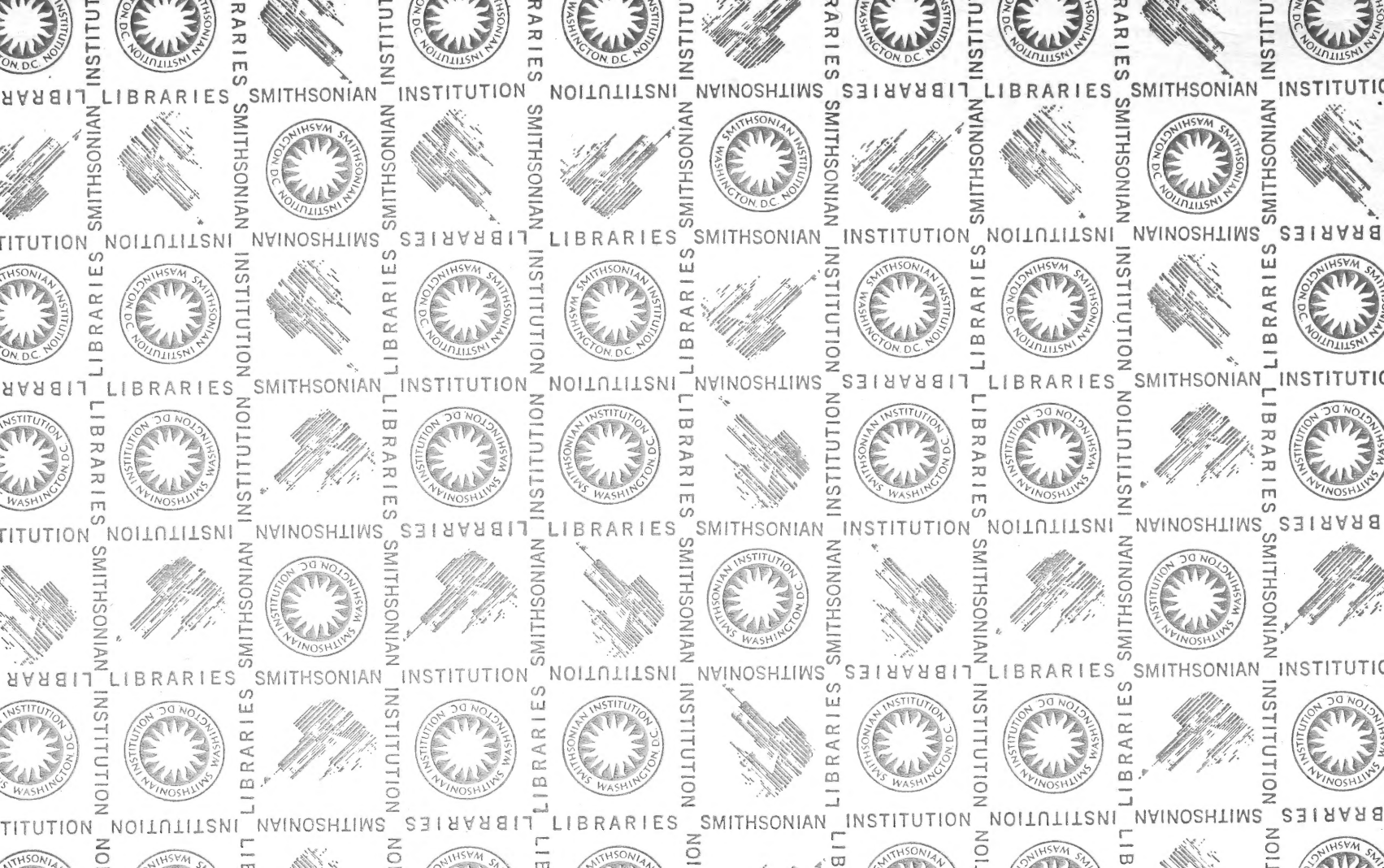
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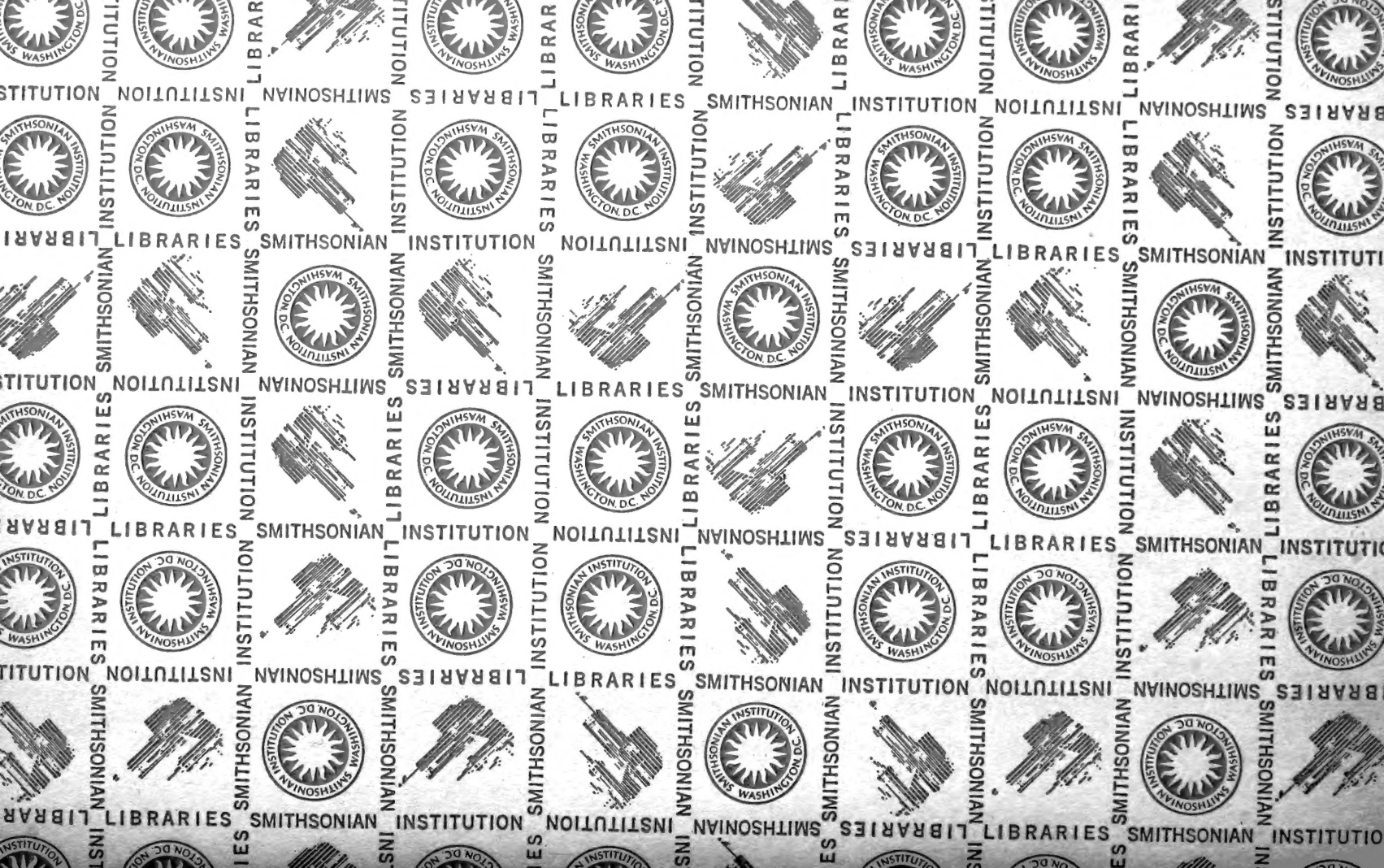
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University of the State of New York

