THE

GEOLOGICAL FORMATIONS

IN THE VICINITY OF

PETERSBURG, VIRGINIA,

WITH ESPECIAL REFERENCE TO THE

APPOMATTOX FORMATION.

A THESIS

BY

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OF VIRGINIA,

IN

APPLICATION FOR THE DEGREE DOCTOR OF SCIENCE

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TO

HIS FATHER,

CHARLES PEEBLES, ESQ.,

THIS PAPER IS INSCRIBED

AS A TOKEN OF AFFECTION

BY

THE AUTHOR.

INTRODUCTORY NOTE.

At the suggestion of Prof. Wm. M. Fontaine, the author undertook the investigation of such of those deposits just above the Tertiary in the Geological column as are in the vicinity of Petersburg—his home, as his practical work for the Doctor's degree.

Owing to the remarkably rainy summer of '89, the explorations were confined to a more limited area than was originally intended, but the exposures described throw considerable light upon the hitherto unknown "Appomattox Formation," and give the characteristic features of the deposit. In order to present a clearer idea of its character and position, it was thought best to briefly mention the occurrence, nature and position of the older formations in the locality examined. Several undescribed exposures of Potomac strata are carefully noted under the proper head.

The frontispiece was prepared from the "Map of Chesterfield County" and from a "Sketch of the Entrenched Lines in Front of Petersburg." There is no complete map of Prince George County, so that a portion of this county is necessarily omitted.

Throughout the paper the exponents refer to points noted on the map, the subscripts to marginal references.

The author desires to acknowledge his indebtedness to Messrs. E. Lacy Gibson and Percy H. Walker, graduate students in the School of Analytical Chemistry or the analyses of clay, tabulated in the Appendix, and to Prof. Fontaine, without whose kind interest, continued encouragement and valuable assistance this paper could not have been prepared.

UNIVERSITY OF VIRGINIA, *May 1, 1890.*

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Petersburg, Virginia, lies chiefly in the county of Dinwiddie, on the south bank of the river Appomattox, twelve miles above its confluence with the James at City Point. Geologically, it is situated partly upon the Archean and partly upon much younger strata, the formations to be seen in the city and its vicinity being, in order of superposition, Archean, Potomac, Tertiary, Appomattox, and Quaternary. These are all more or less well developed, and will be considered in the order beginning with the oldest.

ARCHEAN.

This formation consists of granite and granitoid gneiss, the former predominating. The beds are exposed along the line of Old Town Creek, at the falls of the Appomattox[1], occasionally in the vicinity of Pocahontas, along the canal, near the Central Lunatic Asylum[2], and along Indian Town Creek.[3]

The material, in the main fine grained granite, varies with the locality to some little extent. At the Wakefield Quarry[4] the granite lies in horizontal beds twelve feet thick (approx.), and it is further divided by vertical joints, adjacent to which the rock is partially decomposed. The same is virtually true of the quarry operated by the Petersburg Granite Quarrying Company near the Asylum, and there is no appreciable difference in the quality.

Rogers says of this rock:* "At the Falls of the Appomattox we find a well-"characterized variety of granite. It possesses a coarse crystalline structure, "and consists of yellowish-white feldspar in distinct crystals with a smaller pro-"portion of quartz, and a trivial amount of white or light-colored mica." A portion of this exposure[1] is made up of rock containing only feldspar and mica,

*Geology of the Virginias, page 21.

and the mass of it can be classed as pegmatite. The proportional amount of the constituents varies within very short distances; in some places the mica is present to such an extent that it can be split from its matrix, and in others veins of almost pure quartz break through.

This particular locality[1] was subject to more active eruptive force than prevailed elsewhere along the belt examined, for the strata are contorted and unevenly bedded.

Potomac.

The Potomac Formation is the youngest of the Mesozoic formations in Virginia. Fifty years ago it was studied by Prof. W. B. Rogers in his reconnoissance of the geology of the State, made under the authority of the Legislature. He called it "Upper Secondary" as distinguished from his "Lower Secondary," strata of the Richmond coal field and other areas of similar age.

Recently Mr. W. J. McGee, of the U. S. Geological Survey, following the rule of the survey to use geographical names, proposed the name "Potomac" for these beds, as they are typically developed on the Virginia side of the Potomac from Mt. Vernon to the mouth of Acquia Creek. This name has now been generally adopted.

