The kaolins are associated with a complex group of rocks referred to as the Volcanic Slate Belt. (See accompanying maps). This belt extends in a northeasterly direction through the central and eastern Piedmont of the State, its eastern border being largely covered with thin layers of Coastal Plain sands and gravels. Rocks of the Volcanic Slate Belt consist of slates and tuffs with which are interbedded bands and lenses of volcanic breccia, flows, and ash. In many places the rocks are severely folded and fractured, while in others they are relatively undisturbed.

Sizeable deposits of residual kaolin have formed through normal chemical weathering of certain of the highly sheared rocks, principally fine and coarse-grained felsic tuffs and slates. Contacts between tuffs and slates are often gradational. Thus, at least locally, these rocks are of similar materials and upon weathering form kaolin. In some deposits the fragmental nature of the original rock is evident, small pieces of quartz and feldspar being scattered throughout the kaolin. In others, few or no fragments are noticeable. Bedding planes are prominent in some deposits, whereas shear zones are pronounced throughout.

Although small shallow deposits of residual kaolin occur in many sections of the volcanic slate series, kaolinization has not proceeded rapidly enough to produce this material in volume except locally, where erosion has been retarded, allowing the rocks to be deeply weathered in places. The highly sheared condition of the rocks accelerated the kaolin-forming processes.



GEOLOGIC MAP

EASTERN PIEDMONT AREA

NORTH CAROLINA

It is noteworthy that sands and gravels either directly overlie or are in the immediate vicinity of the larger known deposits. The protection against erosion afforded the kaolins by these overlying sediments favors the formation of larger and more deeply weathered deposits. Although deposits may occur at any place in the Volcanic Slate Belt where highly feldspathic rocks have been deeply weathered, the largest amount of available kaolin appears to be confined to an irregular zone marking the contact between volcanic rocks and Coastal Plain sediments.

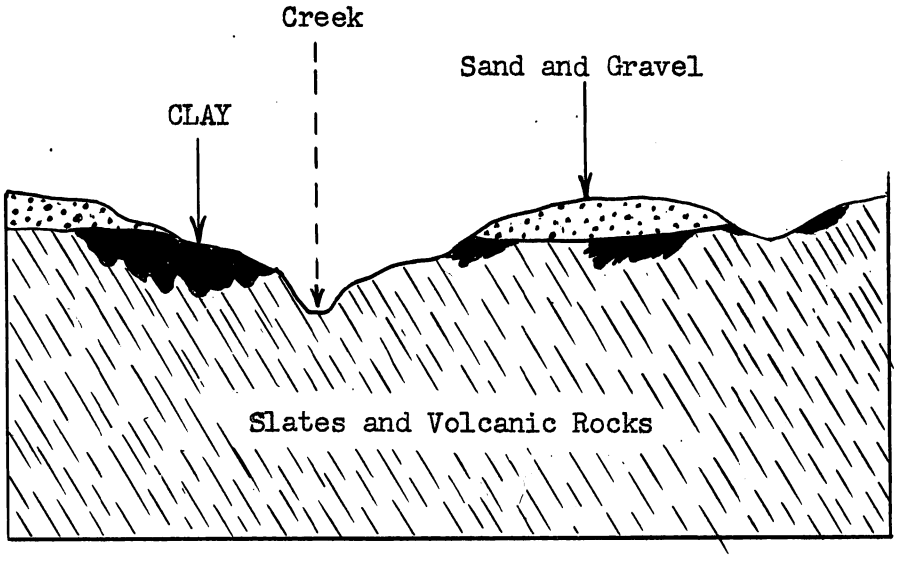
DESCRIPTION OF DEPOSITS

Individual deposits are quite irregular, both vertically and horizontally, but are usually somewhat elongate, trending with the general strike of the surrounding rocks. Contacts between the clay and country rock may be either sharp or gradational, both types often being present in a single deposit. This increases the difficulty of determining the boundaries of workable material.

The deposits range in size from less than ten feet wide and twenty feet long, to as much as 400 feet wide and 800 feet long. Auger holes and prospect pits indicate that the clay varies in depth from two to more than eighteen feet, actual footage largely being controlled by local depths of weathering.