BULLETIN

OF THE

New York State Museum

VOL. 3 No. 12

MARCH 1895

CLAY INDUSTRIES OF NEW YORK

PREPARED UNDER THE DIRECTION OF

FREDERICK J. H. MERRILL, PH. D.

BY

HEINRICH RIES, PH. B.

ALBANY
UNIVERSITY OF THE STATE OF NEW YORK
1895

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ERRATA

Page 130, line 2, "furstules" should be "frustules."

Page 151, seventh line from bottom, "are refractory" should be "are not refractory."

Page 184, "Jova," not "Jover."

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Note by the Director.

The study of the Quaternary deposits of the Hudson River valley was undertaken by me several years ago, and a paper on the subject was published in the American Journal of Science.* In continuation of this it seemed important to investigate the economic side of the question and report on the brick industry, which is so highly developed in this region. The confining duties of administrative work in the museum rendered it necessary for me to delegate the work of the economic investigation, and it was placed in the hands of Mr. Heinrich Ries, Ph. B., who, during the summer of 1891, made a careful study of the methods of brick manufacture in the Hudson River valley, and extended the investigation of the Quaternary geology of this region.† During the season of 1892, the necessity for making a representative collection of clays throughout the State of New York, for the World's Columbian Exposition, afforded an opportunity for obtaining information concerning the clay industries of the interior of New York and of Long Island. As the result of his work conducted during these two seasons, Mr Ries has prepared the following report. Nearly every locality of importance in the State has been visited, and as it is the only exhaustive report on the subject which has been prepared in this country, it commends itself to all who seek information concerning the industrial uses of clay in New York

F. J. H. MERRILL,
Director.

PREFACE.

The following report is intended to deal chiefly with the economic aspect of the subject. In the time at my command it has not been possible to visit all the deposits which are being worked, and, therefore, much information has necessarily been gathered by correspondence. The analyses given in the report have all, unless otherwise stated, been made by Dr. H. T. Vulte, of Columbia College, New York city. All the methods described for obtaining the raw material and working it up to a finished product are those employed in the State of New York.

The writer wishes to express his thanks to Dr. F. J. H. Merrill for suggestions offered during the course of the work. Credit for assistance rendered is due to Messrs E. J. Riederer, of New York city, C. L. Sanford of Southold, L. I., E. J. Burke

*Vol. XLI, June, 1891.

†The results of this work were published in the Annual Report of the State Geologist for 1890.

of Rochester. Mr J. J. Clearwater of Highland, N. Y., and Messrs P. H. and J. Conlon of Newark, N. J., have kindly furnished the records of a number of wells bored by them. In the preparation of this report the following books and periodicals have been consulted: The Clay Worker, the Brickmaker, Brick, Tiles and Terra cotta by C. T. Davis, Engineering News, Engineering Record, and the Encyclopedia Britannica.

The increasing value of clay for the manufacture of brick, tile, terra cotta, pottery, etc., and the ever growing demand for these products have given rise to an industry which is rapidly assuming vast proportions, and will in the near future become one of the most extensive and important in the country Scattered over New York are extensive deposits of clay, many of them capable of being used for the manufacture of terra cotta, roofing tile and the coarser grades of pottery. To add to their value the most extensive beds of clay are situated in close proximity to the water ways and railroads which lead to the principal cities of the state. The commoner kinds of clay products, such as building brick, are marketed within the state, but the higher grades, such as terra cotta and roofing tile, have found good markets outside of New York.

The following table gives the receipts derived from the various branches of the clay industry during the year of 1892:

Building, front and paving brick	$8,500,000
Terra cotta	100,000
Sewer pipe	260,000
Fire brick*	50,000
Stoneware clay	10,000
	$8,870,000

As will be seen from the above statement bricks are the chief source of income. That the other branches of the clay industry are not further advanced is probably due in a large measure to the fact that the clay deposits of the state have been so little exploited or otherwise examined. Though many of the deposits have been opened up and are still being worked, there are numerous others scattered over the state which are still untouched.