The formation has been carefully studied by Prof. W. M. Fontaine of this Institution, and it has yielded to him a number of new plants, to be described in a forthcoming work.

In addition to the locality already mentioned, it is to be found in this State at Rocketts, near Richmond, at Dutch Gap, and other points along the James, and quite frequently in the vicinity of Petersburg.* In this locality it rests upon the Archean, and is consequently the oldest fossiliferous group here displayed. It serves as a base for the Tertiary and Appomattox, and hence is deeply covered, being exposed only in the deepest natural excavations. Two characteristic types are here presented, viz:

1st. Strata consisting in part of water-worn, rounded pebbles. These vary in size, color and composition, being mainly small, white quartzites. They are packed in a light-colored mixture of quartz grains and kaolin, which varies from a sand to a pretty firm sandstone. The white quartzite pebbles, as stated by Rogers, appear identical with the Potsdam quartzites now found in place only on the west side of the Blue Ridge.

2d. Incoherent argillaceous sand, like the finer portion of the first-named variety, ranging in color from light grey or white to various deep colors, such as shades of red, yellow and brown. This sometimes contains kaolinic laminæ and

* Geology of the Virginias, page 448.

masses. These latter are characteristic, and the debris of clay strata which have been torn up, transported and rolled by the floods and currents during Potomac times into the ellipsoidal shapes in which they are commonly found.

The following are typical exposures, viz:

(*a*) The base of the bluff forming the northern boundary of the Appomattox flood plane and the section[5] cut through it by the Petersburg Turnpike show below the Quaternary and Appomattox deposits, hereafter to be described, the following Potomac strata. (The strata are given here and in all other sections in the order descending.) These strata are shown in Section A.

4—Rounded pebbles of quartzite not fully exposed, seen, .	3 feet.
Concealed ground, ...	10 "
5—Light brown clay, ...	1 "
6—Dark blue clay, ...	2 "
7—Pebbles, bedded in impure kaolin, ...	20 "

No. 4 consists almost entirely of compacted pebbles, with very little sand.

Nos. 6 and 7 resemble somewhat the Appomattox strata, hereafter described; but they are more homogeneous, and contain much more sand. No. 7 also contains a considerable amount of comminuted vegetable matter. It may be noted that these strata were not seen elsewhere. Similar exposures, without the clay, Nos. 6 and 7, are found at the cutting[6] through this same bluff along Whitehead's road, at Gatling's on the Appomattox, near Petersburg waterworks[7], at the hill in Pocahontas forming the northern river bank[8], and at Swift Creek crossing of the Atlantic Coast Line[9].

(*b*) An exposure[10] in the side of the table land, which begins on the south side of the river and forms its bank to Bull Hill, shows below the Appomattox, the following Potomac strata, viz.: [See Section B.]

10—Large pebbles, one to five inches diameter, with hardly any matrix, ...	15 feet.
11—Fine yellow sand, ...	3 "
12—Fine, compact, white sand, ...	10 "
13—Layer of iron oxide, ...	1 inch.
14—Fine red sand, ...	2 feet.
15—Pebbly stratum, seen, ...	1 foot.

The pebbles in 10 are in the main water-worn quartzites.

The kaolinic masses before mentioned are imbedded in 11 and 12.

(*c*) Along the line of the Norfolk and Western Railroad[11] these strata are

exposed as highly colored, loosely compacted sandstone with white sandy clay layers and masses of the same. The colors, red, yellow and white, graduate into each other at some places, and at others present a variegated and mottled appearance. Near the end of the last cut[12], where the bank is nearly twenty-five feet high, we find, on the surface, red sand, penetrated by white clay laminæ, gradually merging into deep yellow sand, to which it is fully changed within twenty feet. Below this comes a brick-dust colored stratum containing white and greyish clay masses, some as large as five feet by eight inches. This passes, in descending, into a white sand, which forms the base of the exposure. This sandy material is also to be found along this road[13], in Dinwiddie County.

(*d*) Another exposure along the City Point Railroad[14] again shows the Appomattox resting on the Potomac. We have here the following series of Potomac strata, shown in Section E:

11—Pebbles, one to six inches diameter, water-worn and imbedded in impure kaolin, ...	2½ feet.
12—Smaller pebbles, with no cementing material, .	3 "
13—Fine white sand, seen, ...	1 foot.