Quartz veins, occurring parallel with cracks and fracture, are prominent at some localities. They range in width from a few inches to more than eight feet, averaging less than two feet. Although undesirable economically, these veins were probably important factors in the formation of the clays since their emplacement opened additional avenues for downward percolating waters, thus accelerating kaolinization. Thin films of quartz filling fractures and joints are common.

Although white kaolin is present in most of the deposits, the bulk of available material appears to be a light tan to cream spotted clay. This clay is similar to the white clay except for color. Iron oxides produced during the weathering of pyrite are largely responsible for the discoloration. In the upper portion of some deposits, the pyrite has been oxidized and leached out, leaving little or no stain. Below this zone staining along joints and fractures increases, and spots of limonite occur scattered throughout the clay. Thin flat nodules of limonite are often present along planes of fracture in the upper portion of a deposit, whereas fresh pyrite occurs at or below the present zone of oxidization.



Generalized section showing relation of clays to volcanic rocks and overlying sediments.

Small "sandy" lenses are occasionally present in the clay, but do not appear excessive. Some inclusions or "horses" of a deep red to brown sandy sericitic clay were noted in at least one deposit. However, contacts between this material and the kaolin are relatively sharp.

In the upper highly weathered section of most deposits the clay is very soft and can be easily mined. However it hardens rapidly near drainage levels and assumes characteristics of the rock from which it was derived. Hand augers would not penetrate the harder material.

Most deposits are well covered by unconsolidated sands and gravels which range in thickness from zero to twenty feet, but probably average less than ten feet. In some instances layers of hardpan (sand and gravel cemented with iron) occur near or immediately overlying the clay. These layers range in thickness from less than one inch to about one foot and are not extensive. Where sands and gravels are absent, the overburden consists of several feet of highly stained clay.

Exposures of kaolin are small and limited in number, most deposits having but a single outcrop. The clay is usually exposed in road cuts, or where streams have cut through the sands and gravels to the underlying volcanics. Determinations of the actual horizontal and vertical extent of a deposit and of the continuity of clay within a deposit were impossible because of difficulties encountered in drilling through the overburden with hand augers. Therefore many occurrences were studied on outcrop evidence alone.

IMPORTANT OCCURRENCES

The deposits described in this section are among the larger occurrences investigated. They represent those which, from surface indications, appear favorable for detailed prospecting.

Webb

A deposit of white to tan residual kaolin is on the property of Z. O. Webb, three miles northwest of Ellerbe, in northern Richmond County. It

is one-half mile south of the Sharon Church road which intersects U. S. Route 220 approximately two miles north of Ellerbe. The deposit was worked on a small scale by R. L. Steele of Rockingham during the early part of the century.

The clay, as exposed in the old Steele pit, is white to cream with occasional spots and streaks of brown stain. It is relatively soft to a depth of about ten feet but hardens rapidly, becoming blocky and hard at about fifteen feet. The color is fairly constant. Most of the material encountered in auger holes was a cream to tan clay with brown streaks. The bulk of kaolin from this property is expected to be of this type.

Twenty-seven holes, ranging in depth from two to twelve feet, were drilled with hand augers in an attempt to determine the general size of the deposit and the type of clay present. Clay was encountered over an irregular triangular area of about 15,000 square feet. North and east of the area the hills are capped with sands and gravels containing layers of hardpan. Since the augers were unable to penetrate this material, the extent of the deposit northeastward is unknown.

It is estimated that the clay will range from five to nearly twenty feet in depth. Along the lower hill slopes, where the bulk of the clay was encountered, overburden is light, while on the hilltops sands and gravels range from five to fifteen feet in thickness.

Two samples were taken for test work: one a hand-picked sample of the highest grade material, the other a composite sample from 10 auger holes.

Carriker

This deposit is on the property of Carlton Carriker, 3-1/2 miles northwest of Ellerbe, Richmond County. It is located three-fourths of a mile northwest of Little Mountain Creek and along a paved county road which

intersects U. S. Route 220, approximately two miles north of Ellerbe. R. L. Steele of Rockingham mined a small amount of the clay during the early part of the 1900's.

