THE MINERALOGY OF SOME DEPOSITS OF KAOLINIZED VOLCANIC ASH FROM THE SLATE BELT OF NORTH CAROLINA

JASPER L. STUCKEY, *North Carolina State College.*

INTRODUCTION

The Slate Belt of North Carolina embraces a region which varies in width from 8 to 50 miles and extends across the center of the State in a northeast-southwest direction. The belt reaches its maximum width near the center of the State and narrows to the northeast and southwest. The rocks of this area, because of their well developed cleavage, have been called slates. The whole Slate Belt has not been mapped in detail, but field investigation, petrographic study, and chemical analyses of the rocks from different parts of the belt have shown that the slates are of volcanic origin. In the areas studied the slates are composed of the following materials: (1) flows of rhyolite, dacite, andesite and related rocks; (2) beds of volcanic ash, tuff and breccia of the same general composition as the flow materials; (3) beds of slate composed of the finer ash and tuff materials and land waste.

The metamorphic forces which changed these materials to slates did not act uniformly throughout the whole area. In the northern half of the Slate Belt the rocks are highly slaty and schistose with a well developed cleavage that dips steeply to the southeast, while in the southern half the cleavage is in may areas less well developed and dips to the northwest. In a number of places, particularly along the Seaboard Railway between Wadesboro and Monroe, original bedding planes are well preserved.

Scattered throughout the Slate Belt, but especially common in its southeastern portion in Moore, Montgomery and Richmond counties, are beds of a residual gray to white clay commonly referred to as kaolin. This material while quite similar throughout the area varies from place to place. Some outcrops grade downward into a massive and jointed material while others are distinctly schistose beneath the surface. This study deals with the difference between the massive and schistose phases. In all the deposits the clay has a soft, smooth feel, but gritty material is much more common in some occurrences than in others. The beds are all distinctly lenticular in shape and irregular in size, and vary in areal extent from a few square yards to several acres and in depth up to 25 or 30 feet.

As early as 1897 Ries[1] studied and tested samples of this material from Richmond and Montgomery counties which yielded upon washing from 15 to 40 per cent of clay substance. Tests showed that this clay substance compared favorably with standard kaolin.

Bayley[2] while studying the kaolin of North Carolina in 1918 visited Montgomery and Richmond counties and described some of the deposits. Describing the Overton deposit near the Iola Gold Mine at Candor he says: "The sample furnished is a loose, very light pinkish gray, gritty, flour-like mixture of very fine quartz and kaolin.****Under the microscope the principal constituents are quartz grains of all sizes from the most minute to those 0.2 millimeter in length. Perhaps the greatest number have diameters between 0.05 and 0.06 millimeter. Besides these are a few white opaque grains with straight edges that may be altered feldspar grains and a fair quantity of small kaolinite particles of about the size of the smallest quartz particles. Occasionally there is a shred of kaolinite 0.06 millimeter long but most particles are less than 0.004 millimeter across."

Describing the Eames Prospect near Mount Gilead he says: "The sample looks very much like that from the Iola Mine at Candor. It is a very fine, gritty, flour-like material of a very pale grayish white color. The crude material is made up mainly of small quartz grains with diameters between 0.02 and 0.04 millimeter. In addition there are a few particles of rutile, hydromica and strained feldspar and a very few tiny plates of kaolinite. The quartz is in little sharp-edged splinters, in subangular grains, in very irregular shaped particles and in a very few cases in rounded grains. Evidently the material has not been carried far from its source. It may be a residual mass, like that at the Iola Mine from which most of the kaolinite has been removed." He concludes that the material probably has been formed from a fine-grained, volcanic rock.

Nature of Deposits and Methods of Study

During the past two or three years interest has been revived in these clays and attempts have been made to find uses for them. In addition to the occurrences studied by Ries and Bayley other de-

[1] Ries, H., Clay Deposits and Clay Industry in North Carolina: *N. C. Geol. Survey Bull.* **13**, pp. 64–70, 1897.