*This does not include those manufactured in the state from clays obtained in other states.

Few of the clays are found to be of sufficiently refractory character to be used for making fire brick, gas retorts, or other products which in use are subjected to a high degree of heat; but for the manufacture of coarse pottery, terra cotta, paving brick, etc., many of the clays are eminently suited.

Within the last four or five years the manufacturers in New York have turned their attention toward the extensive beds of argillaceous shale which the state contains, and which on trial have given very satisfactory results. Several large firms are using them for the manufacture of sewer pipe, terra cotta and roofing tile. The shale formations at present used are the Salina, Hamilton and Chemung. The Hudson River shales are no doubt sufficiently argillaceous over many areas to be used for the manufacture of clay products, and the same may be said of the Niagara shale, which weathers to a red clay. A sample of this latter shale from Niagara Falls was first ground and then molded in a stiff mud machine and found to burn to a white brick, which was unaffected by a temperature of 2,500 degrees.

That the clays and shales of New York are comparatively undeveloped is, no doubt, largely due to the lack of knowledge of their extent and character. There seems, however, to be no reasonable doubt that they will in future become a valuable source of revenue.

HEINRICH RIES.

New York city, April, 1893

GEOLOGY AND GEOGRAPHY OF THE CLAY DEPOSITS.

Deposits of clay occur in nearly every county of New York. They belong to three geological periods, viz.:

Quaternary, Tertiary and Cretaceous.

The first class is by far the most common. The second class is somewhat indefinite in extent, but a large number of the Long Island deposits probably belong to it.* Of the third class there are undoubted representatives on Long Island and Staten Island, as well as some additional ones on Long Island, which are questionable.

The clays of the mainland are all Quaternary so far as known. The problems of the Quaternary formations in New York are by no means solved, and it is not always possible to decide on the causes leading to the deposition of any particular body of clay by a single visit to the locality.

A great majority of the deposits are local and basin-shaped, lying in the bottoms of valleys which are often broad and fertile. They vary in depth from four to 20 or even 50 feet; as a rule they are underlain by modified drift or by bed rock. The clay is generally of a blue color, the upper few feet being weathered mostly to red. Stratification is rarely present, but streaks of marl are common. In some of the beds small pebbles, usually of limestone, are found, and these have to be separated by special machinery in the process of manufacture. In many instances the clay is covered by a foot or more of peat.

The basin-shaped deposits are no doubt the sites of former ponds or lakes, formed in many instances by the damming up of the valleys, and which have been filled later with the sediment of the streams from the retreating ice sheet. The valleys in which these deposits lie are usually broad and shallow. The broad flat valley in which the Genesee River flows from Mt. Morris to Rochester is a good example. The waters of the river

* F. J. H. Merrill, Geol. of L. I., Ann. N. Y. Acad. Sci., Nov., 1884.

were backed up by the ice for a time, during which the valley was converted into a shallow lake in which a large amount of

Old lake bottom, Spencer, N. Y.

aluminous mud was deposited. This material has been employed for common brick.

An idea of the depth of clay and alluvium in the Genesee valley may be had from the following table:

The figures have been taken from the records of salt wells.

York†	York Salt co.	Clay	52 ft.
Piffard†	Genesee Salt co.	Clay and gravel	64 ft.
" †	Livingston Salt co.	"Soil"*	158 ft.
Cuylerville†	.....	"Soil"	184 ft.
Mt Morris‡	Royal Salt co.	"Soil"	191 ft.

For other localities the following depths are given:

Aurora†	.....	Blue clay	15 ft.
Wyoming†	Pioneer Well	Soil and clay	40 ft.
Warsaw†	Standard Salt co.	Surface, soil and clay	26 ft.
" †	Guinlock and Humphrey	Clay	17 ft.

There are a number of these deposits which are of sufficient interest, geologically as well as commercially, to be mentioned in some detail.

*The term soil is probably meant to indicate sand and clay.

†I. P. Bishop, 5th Ann. Rep't, N. Y. State Geologist, 1885.

‡Ann. Rep't, Sup't Onondaga Salt Springs for 1888, p. 19.

There is a bed of clay at Dunkirk having a depth of over 20 feet. The upper six feet are yellow and of a sandy nature, while the lower two thirds is blue and of much better quality. It is mentioned by Prof. Hall* in his report, and is an instructive example of the manner in which the clay changes in color, downward as far as the water can percolate and oxydize the iron.

Around Buffalo is an extensive series of flats underlain by a red clay. A thin layer of sand suitable for tempering overlies the clay in spots, and limestone pebbles are scattered through it. Similar deposits occur at several localities to the north of the ridge road and around Niagara Falls, also at Tonawanda and La Salle, to the north of Buffalo, as well as south of it along the shore of Lake Erie. No doubt much of this clay was deposited during the former extension of the Great Lakes.

Prof. Hall mentions deposits of clay at the following localities: at Linden one mile south of Yates Center;† along the shore of Lake Ontario east of Lewiston; on Cashaqua Creek‡ deposits of tenacious clay due to the crumbling of the argillaceous green shales; in Niagara County§ beds of clay are said to occur in every town, but they often contain a considerable amount of lime.

A bed of blue and red clay is being worked at Brighton near Rochester. This deposit lies near the head of Irondequoit bay and was deposited by some stream flowing into it. To the southeast of Rochester is a large esker which extends in a northeast direction to near Brighton. Mr. Upham, who has described this esker, considers that it was formed by a river which flowed between walls of ice and deposited the bed of clay above mentioned.‖

Clays are also found at several points in the valley of the Oswego River from Syracuse to Oswego, an important one being at Three Rivers.

An extensive bed of red and gray clay, 20 acres in extent and horizontally stratified, occurs at Watertown. The deposit is 20 feet thick and rests on Trenton limestone.