The deposit is situated near the upper edge of, and parallel to, the valley of a small stream. Kaolin is best exposed along the road where it is traceable for nearly 100 feet. Immediately north of this exposure, sands and gravels ranging from three to more than ten feet in thickness cover the deposit. Overburden is estimated to average from three to four feet. Southward toward the creek, there is little sand or gravel, however the deposit is covered by about two feet of sandy soil and clay. fifty feet east of the exposure along the road is the old Steele Exploration Company's pit, now abandoned.

The kaolin is very fine-grained, relatively soft and contains little grit in the upper portions of the deposit. Although zones of very white clay are present, there are indications that most of the workable kaolin is of a light cream color. Near the surface, thin flat nodules of limonite occur in many of the prominent fracture planes in the clay but were not observed at depth.

As indicated by old workings, the clay was mined to a depth of about ten feet, while recent borings proved the material at that locality to extend to a depth of more than fourteen feet. The depth of workable material appears to be quite erratic, and there are indications that it may average less than ten feet.

Quartz veins ranging in width from a few inches to six feet are common and may present a problem if the clay is exploited. The upper portion of the deposit is quite soft, but the kaolin probably hardens rapidly at depths approaching local drainage levels. Relatively hard green and

brown volcanic rocks are exposed within 100 feet of the old pit.

Bore holes on 200-foot centers encountered white to tan clay over an irregular area of about 400 x 1000 feet. Overburden averaged about three feet. The depth of the deposit was not determined because of difficulties in drilling the clay with hand augers. The full potentialities of this deposit can best be determined by prospecting with power equipment.

One sample was collected representing material from outcrops along the road, the old pit, and 6 auger holes.

Haithcock

Residual kaolin crops out in a large gully on the John Haithcock property, two miles west of Wadeville, Montgomery County. The size of the deposit is unknown; however, it is exposed throughout the gully which is approximately fifty feet long, fifteen feet wide, and ten feet deep. Clay was encountered the length of an auger hole drilled 12 feet below the bottom of the gully. In contrast to other sizeable occurrences, there are no sands or gravels covering this deposit.

The kaolin is white, fine-grained, and soft. Outlines of large fragments, now highly kaolinized, are prominent, often comprising over 50% of the clay material. Staining is excessive along the upper sides of the gully, and the clay is reddish brown in color. Toward the bottom, staining is largely confined to joints and fractures, and to occasional spots within the clay. Two samples were taken for testing.

Overburden is light near the exposure and consists principally of a red to brown rather compact clay. Further prospecting is necessary before the potentialities of this deposit can be determined.

Ewing - Tomlinson

A deposit of relatively high-grade kaolin is on the Bill and Dan Ewing property and the adjoining J. G. Tomlinson property, three miles south of Candor and one-half mile west of N. C. Route 731, in Montgomery County. The clay is best exposed along the creek dividing the properties and in shallow prospect trenches on the Ewing property. Along the creek outcrops are prominent, in places forming bluffs five to ten feet high. Except where exposed in creek valleys, the clay is capped by a layer of sand, gravel, and hardpan from about three to fifteen or more feet in thickness. In a draw some 500 feet north of the main creek, a small amount of clay is exposed, and a relatively high-grade material was uncovered by prospect trenches 200 feet north of the creek. South of the creek the deposit is covered by a heavy layer of sand and gravel. However, there are indications that the clay may extend for considerable distances both north and south of the creek. Kaolin was encountered in an excavation some 1200 feet southeast of the outcrop in the creek, but the extent of the material at this locality is unknown.

The clay ranges from white to cream in color, sometimes having a slightly greenish appearance. It is very fine-grained except for occasional coarse "sandy lenses," which are narrow and of limited extent. Small pieces of limonite are scattered intermittently throughout the upper portions of the deposit, and small cubes of pyrite are exposed in the clay at creek level. There is some staining along joints and fractures, although it is not excessive. The clay is quite hard and blocky. Three samples were obtained for test work.