Tertiary.

The region examined is within the Miocene District of Rogers, and only Miocene strata have been positively identified.

The beds are developed on the south and southeastern sides of the city. The more common shells can be found all along the course of Lieutenant Run, which has transported them from their native bed[15], near its head. The bed, more or less exposed along the Run for five hundred feet, consists of various shells closely packed in fine blue clay. At its beginning, or upper portion, the larger varieties predominate; but, as we descend the smaller species become more abundant, until near the base Turritellæ are found alone.

The bank, near the water-works[7] (see section "C"), is partly composed of Tertiary strata, here consisting of compact yellow clay, containing casts of Chamæ with a lower layer of fine greenish sand.

The same strata outcrop near the Crater[16] and have been worked for marl. There are on exhibition in the Crater Museum sharks' teeth and a portion of the head, the vertebra and several ribs belonging to a Cetacean dug from this bed. The "Marl Bank Farm," in this same locality, is also said to show interesting exposures.

QUATERNARY.

The Quaternary near Petersburg is developed generally in the form of a compact, homogeneous clay of such consistency as to be useful in brickmaking, though a few localities show other types. Its characteristic feature is the facility with which it is worn and cut into pillars and fantastic shapes.

We note the following exposures, viz.:

(*a*) At the brick kiln[17] in Chesterfield County, the deposit consists of homogeneous, compact, yellowish clay, showing no lamination. It is exposed for a maximum depth of eighteen feet, and is developed in a southwest direction.

On the north side of the wood the stratum is much thinner, and is overlaid with a hard pan of iron. Wherever this is broken so as to allow the percolation of water the clay is sculptured into little columns, each bearing on its top a small portion of the ferruginous layer. Similar deposits can be seen on Fleet's Hill[18], at Whitehead's[19], at kiln marked "20" (see map), along Atlantic Coast line, City Point Railroad and the river, on Water Works Hill and near the Cemetery[21] in Blandford.

(*b*) An exposure[8] in the bank in Pocahontas, opposite the mouth of Lieutenant Run, shows a rather unusual type. We have here four feet of large water-worn pebbles and boulders, some as large as three feet by six, resting upon the Potomac.

THE APPOMATTOX.

The Appomattox formation is composed of those strata which overlay the Miocene, and which were considered by Prof. Rogers as occupying a doubtful position in the Tertiary series.

They are described by him as "Argillaceous and ferruginous sand, of a "yellow, and sometimes of a reddish color, in which are occasionally found, at "or near the surface, pebbles and small boulders of sandstone, rarely as much "as six inches in diameter. In some places this stratum consists of little else "than a white siliceous sand; *in others, the admixture of ochreous clay is so con-"siderable as to furnish a suitable material for the manufacture of bricks.** Beneath "this superficial layer, beds of a very argillaceous clay occasionally occur, some-"times of a considerable depth and of a texture to be useful in puddling. Its "color is various, being in some places a dark blue or green, in others of a bright "red or dingy yellow. In many places the argillaceous beds consist of yellowish "clay, beautifully variegated by streaks of blue and red.

* Italics ours. This is most probably Quaternary.

"A thin stratum of red ferrugenous stone, containing a large proportion of "oxide of iron, is found in this region, running horizontally below and some- "times in the beds of clay before described, and generally separated by only a "few feet from the underlying masses of shells."*

In the vicinity of Petersburg, the Miocene beds have been eroded to such an extent that the strata mentioned above are seldom to be found resting upon them, but more generally upon the Potomac, and sometimes upon the Archean, thus demonstrating that these strata are considerably younger than the youngest of the Tertiary series. The formation, so far as we have been able to ascertain, contains no fossils. It is so variable that no general description will include all exposures, though the variation is mainly between siliceous and argillaceous sand and compact clay. It is particularly well developed in the neighborhood of Petersburg, but it is not confined to this locality. The following exposures from the "Geology of the Virginias" are given to show its character in other parts of the State.

(*a*) At King's Mill†, near Williamsburg, the deposit of Miocene shells is covered by the following Appomattox strata, viz.:

1—Brownish yellow sand mixed with stripes of clay, . .	6 feet.
2—Red, ferruginous and argillaceous clay, . . .	1 foot.
3—Yellow sand, ...	2 feet.