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* Geology of New York, 4th District, 1843, p. 362.
‡ Ibid. p. 227.
† Ibid. p. 437.
§ Ibid, p. 444.
‖ Proc. Amer. Asso. Adv. Sci., vol. XLI.

Another deposit of considerable size is being worked at Ogdensburg. The clay is blue and has a depth of 60 feet.

At Madrid, in St. Lawrence county, is a small deposit, probably the remnant of a formerly extensive one. The section is:

Yellow stratified sand	3 feet
Blue clay with shells	1 "
Blue clay	20 "
Total thickness	24 "

The shells are probably *Macoma fusca.*

Turning our attention to the southern portion of the state we find clays in abundance, in all the valleys, and lowlands. The extensive marshes near Randolph and Conewango are said to be underlain by clay throughout their entire extent.*

At Levant, four miles east of Jamestown, Chautauqua county, is an interesting bed of blue clay underlying an area of several acres. It is probably of post-glacial age, and the section as determined by an artesian well-boring is :

Yellow sand	4 feet
Quicksand	4 inches
Yellow clay	5 feet
Blue clay	70 "
Hardpan	"
Total thickness	83 "

The owner of the clay bed informed me that leaves were often found between the layers of the clay at a depth of 15 or 20 feet.

At Breesport near Elmira is a bank of blue clay rising from the valley to a height of 50 feet. It was evidently formed when the valley was dammed up, and has subsequently been much eroded so that all that now remains is a narrow terrace along the side of the valley. A similar deposit is found at Newfield south of Ithaca. A moraine crosses the valley a mile or two south of it. Deposits of clay suitable for brick and tile occur extensively in the lowlands bordering the Mohawk River from Rome to Schenectady. The beds vary in thickness from six to 15 feet and are mostly of a red, blue, or gray color.

* Geol. New York, 4th district, 1.

Among the most extensive and important clay formations occurring in New York are those of the Hudson valley.* Here are deposits of two types. (1) Estuary deposits of fine stratified sand, yellow and blue clay, and (2) cross bedded delta deposits, the materials of which are much coarser. The estuary deposits indicate a period of depression, and deposition in quiet water. The clay is chiefly blue, but where the overlying sand is wanting or is of slight thickness, it is weathered to yellow, this weathering often extending to a depth of 15 feet below the surface, and to a still greater depth along the line of fissures through which the water can percolate. The depth of oxidation is of course influenced by the nature of the clay; the upper portion weathering easily on account of its more sandy nature and hence looser texture. Horizontal stratification is usually present and the layers of clay are separated by extremely thin laminæ of sand. At some localities the layers of the clay are very thin and alternate with equally thin layers of sandy clay. This condition is found at Haverstraw, Croton, Dutchess Junction, Stony Point, Fishkill, Cornwall, New Windsor, Catskill and Port Ewen. At all of the above-mentioned localities except the last two, the clay is overlain by the delta deposits of rivers tributary to the Hudson, and the alternation of layers may be due to variations in the flow of the rivers emptying at those points, the sandy layers being deposited during period of floods. The delta of Catskill creek has been found at Leeds, some two miles west of the Hudson River.† The delta of Rondout creek which flows into the Hudson at Port Ewen will no doubt be found by following the creek back to the ancient shore line of the Hudson estuary. Isolated ice-scratched bowlders are not uncommonly found in the clay.

There is often a sharp line of division between the yellow weathered portion and the blue or unweathered part of the clay. The line of separation between the clay and overlying sand is also quite distinct in most cases. Of the blue and the yellow clay the former is the more plastic, but both effervesce readily with acid due to the presence of three to six per cent of carbonate of lime, and

*H. Ries, Rep't of N. Y. State Geologist, 1890.
†W. M. Davis, Proc Bos. Soc. Nat. His. Nov. '92.

are therefore, properly speaking, marly clays. The clay is underlain by a bed of gravel, sand, hardpan, bowlder, till or bed rock. From Albany to Catskill the underlying material is a dark gray or black sand with pebbles of shale and quartz. The sand grains are chiefly ground up shale, the rest being siliceous and calcareous with a few grains of feldspar and garnet. This sand can often be used for tempering but at Catskill contains too much lime for this purpose.

I have not observed this underlying sand and gravel to reach a greater height than 90 to 100 feet.

From Catskill northward the clay is in most cases covered by but a foot or two of loam. South of Catskill the character of the overlying material varies. At Catskill a terrace extends back two miles and probably more; it is deeply incised by Catskill and Kaaterskill Creeks and smaller streams; rocky islands project above its surface at various points. Along the West Shore track, about 150 feet south of the station, the side of the cutting consists of thin alternating layers of clay and sand 27 feet thick. Above this in places is nine feet of fine stratified yellowish sand. The clay extends along the track for about one fourth mile until it meets an outcrop of Hudson River sandstone. On the south side of the Catskill Mt. R. R. 100 feet from the bridge is an exposure of sand and gravel, the pebbles being very coarse. It is presumably drift material, but the exposure is an isolated one and does not show its relation to other deposits of the vicinity. At Smith's Dock, on the land of T. Brousseau near the river, the upper portion of the terrace escarpment consists of fine stratified sand, which has been excavated to a depth of 12 feet without finding clay, while farther back from the river the clay extends to within two feet of the terrace level.

The Hudson River shale rises steeply along the water's edge from here down to Malden, and crops out at numerous points in the terrace escarpment. The clay along here is probably not of great depth. Clay is found in the railroad cutting to the north of Malden station, about seven feet above the track level, and clay is exposed in numerous cuttings of the West Shore Railroad, from Malden to Mt. Marion.

From Glasco to Rondout the terrace, which is perhaps one eighth mile broad at Glasco, narrows as it nears Rondout, and

has an average height of 150 feet. The clays, so far as could be ascertained, lie on the upturned edges of the Utica shale.