Bedding planes are somewhat pronounced and indicate a generally northwest strike and a dip of about thirty degrees toward the southwest. Fracture planes are often filled with thin films of quartz and very fine

highly weathered kaolin, probably derived from the upper portion of the deposit and deposited along the fracture. Small veins of quartz occur but are not exposed in abundance.

A considerable volume of kaolin might be developed on these properties if the deposit is continuous over the area indicated by outcrops. However, detailed prospecting will be necessary to prove the value of the deposit.

Several hundred feet southwest of the white clay exposures, a soft blue banded clay crops out along the stream. In places the clay is dark blue and carries a considerable amount of pyrite. Most of the material, however, is light gray with dark blue bands. Upon weathering the clay becomes light gray to white but usually retains its banded appearance. Grit does not appear to be excessive.

This deposit is traceable along the creek for over 800 feet and is exposed to depths of 35 feet in places. Overburden, largely composed of sand and gravel, is light. The deposit appears to contain a relatively large volume of banded clay which could be easily mined. Two samples were taken for test work.

Cagle Mine

White residual kaolin is exposed in workings at the old Cagle Gold mine along the western side of Cabin Creek, 1-3/4 miles west of Robbins, Moore County. The deposit is traceable for nearly 125 feet across strike and extends to a depth of twenty or more feet. About 200 feet east of the creek, similar material is exposed for a short distance along the county road but was not observed in the creek between the two areas of outcrop.

The rock is a highly sheared tuff, the fragmental nature being quite apparent in most instances. It strikes in a northeasterly direction and

dips at approximately 55° toward the northwest. Weathering appears relatively deep but probably does not extend far below the creek level since the stream is bottomed on hard rock. Most of the soft material occurs along the northwestern half of the mine, and east of the creek. Relatively hard ribs of semi-weathered sheared tuff are present along the southern and eastern parts of the old workings.

The soft kaolin is fine-grained, light cream to white, and contains some fine grit. In general it is relatively unstained except in the upper portions. The harder semi-weathered material underlying and grading into the kaolin is a light tan to greenish tuff in which the fragments are readily visible. It is relatively soft and has a somewhat greasy appearance, indicating the possibility of sericite being present. Samples were collected of both types of material.

Overburden is light, largely consisting of somewhat sandy soil and clay which range in depth from one to five feet. The deposit is readily accessible to a railroad and a well-graded county road.

Although exposures indicate that a sizeable tonnage of clay may be present in this deposit, the presence of hard rock both in the creek and immediately south of the mine makes detailed prospecting north of the exposures advisable to prove sufficient tonnages for commercial consideration.

McKinnis

This deposit is on the property of Daughton McKinnis, nine miles west of Carthage and six miles northeast of Eagle Springs. It is approximately 1-1/2 miles east of N. C. Route 705, between Gardners Store and Eagle Springs.

The deposit was worked on a small scale in 1940, the clay being mined

for the filler trade. It is reported that auger holes drilled on the property indicated a sizeable tonnage over several acres but that the depth of the deposit was erratic. In places, the clay is only two or three feet deep; however, at the old pit it was mined to a reported depth of about twenty feet and high and high-grade clay was being mined when the property was closed.

A very white, soft, fine-grained clay, relatively free of grit and stain, is exposed for nearly 100 feet in a shallow open cut. Bedding planes and fractures are rather prominent. The deposit is overlain by two to six feet of sand and small gravel. One sample was taken for test work.

If reports on drilling are correct, a considerable tonnage of high-grade clay might be developed on this property.

Mitchner

Residual kaolin is exposed for over 250 feet along the hard-surfaced county road between Smithfield and Wilson Mills, Johnston County. This road intersects U. S. Route 70 one mile northwest of Smithfield. The deposit is located along, and one-half mile above, the mouth of Little Creek, the best exposures being north of the creek on the Howard Mitchner property.