(*b.*) On York River, the fossiliferous beds are "covered to a variable depth "by a stratum of coarse sand of various strong tints and evidently highly ferru- "ginous‡."

(*c*) The Stratford cliffs in Westmoreland County, near the mouth of Chantilly Creek, show below the shallow soil and diluvial gravel about forty feet of alternately sand and ferruginous mottled clay§—Appomattox.

(*d*) The banks of the Rappahannock, in Lancaster County, show:

(1) Six feet of diluvium—Quaternary.

(2) Five feet of sand with ferruginous blotches‖—Appomattox.

*Geology of the Virginias, page 30. † Page 36. ‡ Page 37. § Page 428. ‖Page 431.

EXPOSURES IN THE NEIGHBORHOOD OF PETERSBURG.

A.—Exposures along the Atlantic Coast Line.

(*a*) At "22" (see map) we find the following strata:

1—Red, argillaceous sand,	6 feet.
2—Reddish sand, well mixed with fine pebbles,	10 "
3—Red clay, with purer grey laminæ,	4 "
4—Compact, grey clay,	12 "
5—Ferruginous sand,	2 "

The last two strata are exposed in the banks of a branch[23] near the first cut.

(*b*) At Butterworth's bridge[24] a characteristic exposure is to be seen. The material shown is about twenty feet thick, and consists of red, mottled clay, more or less sandy, neither stratified nor laminated, but divided by seams into irregular shapes, the whole presenting the appearance of cracked material penetrated by a blood-red liquid. The bank shows a tendency to weather into rounded, mottled fragments, which, when moist, seem as if blood stained.

Another exposure of the same character and appearance is to be found at the "crater"[16]. Here, however, the material is more homogeneous, containing but little, if any, sand. When moist it is like putty in consistency. Mr. Griffith uses it for models of the brass uniform mountings found upon his farm as relics of the Crater fight shown to visitors.

B.—Exposures along Lieutenant Run.

The course of this stream is through a valley varying from one to five hundred feet in width, and bounded by bluffs approximately parallel ranging from twenty to a hundred feet in height. We have along it the following exposures, viz:

(*a*) A section[25] of the northern bluff about five hundred feet east of Butterworth's bridge shows the following strata:

1—Fine pebbles, averaging one inch diameter,	4 feet.
2—Red, sandy clay, laminated,	1 foot.
3—Whitish sand, seen,	10 feet.

No. 3 is laminated by red sandy veins and presents a marbled appearance.

(*b*) The Miocene outcrop fines out within five hundred feet, a stratum of fine sand and pebbles resting upon and succeeding it as we go down the stream, the whole being overtopped by twenty to thirty feet of red pebbly Appomattox clay.

(*c*) The strata exposed at and near Water Works Hill[26] are as follows (see section "C"):

1—Red clay,	Quaternary,	15 feet.
2—Grey clay, veined,	Appomattox,	50 "
3—Compact yellow clay,	Miocene,	4 "
4—Greenish siliceous sand, not seen,	Miocene,	6 "
	Miocene,	5 "
5—Blue clay, no fossils,	Miocene,	6 "
6—Fine white sand,	Miocene,	2 "
7—Iron layer,	Potomac,	1 to 2 inches.
8—Quartzites,	Potomac,	5 feet.

"1" forms the summit of the hill, is compact red clay, and could be used for brickmaking.

"2" is a homogeneous grey clay, with hardly any grit, neither stratified nor laminated, but divided by thin, yellow, ferruginous layers into irregular masses.

"3" contains casts of Chamæ.

"4" contains no fossils, and is not the Eocene sand.

"8" is composed of water-worn rounded quartzites, varying from one to five inches in length, bedded in a white clay.

Like exposures are to be found higher up on both sides of the Run, at the head of Sycamore street[27], and at Johnston's road crossing[28].

C.—Exposures along Richmond and Petersburg Railroad.

(*a*) At the point "29" (see map) where this road is cut through the bluff before mentioned as forming the northern limit of the Appomattox flood plane, we have the following series of strata:

1—Reddish sand,	12 feet.
2—Fine pebbles,	2 feet.
3—Red clay seam,	18 inches.
4—Fine red sand,	15 feet.

"2" has for its matrix fine clay. The pebbles are water-worn and not over two inches diameter.

"4" is nearly pure, but is laminated by ferruginous layers and contains fine pebbles.