At the rear of A. S. Staples' yard hardpan underlies the clay. The overlying material at this locality consists of sand and gravel in many instances stratified and sometimes cross-bedded. The sand in some spots is 10 to 15 feet thick and fine enough to be blown by the wind.

At Port Ewen the clay is mostly blue, resting on a mass of hardpan, and in a few places on the glaciated rock surface. According to Mr. Kline, of Port Ewen, the clay around the village is nowhere over 18 feet in actual thickness and is underlaid by hardpan. A point worthy of notice is the difference in level of 50 feet between the terrace at Port Ewen and at Glasco.

It has been suggested by Dr. F. J. H. Merrill that this may be due to the fact that when sediment is deposited in the basin its edge would be higher than the center. The Quaternary formation broadens on toward the west, and Port Ewen would be a point on the basin's edge while Glasco is near the center.

In this connection the following well records are of interest: A boring made on the property of Isaac Tamney, at Eddyville, showed

Sandy loam	10 feet
Quicksand	70 "
Blue clay	10 "
Gravel	... "
	90 "

In boring another well at the same locality the following strata were passed through:

Yellow clay	10 feet
Blue clay	137 "
Gravel	5 "
	152 "

Still another at Rosendale, on the land of R. Lefever:

Loam and yellow clay	20	feet
Sand	50	"
Blue clay	30	"
Gravel	...	"
	100	"

At Lefever Falls:

Coarse sand	40	feet
Quicksand	60	"
Blue clay	42	"
Rock	...	"
Total thickness	142	"

At Rosendale Plains:

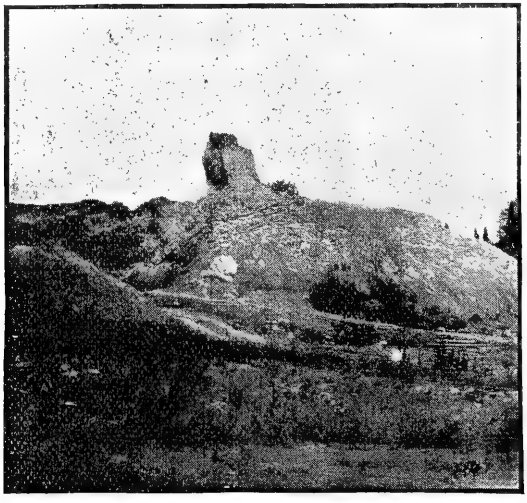
Sandy soil	10	feet
Blue clay	10	"
Quicksand	10	"
Blue clay and quicksand alternating	150	"
Total thickness	180	"

We now come to a narrow portion of the river from Staatsburg to New Hamburg, where the terrace if present is of small extent and presumably underlain by drift material.

Where the river broadens out again at Roseton at the head of Newburg bay, there is a thick bed of clay. It is nearly all blue and underlies the remnant of a terrace 120 feet high, which has escaped entire destruction owing to its position in a reëntrant angle of the upper Cambrian limestone ridge along the river at this point. The overlying stratified sand and gravel is 10 to 15 feet thick. At Jova's upper yard the clay rests on the glaciated limestone, over whose surface are scattered several bowlders of the same rock. The clay at Rose's yard is 180 feet thick, while that at Jova's has a total thickness of 240 feet. A boring of 135 feet made at Rose's yard at river level is of interest in connection with the depth of the preglacial channel of the Hudson.

About 800 feet south of Roseton station the material under the terrace is a yellowish loamy clay, thinly stratified. This may be a portion of the secondary cone of the delta of Wappinger's creek at New Hamburg. North of this a cutting has been made in the terrace escarpment, the section exposed showing alternating layers of yellow and black sand.

From Newburg to New Windsor the clay is overlain by the extensive delta deposits of Quassaic Creek and Moodna River. To



Clay at New Windsor showing glaciated bowlder in it.

the east of Mrs T. Christie's yard the clay, which is mostly blue and thin layered, is overlain by fine gravel and sand obscurely cross stratified in places. Over this is three to four feet sandy soil. The upper layers of the clay are wrinkled in places, probably owing to the oblique downward pressure of the overlying delta deposits. It seems likely that at this spot only a small portion of them remain, much having probably been eroded. At Lang's yard, south of Christie's, there is four to six feet of sand and gravel over the clay, of the same nature as that previously mentioned. Scattered all through the clay are cobbles of limestone. The upper strata are loamy and contorted, while underneath in the yellow clay, which is very tough, the stratification is almost entirely obliterated. At the next bank, also belonging to Lang, there is six feet of overlying sand and gravel. Scattered through the clay are several bowlders of Calciferous sandrock,

sandstone, black crystalline limestone and gneiss. The overlying material is mostly unstratified and many of the pebbles are eight inches in diameter. At the bank of J. T. Moore the clay is very tough, and the stratification is obliterated in spots. Several ice-scratched bowlders of light blue limestone, sandstone and Calciferous sandrock were found in the clay. In Moore & Lahey's bank the clay is tough and compressed, similar to the other yards. It likewise contains scratched bowlders, specially of a light blue crystalline limestone. Over the clay is two to four feet of coarse sand and gravel.

On the west side of the New York, Ontario & Western R. R., where it branches off from the West Shore R. R., a cutting in the hillside shows a cross-bedded, yellowish sand and loamy clay with patches of gravel and cobblestones in it. Following along the track a few hundred feet we come to the clay bank of C. A. and A. P. Hedges. This shows an interesting section of blue clay overlaid by 50 to 60 feet of cross-bedded delta deposits of sand and gravel. The clay layers are obliterated in spots and in others much contorted. To the north of Hedges yard in the R. R. cutting the clay is overlaid by five to six feet of sand and coarse stones, unstratified. Following up the track on the left side just beyond the crossing of the road from Canterbury to New Windsor the embankment of sand and coarse gravel is cross-stratified, being a portion of the delta of Moodna River. The character of this embankment changes after about 400 feet to unstratified drift, containing bowlders. This underlies the delta material. The upper terrace at Cornwall is underlain by bowlder drift.