[2] Bayley, W. S., Kaolins of North Carolina: *N. C. Geol. Survey Bull.* **29**, pp. 126–127, 1925.

posits have been prospected, three of which are described below. One of these lies along Drowning Creek in the western edge of Moore and the eas‘ern edge of Montgomery counties, some 5 miles west of Eagle Springs. Another lies in Randolph county 4 miles west of Staley and about 25 miles south of Greensboro. The third deposit is located in Granville county about 2 miles north of Stem and some 20 miles south of the Virginia line. Careful field investigation of the three areas indicates that each deposit is associated with and occurs in acid volcanic rocks that consist chiefly of ash and fine tuff.

Seven samples were collected from these three deposits for study, 5 of which came from the deposit on Drowning Creek in Moore and Montgomery counties, and one each from the deposits near Staley, Randolph county and Stem, Granville county. Wet screen tests, partial chemical analyses and microscopic examinations were made.

For screen tests samples of each clay were crushed to disintegrate any lumps present, care being taken to avoid grinding or reducing the natural grain size. Portions of exactly 300 grams each were weighed out and put into 500 cc. of water to which a few drops of NH_4OH were added. The samples were left over night and screened through a nest of hand screens consisting of the 150 mesh screen above the 200 mesh. The results of the screen tests are given in Table 1, and partial chemical analyses are recorded in Table 2.

Microscopic study was carried out by mounting the clays in index liquids which recently had been standardized. A small particle of the material was placed on a glass slide and crushed with the thumb nail, a few drops of the index liquid were added and a cover glass placed over the mount. The minerals present were determined by indices of refraction and general optical properties, including interference figures where possible.

Description of Samples

Drowning Creek has cut through the deposit in Moore and Montgomery counties to the parent material below, and by deflection against its southern bank has produced a bluff some 15 feet high. All the evidence obtained indicates that the clay is residual. The outcrop is jointed but much freer from schistose structure than deposits farther north in the Slate Belt. The clay is gray to

white in color while the bed rock just above the water level in the creek is gray to yellow. About 1000 feet to the south of the stream bed rock is exposed at the surface as a crudely stratified, gray to pinkish colored material.

Five samples were taken from this deposit for study as follows: one sample from the parent rock just above the water level of the stream, one sample of the bed rock about 1000 feet south of the stream, and three samples at different levels from the stream bluff.

Sample 1. The parent material from just above the stream level though badly weathered resembles in hand specimen the fine-grained, fragmental materials characteristic of the Slate Belt. In structure it is only slightly schistose while the color is distinctly gray to yellow. The microscope shows a fragmental material composed of angular and irregular grains of quartz and feldspar in a fine grained matrix. Quartz is a common mineral occurring as splinters and sharp edged grains. Feldspar is present in partly altered grains. Small amounts of epidote, kaolinite, sericite and iron oxides are present in a fine-grained ground mass some of which is non-polarizing.

Sample 2. The bed rock from the north end of the deposit is a crudely stratified material which contains gray and chocolate colored layers. It is extremely fine-grained and sufficiently weathered to break readily in one's hands and crumbles into a pink colored powder. The microscope reveals a very fine-grained material much like that in sample 1, the chief difference being that this is much finer grained. Quartz and feldspar are present in small amounts as angular grains in a very fine-grained ground mass. The finer materials consist of tiny grains and shreds of epidote, iron oxides, kaolinite, and sericite in a mass either non-polarizing or too fine to identify.

Sample 3. A sample of the clay taken from the bluff two or three feet above the parent rock is a soft, gritty, rather white, flour-like material free from lumps and fragments. The microscope shows quartz common in angular, splinter-edged and curved faced grains, the greater part of which vary between 0.02 and 0.04 millimeter in diameter. Kaolinite is abundant in shreds and plates about the size of the smaller quartz grains, while fan and worm shaped masses two or three times the size of the largest quartz grains are common.

A few grains of halloysite, sericite, hydromica, rutile and titanite are also present.