The *second* stratum on the eastern side, about five hundred feet from the beginning of the cut, consists of five layers of white sand and shows a distinct dip, which is the more noticeable, as the stratum does not outcrop, but becomes nearly horizontal.

(*b*) At "30" (see map) the strata are well exposed, as the sand from this locality is used as ballast. We note the following order of superposition:

1—Red clay,	Quaternary,	6 feet.
2—The same, but more sandy,	Appomattox,	4 "
3—Ferruginous layer,		3 inches.
4—Red sand,		3 feet.
5—White sand, seen,		4 "

"2" consists of red clay laminated with grey layers of purer material, and distinctly separated from 1.

The two sandy strata, 4 and 5, yield fine, well divided sand.

D.—Exposures along Petersburg Turnpike.

The strata exposed along the cut[5], through which this road mounts the bluff, are shown in Section A. The Potomac strata forming the base, and the Quaternary the summit, have already been described. Upon the Potomac, we have the following:

2—Sand, graduating into sandy clay, red,	12.5 feet.
3—Yellowish, mottled clayey sand,	15 "

In Section "A" the strata from 4 to 8, inclusive, are developed along the road; 1 to 3 are shown at "20." "2" is further subdivided as follows:

(1) Sandy clay, red,	6 feet.
(2) Fine white sand,	6 inches.
(3) Red clay,	1 inch.
(4) Fine white sand,	9 inches.
(5) Red clay,	1 inch.
(6) Coarse white sand,	1 "
(7) Purer and finer white sand, seen,	5 feet.

The sand from 2 to 6, inclusive, is mixed with finely divided mica, and the separating clay layers contain black laminæ, seemingly of organic origin.

E.—Exposures along and near City Point Railroad.

(*a*) At Norfolk and Western crossing[31], below the usual soil, we find:

1—Sand,	1 foot.
2—Pebbly stratum,	1.5 "

3—Sand, with fine pebbles,	2	feet.
4—Mixed pebbles, one to four inches diameter,	2	"
5—White sand veined with red,	5	"
6—Fine white sand, seen,	2	"

(*b*) Another exposure[32], about one thousand feet toward the city along the road from City Point, shows about twenty feet of coarse red sand, which becomes finer toward its base and is irregularly stratified with pebbles and fine white sandy layers.

(*c*) Along the Norfolk and Western Railroad, about four hundred feet from "31," we find thirty feet of dark red sand, neither stratified nor laminated. This is seemingly just above the stratum numbered one.

(*d*) At the point marked "14" on map there is an extensive pocket, or local deposit, of almost pure sandy strata somewhat similar to those already described along the Richmond and Petersburg railroad. We have here (see also Section "D"):

1—Fine, deep red clay,	Quaternary,	2 feet.
2—Gritty white sand, with fine sand laminæ,	Appomattox,	3 "
3—White sand, obliquely laminated,		5 "
4—Blackish-yellow sand,		6 inches.
5—Yellow sand, mixed with fine grit,		1 foot.
6—Fine pebbles,		2 inches.
7—White sand, seen,		2 feet.

"3" is separated into layers by thin strata of pure grit.

"4" contains much iron, and is overlaid by a variable layer of dark, black grit.

"3" rests unconformably upon "4," as shown, indicating a lapse of time between the deposition of these strata. This unconformability seems local, as it was not noticed elsewhere.

The oblique lamination and inclined stratification of "3" indicate local, rapid shifting currents, or the chafing of the waves on an exposed beach.

"7" is penetrated by irregular laminæ of finely-divided dark, black stuff, possibly the remains of decomposed vegetable matter. These same laminæ were observed and noted in the exposure along the turnpike road in Chesterfield County.

(*e*) Along this same railroad, about three miles below the city, the following series of strata are to be observed (see Section E):

1—Red, sandy clay,	Appomattox,	1.5 feet.
2—Fine yellow sand, with fine pebbles,		2 "
3—Ditto, but with fewer pebbles,		3 "
4—Fine white, compact sand,		2.5 "
5—Water-worn pebbles,		4.5 "
6—Fine, red, sandy clay,		2 inches.
7—Pebbly stratum,		1.75 feet.
8—Red, sandy clay,		2 "
9—Fine pebbles,		0.5 foot.
10—Red, sandy clay,		2 feet.
11—Pebbles, packed in sand,	Potomac,	2.5 "
12—Smaller pebbles,		3 "
13—Fine, white sand,		1 foot.