Its structure is well shown along the track at Cornwall. Clay was observed in a meadow opposite the Roman Catholic church ; it was exposed in digging drainage trenches. Near this locality, but a little nearer the river, were found several mastodon bones.

At Jones' Point there was formerly a small deposit of clay, but it has been entirely worked out.

Haverstraw has three terraces, viz.: At 20, 60 and 100 feet. The clay so far as known is only found underlying the two lower ones ; the upper one being underlain by drift and delta deposits.

There is a deposit of clay at Stony Point forming a portion of the 20-foot terrace. The upper layers of clay are in places

loamy and undulating. Over the clay is a mass of unstratified material from two to eight feet thick and the upper surface of the clay is uneven. The overlying unstratified material is a coarse sand full of cobblestones, of gneiss, schist and granite, all of them rounded but not scratched. On the hillside to the west of this deposit is a large, isolated bowlder of granite. The upper terrace at Stony Point is about 75 feet higher than the station level; a portion of this terrace remains about one eighth mile north of Stony Point station on the west side of the track. On the west side of the track where it crosses Cedar Pond brook the delta structure is observable in the embankment, the upper portion of which consists of coarse sand, pebbles and cobblestones which are mostly of gneiss. The lower layers exposed at this point are quite argillaceous. A short distance below the West Haverstraw station and some 500 feet west of the track, an excavation had been made for tempering material. It exposes a fine yellowish cross-stratified sand overlain by several feet of coarse sand and cobblestones.

In T. Malley's clay bank along the shore on the north side of Grassy Point, the clay is not found above tide level and is overlaid by three to four feet of fine gravel. To the northeast of P. Brophy's yard is the remnant of a terrace. It is composed of obscurely cross-stratified sand and gravel, overlaid by a few feet of loamy clay, very thinly stratified and the layers wavy. There is a bowlder of norite in this bank; there are also cobblestones of diorite, gneiss and red sandstone. About 600 feet to the west of the yard of D. Fowler Jr. and Washburn the clay is being excavated in the terrace escarpment which is here 45 to 50 feet high. It is mostly blue, thinly stratified and overlain by obscurely stratified gravel and sand. In this excavation was a small ice-scratched bowlder which had been found in the clay. At J. Brennan's yard the clay is overlain by two to three feet of fine sand, and on this is a layer of indistinctly stratified fine gravel six to seven feet thick, with a covering of one foot of soil. The terrace at this point is about 50 feet high. Cobbles one to two feet in diameter of granite, gneiss and pegmatite were found in this bank. Further south at Peck's yard, several bowlders of granite, limestone and sandstone were found in the clay. Those seen were in the lower portion of the bed but I was told that several had been found in the upper portion.

Along the river behind the yards of the Excelsior and Diamond Brick Co. most of the overlying material has been removed by stripping, but judging from what is left it must have been 10 to 15 feet thick. South of Haverstraw the contact of the clay with the underlying drift can be observed, the clay thinning out as it approaches the hill. Some two miles south from Haverstraw, and half way between the stations of Ivy Leaf and Thiells on the New York & New Jersey R. R. in the valley of Ivory Creek, is a basin-shaped deposit of clay belonging to E. W. Christie. It is not over 15 feet thick as determined by boring, and has a slightly elliptical outline. The valley in which it lies is full of glacial material, and contains numerous kames, whose axes lie parallel to the direction of the valley. The clay is underlain by drift material containing bowlders of quartzite, calciferous sandrock, granite, sandstone, gneiss and schist. Over the clay is one to two feet of sand containing large ice-scratched stones of quartzite, gneiss and schist. This clay deposit was probably formed in a small lake. If it were a portion of the Hudson River estuary deposits, it would indicate a much greater submergence than that of 100 feet, supposed for this region, for this locality is 250 feet above the level of the Hudson River. On either side of the track at Thiells are probably remnants of a terrace.

The clay bank of the Anchor Brick Co. at Croton Landing, is elliptical in outline and lies on a bed of granite, gneiss, schist, and white crystalline limestone pebbles, cemented together by clay, covered with limonite. Large pebbles are scattered through the clay, the layers of which are undulating, conforming to the shape of the underlying surface. Over the clay is four or five feet of gravel and sand. South of this yard an excavation has been made under the terrace for obtaining gravel, exposing a section of Croton delta. Projecting up into it is a mass of bowlder-till.

About the middle of Croton Point are the clay-pits of the Underhill Brick Co. Their clay is overlain by the sandy beds of Croton delta. The material composing it was evidently derived from the crystalline rocks of the surrounding country. It is often micaceous and of a yellow color. Scattered through this sand are great numbers of botryoidal sand concretions, some

of them forming masses six feet long and three to four feet wide. They show the layers of deposition of the sand.

The clay at Cruger's, Montrose and Verplank lies in hollows in the rock, being as much as 50 feet thick in some places. At Cruger's it is overlain by a few feet of loam; at Montrose by stratified sand, varying in depth from five to 20 feet, according to borings made. Along the Hudson River R. R. track below Montrose, at Morton's yard, the clay is overlain by from eight to 10 feet of fine gravel, and cross-stratified sand of a dark gray or black color. The materials composing it are, to a great extent, ground up crystalline rocks. The same material covers the clay at McConnell and O'Brien's bank. At the clay beds of of the Hudson River Brick Co. at Verplank, the clay is covered by yellowish sand and fine dark-colored gravel; usually they are unstratified, but in a few spots show cross-bedding.

A short distance below Peekskill, at Bonner & Cole's yard, is a remnant of a 20-foot terrace. There is here a deposit of clay not extending more than four feet above tide, and overlain by an unstratified layer five feet thick, of coarse sand and cobblestones, mostly gneiss.