Sample 4. A sample of the clay taken about midway between the top and bottom of the bluff is a grayish white, rather gritty, flour-like material containing a few yellow streaks probably due to iron stain. Quartz is abundant in irregular and angular grains 0.01 to 0.03 millimeter in diameter. Kaolinite is common in tiny shreds and flakes and sparingly in excellent plates. Small amounts of sericite, hydromica and rutile are also present.

Sample 5. A sample taken from just beneath the soil is distinctly gray in color, rather gritty and free from lumps. The most common mineral identified is quartz. It occurs in irregular grains of dust-like size that vary from 0.003 to 0.02 millimeter in diameter. Much fine-grained material like kaolin is present though no definite flakes or fan structures were seen. Small amounts of sericite, some hydromica and titanite are present in a fine-grained dirty ground mass much of which is non-polarizing.

The deposit near Staley, Randolph County, occurs as the hanging wall of a pyrophyllite body, but some 50 feet away from the mineralized zone in which the pyrophyllite is found. It has been prospected by a trench 40 feet long and a pit 20 feet deep. In the pit the material has a well developed schistose structure which dips steeply to the northwest.

Sample 6. A representative specimen from this pit crumbles readily in one's hands to a very fine, flour-like material, free from any gritty feel and is light gray to white in color. Microscopic examination shows quartz abundant as dust-like fragments with a maximum diameter of 0.02 millimeter. Kaolin is sparingly present in tiny particles a very few of which are doubtless distinct flakes of kaolinite. Sericite is abundant in characteristic scales and fibers. Rutile is common in needles and elbow twins, while titanite is occasionally found.

In the deposit near Stem, Granville County, the material as exposed in a small pit on the side of a hill has an extreme schistose structure that dips steeply to the southeast.

Sample 7. A hand specimen from this pit crushes readily to a fine-grained, flour-like material that is free from any gritty feel and is light gray to white in color. Under the microscope quartz and sericite are the only minerals readily determined. The shape and size of the grains are much like those already described, particularly in sample 6, and need not be repeated.

TABLE 1. WET SCREEN TESTS OF SAMPLES

	1 PER CENT	2 PER CENT	3 PER CENT	4 PER CENT	5 PER CENT	6 PER CENT	7 PER CENT
On 150 Mesh	29.93	2.86	29.20	30.23	6.16	0.40	2.16
On 200 Mesh	1.46	0.20	2.76	1.56	2.93	0.53	0.50
Total through 200 Mesh	68.61	96.94	68.04	68.21	90.91	99.07	97.34

TABLE 2. CHEMICAL ANALYSES OF SAMPLES*

	1	2	3	4	5	6	7
SiO_2	59.90	64.70	70.40	74.40	75.70	73.20	67.10
Al_2O_3+ Fe_2O_3	29.20	26.00	22.00	19.20	19.10	18.70	22.90
Ign. Loss	7.90	5.50	4.60	4.40	4.60	4.72	3.30
Na_2O	—	—	—	—	—	—	2.01
K_2O	—	—	—	—	—	—	5.64
Total	97.10	96.20	97.00	98.00	99.40	96.12	100.95

* Analyses by G. R. Shelton, Ceramic Chemist, Bureau of Standards, Columbus Branch, Columbus, Ohio.

SUMMARY AND CONCLUSIONS

Field evidence shows that the three deposits described lie in areas of acid volcanic rocks. Microscopic examination of samples 1 and 2 reveals a material which, though much weathered, has many characteristics of a fine tuff or volcanic ash. The other 5 samples due to weathering show little resemblance microscopically to true fragmental materials. However, the general similarity of all the materials and their association with acid volcanic rocks indicate that they were originally fine-grained tuff or volcanic ash.

The present mineral composition of these deposits seems to be related to the amount of metamorphism they have undergone. In the northern part of the Slate Belt where metamorphism has been severe the fine-grained materials doubtless have been changed directly to sericite schist, while farther south where dynamic forces were less intense they have weathered to impure kaolin.