Strata, from 1 to 5, inclusive, are to be seen along the railroad cut; from 6 to 13 along the county road as it crossed the railroad.

"11" consists of water-worn pebbles, one to six inches in diameter, bedded in impure kaolin.

"12" contains smaller pebbles of same kind, but with no cementing material.

F.—Exposures along Appomattox River.

The stream flows upon the Archean rocks from Matoaca[33], and until we reach Campbell's bridge[1] the water is churned into foam by the irregular bed. Below this bridge the Archean strata outcrop but seldom, the last exposure being in the vicinity of Pocahontas.

The river is separated from a parallel bluff on its northern side by an intervening bottom of varying width, seldom over five hundred feet. The bluff, whose several exposures have been noted, extends far up, but bends toward the north near Pocahontas, and for several miles down the river this shore is low and swampy. Upon the southern side, the corresponding bluff rises from near the water level at Pocahontas bridge[34] to about thirty feet above it, near the junction[31] of the City Point and Norfolk and Western Railroads. About six hundred feet from this point, a table land begins and forms the southern bank to Bull Hill. It is approximately fifty feet high upon the river side, and nearly vertical. Arranging the Appomattox strata here[10] exposed, in order of superposition, we have the following series (see Section "B"):

(*a*) 1—Red sandy clay, ... 1 foot.

2—Red sand, purer,	2½ feet.
3—Hardened sandy clay,	3½ "
4—Layer of iron,	1 inch.
5—Pebbles, none greater than one inch diameter,	2 feet.
6—Pebbles, but finer than 5,	3 "
7—Fine red sand mixed with pebbles,	4 "
8—Green siliceous sand,	2 "
9—Fine pebbles mixed with sand,	10 "

10, 11, 12, 13, 14, 15, Potomac, and described under that head.

(*b*) The following series of strata were exposed by the land slide at Gatling's farm, about six miles below the city (see Section F):

(1) Compact, ferruginous red sand,	Appomattox,	3 feet.
(2) Compact white sand,		5 inches.
(3) Red sand, same as "1,"		17 "
(4) White sand, same as 2,		10 "
(5) Red sand, but with fine pebbles,		14 "
(6) Fine red clay, stratified,		3 "
(7) Very fine compact clay, no pebbles,	Potomac,	3 feet.
(8) Water-worn pebbles, seen,		4 "

"7" may be Miocene, but it could not be identified.

"8" consists of water-worn pebbles from one-fourth to twelve inches in diameter, bedded in impure kaolin.

G.—These strata are also developed along the Petersburg and Asylum Railroad. Here they consist of fine red sand and sandy grit. Near the Asylum[2] they rest on the Archean.

H.—The few exposures along the river road to Matoaca show sandy grit overlaid here and there with red clay. An old well near this road[35] showed ten feet of compact red clay separated by grey clay laminæ.

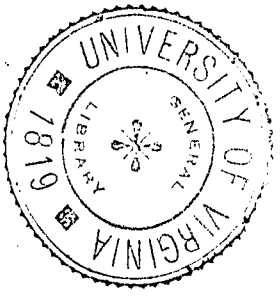
Conclusion.

The absence of fossils, irregular stratification, varying composition and often coarse texture of the Appomattox deposits indicate that the materials were laid down in comparatively shallow and agitated waters which were loaded with sediment.

The events seem to have been a shoaling of the Tertiary seas to bring their

deposits within the action of the waves, then deepening, to permit laying down of the Appomattox. This would require a long time, as a material change in the topography took place, and the Miocene beds, where the Appomattox rests on them, often show much erosion.

In Miocene times, in the vicinity of Petersburg, deep seas crowded with marine life prevailed. In Appomattox times the conditions appear to have been favorable for the deposition of shore and off-shore deposits, with no trace of life.



APPENDIX.