From Storm King station to Dutchess Junction there is a stretch of terrace, which extends back to the foot of Breakneck and Fishkill Mts. The maximum height of it is 210 feet. Various firms are digging clay in the terrace escarpment the greater part of its length. A well of 65 feet sunk at Aldridge's yard from tide level still showed clay, and adding to this 65 feet of clay above the river level, gives us a thickness of 130 feet at this point. The character and thickness of the overlying material varies somewhat. To the rear of Timoney's yard some 700 feet, the terrace has been excavated to a depth of 30 feet, exposing a mass of coarse sand, gravel and cobblestones, mostly granites, gneisses and schists. One portion of it is stratified, and at the base of the excavation at one point yellow clay has been found. At Timoney's yard there is one or two feet of loam overlying the clay and a growth of brush covers the terrace. At Van Buren's yard the upper layers of clay alternate with layers of sand; the upper six feet of the terrace at this point is gravel, the pebbles of it being mostly granite and gneisses. At Aldridge's yard the clay is covered by six to eight feet of unstratified gravel and sand, while at another

spot on top of his bank are 12 to 15 feet of fine yellow sand; which shows no stratification. The upper layers of Barnacue and Dow's clay are like those at Van Buren's, but covered by four feet of sand and over this in places six to eight feet of coarse gravel. Nothing is known of the underlying material of these yards.

The whole of Denning's Point is covered with a fine stratified yellowish sand. The clay, which lies at the base of the point, has a thin covering of loam, and the upper layers are somewhat wrinkled.

There is another stretch of terrace, similar to that below Dutchess Junction and of the same height, extending from one half mile above Fishkill to Low Point. At most places the clay is covered by a few feet of loamy soil. Several bowlders have been found in the clay at Brockway's yard. Several feet of loam overlie the clay at Lahey's, Brockway's and Dinan and Butler's yards. At J. V. Meade's yard a short distance below Low Point, the clay is covered by about three feet of sand, faintly stratified, and above this six to eight feet of unstratified material; coarse sand, pebbles and cobblestones, some of them 18 inches in diameter. Most of them are Archean rocks, but there are also fragments of shale, limestone, sandstone and a few of them contained Palæozoic fossils.

About 1,000 feet south of Meade's yard is a gravel bank eight to 15 feet thick of material similar to that overlying the clay in Meade's bank. At the base of this embankment in a few spots yellowish clay overlaid by stratified sand has been struck.

The following sections are those of wells bored at Rhinebeck.

On the land of Robert Duckley:

Soil and yellow clay	10 feet
Blue clay	82 "
Rock	....
Total thickness	92 "

On T. Reed's property:

Soil and yellow clay	20 feet
Quicksand	100 "
Hardpan	....
Total thickness	120 "

On J. O'Brien's property:

Clay	20 feet
Quicksand	25 "
Hardpan	2 "
Gravel	....
Total thickness	47 "

The clay deposits of Hudson, Stockport and Stuyvesant are like those at Coeymans Landing, being overlaid in most places by a few feet of loam and underlain by dark sand and gravel. At Stockport two ice-scratched bowlders were found in the clay; one of them three feet in diameter, the other three times as large. To the north of Brousseau's yard at Stuyvesant the surface material is stratified sand, 15 feet of it being exposed thus far.

The delta deposits of the streams tributary to the Hudson River are extremely interesting. They give us an idea of the size of the rivers flowing into the Hudson Valley when it formed an estuary, and also indicate the amount of depression which took place at those localities. All three portions of a delta may be observed in the ancient deltas on the Hudson; they are the thin layers of loamy clay which form the secondary alluvial cone of the delta, the cross-stratified sand and gravel and the overlying unassorted material. This latter was observed at Haverstraw, New Windsor, Low Point and Dutchess Junction.

The following streams between New York and Poughkeepsie have formed delta deposits; (as noted by Dr. Merrill.*) Wappinger Creek, New Hamburg; Fishkill Creek; Indian Creek, Cold Spring; Peekskill; Croton River; Pocantico River, Tarrytown; Sawmill River, Yonkers; Tibbitt's Brook, Van Cortland; Minisceongo Creek, Haverstraw; Cedar Pond Brook, Haverstraw; Moodna River, Cornwall; and Quassaic Creek, Newburg. At the present day but traces of these deposits remain, and the streams which formed them have cut down through them below tide-level. Dr. Merrill thinks it highly probable that these deltas once filled a large portion of the valley in the Highlands. At Roseton, as already mentioned, there is a deposit which may have come from the delta of Wappinger Creek. Also at Jones' Point opposite Peekskill there is a terrace composed of transported

*Amer. Jour. Sci. iii, XLI, June 1891.

material, which Dr. Merrill for a while regarded as a portion of Peek's Kill delta; the size of the pebbles composing it however caused him to give up this view. There is however in the upper portion of the terrace, a layer of unassorted material which is slightly separated from the rest; also at the south end of the terrace, a portion of thinly and obscurely stratified loamy clay, which may have formed a portion of the secondary cone of this delta. At Croton, Haverstraw and Cornwall, also at New Windsor, the clay is overlain by delta material, and where this occurs, specially at Croton, the upper limit of the clay is comparatively low, it having probably been eroded to a certain extent by the river entering the estuary at that point, and again it is not likely that very much clay would be deposited around the mouth of the river on account of the current. This may have been the case below Peekskill.

In general the upper limit of the clay increases northward as does the terrace level. To illustrate this point we have the following altitudes:

East side.

Croton	100
Peekskill	120
Fishkill	205

West side.