The clay is white to tan, occasionally being brown and pink. Most of the material is white with tan specks or streaks. Staining is more pronounced toward the creek where the tan and pink clays are exposed. Narrow brown sandy lenses high in limonite occur in some parts of the exposure. The kaolin does not appear as fine-grained as some of those from Moore and Richmond counties, and the amount of sericite is higher. For the most part, the clay is hard and retains the general appearance

of the sheared tuff from which it was derived. Indications from this principal exposure are that the deposit may not be deeply weathered.

Overburden, consisting of sand and gravel, ranges from two to six feet deep. No holes were drilled to determine the extent of the deposit, although it can be traced for approximately 100 feet east of the road, where the overburden has been partially removed. Two samples were taken for test work.

OTHER OCCURRENCES

In addition to those previously described, there are several occurrences of residual kaolin which are worthy of mention. Some are of doubtful commercial importance but are of value in showing the general distribution of the clay bearing areas.

Three miles southeast of Candor, Montgomery County, and west of Drowning Creek, a very white clay is exposed near the old mill site on the property of Rom Kellis. The kaolin is white and contains a small amount of grit. However, the material is not traceable over a large area. Along the old road leading to the mill site, a cream to white clay is exposed. Auger holes encountered a considerable number of dark red limonitic zones, and rounded pebbles as much as ten feet below the surface.

One mile north of Candor on the Alex Leach property, a multicolored residual clay is exposed. Ten auger holes scattered over the area encountered white, red and chocolate brown clays. The deposit does not appear to be large nor of great depth.

A white clay is exposed on the Fate Stryder property one mile north of Candor, and east of the Leach property. The extent of this deposit is unknown. There are indications, however, the deposit is not deeply weathered.

On the D. C. McCallum property, 1-1/2 miles southwest of Candor,

small pits have exposed a white to cream residual kaolin a few hundred feet north of the lake. The clay is of good grade but is not extensive.

A white residual clay, somewhat hard and blocky, is exposed for more than 100 feet in a road cut along the south side of N. C. Route 27, three miles east of Biscoe, Montgomery County. The clay is of good quality, but it is expected to harden rapidly a few feet beneath the surface.

Along U. S. Route 15-A, about twelve miles south of Raleigh, a high grade white clay is exposed for about 100 feet. Small quartz veins and stringers are associated with the clay. This exposure is in the lower part of a small stream valley, multicolored volcanic rocks being exposed along either side.

There are several occurrences in Nash County. Five miles south of Spring Hope, a highly weathered tuffaceous rock is exposed in a deep road cut along N. C. Route 581 just south of the Tar River. This rock is light gray, somewhat gritty, and highly sheared. It is relatively soft to a depth of at least fifteen feet. The material is exposed for about 200 feet along the highway and appears to be about 100 feet wide.

A white clay occurs at Samaria, about 7-1/2 miles southeast of Spring Hope, Nash County. It is best exposed along N. C. Route 231, one-quarter mile north of the village. The clay contains numerous particles of quartz and feldspar and is somewhat stained.

RESERVES & CONCLUSIONS

The great irregularity of the deposits as to size, extent and continuity, and the lack of good exposures make any estimate of reserves highly speculative. However, field evidence indicates that there are probably over 725,000 tons of residual kaolin available in the deposits investigated and that these deposits are readily adaptable to open-cut

mining. Other deposits will probably be uncovered by detailed prospecting.

Although some of the kaolin is very white and unstained, most of the material is slightly stained with iron oxide which was probably formed during the weathering of pyrite. Small amounts of pyrite can be expected in most deposits, especially at lower levels. The kaolin will harden rapidly at or near local drainage levels.

Many deposits are too small to be of importance, although the kaolin is of good quality. Others appear larger and to have possibilities of becoming producers if a suitable market is developed. However, because of the processes by which the clay was formed and the erratic occurrence of the rocks from which it was formed, the deposits are expected to be irregular both horizontally and vertically. Therefore, a considerable amount of detailed prospecting will be necessary to determine the potentialities of individual deposits.

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2. Bayley, W. S., The kaolins of North Carolina: North Carolina Geol. & Econ. Survey Bull. 29, pp. 121 - 128, 1925.