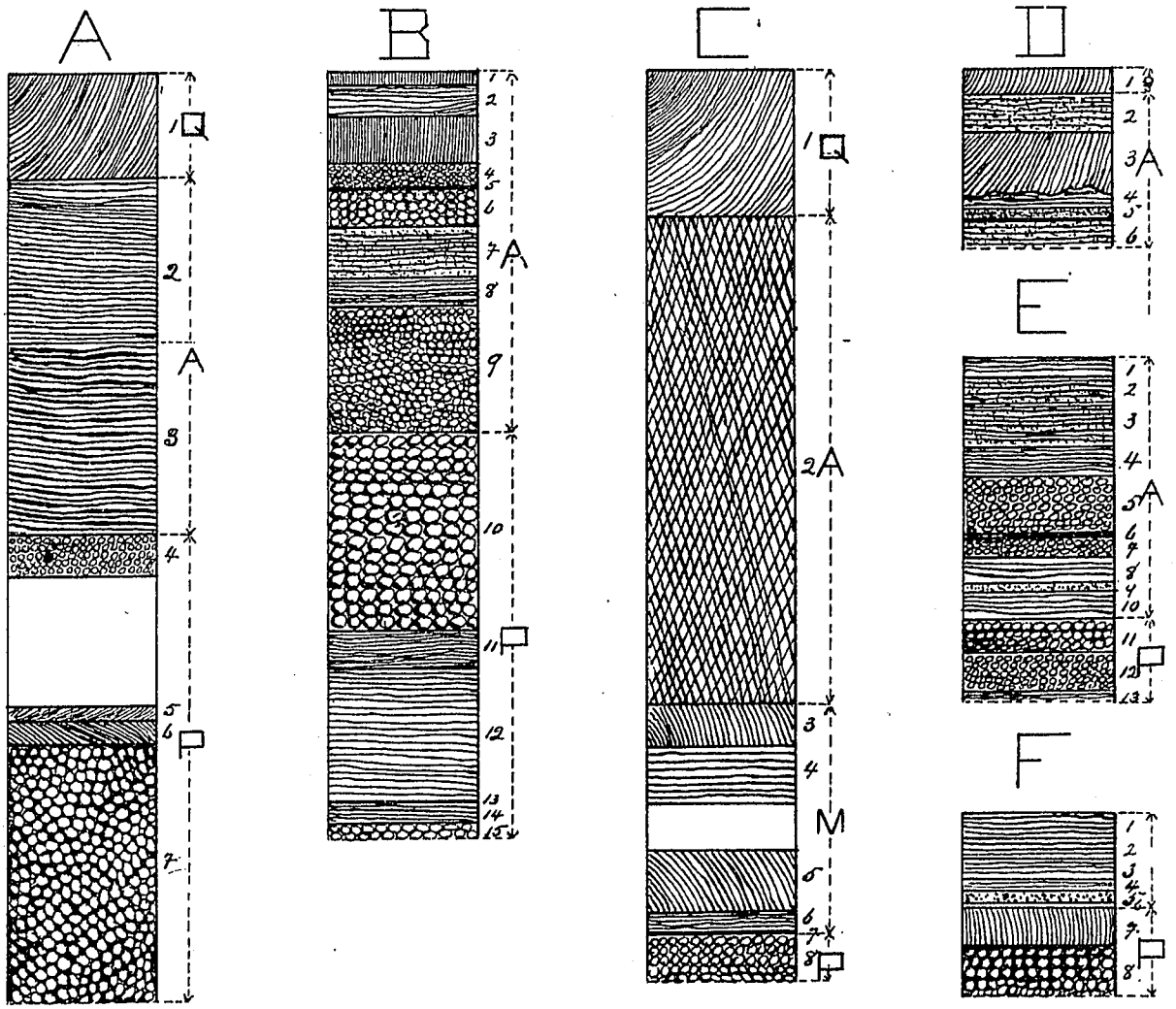
Analysis of a specimen of clay from the bank at the head of Sycamore street[27], by Percy H. Walker, Esq.:

Constituents Sought.	Per Cent.
SiO_2 (hydrated),	18.69
SiO_2 (quartz),	46.97
Al_2O_3,	17.75
FeO,	3.54
K_2O,	2.30
Na_2O,	.57
M_9O,	.74
H_2O,	9.93
CaO,	Trace.

Analysis of a specimen from the "Crater[16] Farm," by E. Lacy Gibson, Esq.:

Constituents Sought.	Per Cent.
SiO_2 (hydrated),	.91
SiO_2 (quartz),	71.23
TiO_2,	1.20
Al_2O_3,	12.87
Fe_2O_3,	4.24
CaO,	.70
MgO,	Trace.
Na_2O,	.33
K_2O,	.98
H_2O,	7.13

SECTIONS.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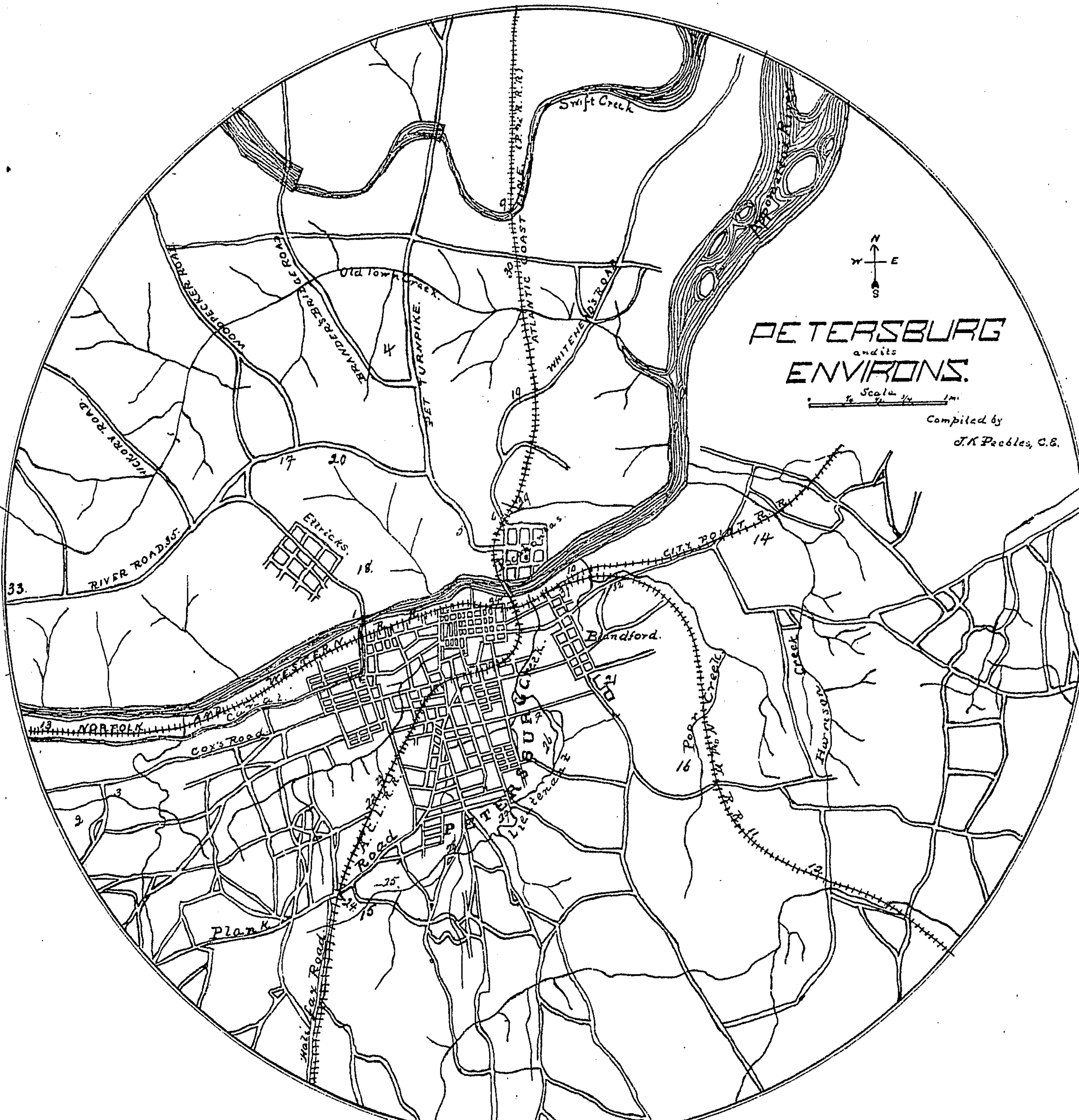
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BRANDERS BRIDGE ROAD
TURNPIKE
ATLANTIC COAST LINE
WHITEHEAD'S ROAD
HICKORY ROAD
RIVER ROAD
Ettricks
CITY POINT R.R.
Blandford
Poor Creek
Harrison Creek
NORFOLK
Canal
Cox's Road
Plank
Halifax Road
Road
Lieutenant