Haverstraw	100
West Point	185
Cornwall	200
Newburg	205
Port Ewen	207
Schenectady	360

These measurements apply, of course, to the upper terrace, which can be traced along many portions of the river.*

An examination of the above figures and the distances between the points mentioned indicate an interesting fact. Between New York and Peekskill, a distance of 45 miles, the terrace rises 40 feet, or eight ninths of a foot per mile. From Peekskill to West Point the rise is eight feet per mile. From West Point to Newburg the terraces ascend two and one half feet, and from Newburg to Albany about five twelfths of a foot per mile. From the above it would seem that the uplift from New York to Albany

*For detailed statement of terrace altitudes, see H. Ries, Trans. N. Y. Acad. Sci., Nov., 1891

did not increase uniformly, but was slightly greater along the axis of the Highlands. To determine this point definitely requires a large number of accurate terrace measurements. The following are the number of terraces noticed at the different localities:

Athens	2
Port Ewen	2
Cornwall	2
Haverstraw	2
Stony Point	3
Peekskill	1 and 2
Fishkill	2
Storm King	2
Schodack	2

The shore-line of the upper terrace is generally some distance back from the river. In fact, as we go up the river, especially above Port Ewen, the shore-line recedes. At Port Ewen the terrace is 207 feet, but it is fully 225 feet at the base of Hussey Mt, which was an island in the estuary. The terrace extends up the Walkill valley several miles.* It seems not improbable that a shore line of this Quaternary deposit will be found along the base of the Catskill Mts, or not far from there. At Coeymans Landing the terrace is 140 feet, and it rises to 177 feet at the W. S. R. R. station, about a mile from the river, then a hill hides the further continuation of it from view.

From Catskill up to Albany the terrace at most points is very wide. At Coxsackie it extends behind the hill to the south of the town, and comes down along Murder Creek to Athens. From Albany an alluvial plain, belonging to this formation, spreads westward, reaching a height of 360 feet near Schenectady. The surface of these terraces is usually a loamy soil of much agricultural value.

Following up Croton River as far as Croton Lake, remnants of terraces are seen at various points, their height above the river bed decreasing as we recede from the Hudson. The majority of these detached pieces seem to belong to a terrace formed at the same time as the 100-foot one at Croton Landing. There are at a few places traces of a second and lower terrace, and besides this a third one, being formed by the river during its floods at the present day.

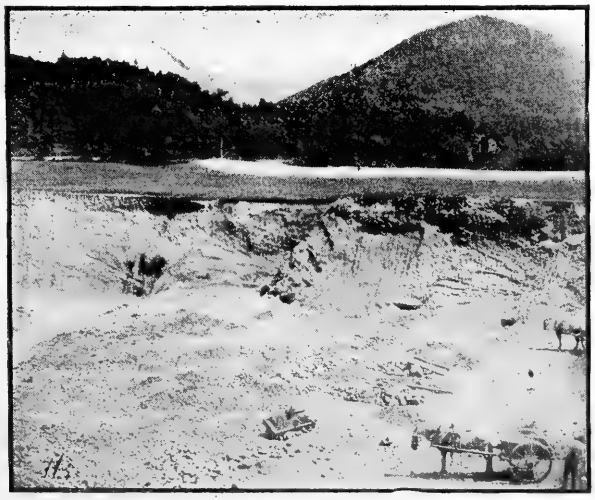
* Mather, Geol. 1st Dist. N. Y., p. 131.

From the facts as observed, quoted above, the following may be deduced. That during the retreat of the ice sheet from the Hudson valley the glacial streams deposited as kames a great amount of ground up material, principally shale; the material found underlying the clays along the upper portions of the valley.

That subsequent to the retreat of the glacier there was a depression of the land, which, according to Dr. Merrill,* amounted to 80 feet at New York city and near Schenectady to about 360 feet.

During this period a great amount of plastic clay was deposited produced by glacial attrition of the shales and limestones, the latter no doubt giving to it the marly character and influencing its color.

The upper portion of the clay is more siliceous and overlying it is an extensive deposit of sand, indicating a change in the nature of the material washed into the estuary. During the period of submergence much of the siliceous matter washed into the estuary was deposited at the mouths of the tributary streams to form deltas.



Terrace and sand pit, Dutchess Junction.

It has been suggested by Dr. Merrill † that the change in the estuary deposits from clay to sand might be due to the exposure

* Amer. Jour. Sci., June, 1891.
† Amer. Jour. Sci., June, 1891.

by elevation of an area of land around the basin, which would afford more siliceous matter.

An elevation would be accompanied by an acceleration of the streams, and much of the siliceous matter transported by them would be carried farther out into the estuary and spread over its bottom, while the finer clayey sediment would be carried out to sea. A readvance of the ice, it would seem, would likewise cause an acceleration of the streams, and with the results stated above.

To account for the isolated bowlders in the clay it seems highly probable that icebergs or icefloes having stones and dirt imprisoned within their mass detached themselves from the retreating glacier, and, floating down the estuary to the sea, dropped their burdens.

The unstratified material found with it and in some cases overlying the stratified delta deposits is a matter of interest as concerns its origin. Three things may be noticed regarding it.

1. The material is sand, pebbles and cobblestones lying mixed together without any separation of the coarse from the fine.*

2 The pebbles and stone are rounded and do not show any scratches.

3 The materials are mostly of the same character as the rocks of the vicinity.

Now as the land rose from its submergence the velocity and with it the transporting power of the streams would increase, washing down quantities of large stones and gravel. Dr. Merrill considers that a rapid flow of water took place down through the Hudson Valley in the late Quaternary. This water must have come down through the valleys of the tributary streams, having a much greater velocity in their valleys than it would have after it turned into the Hudson Valley, and the checking of its velocity as it reached the Hudson would cause the deposition of the greater part of its load. A large stream rushing down the valley of the Fishkill would drop its burden specially below it, where we find them heaviest as the flow of the water was toward the south. Again, Peek's Kill would behave in a similar manner.

A curious and interesting phenomenon is the crumpling of the clay at many localities. This disturbance often extends through-

* The only locality where stratification was observable was at Timoney's yard near Dutchess Junction

out the section, and has been caused by slips or pressure from above, as when the clay is covered by a thick delta deposit. Prof. R. P. Whitfield has told the writer of instances where the clay layers had been disturbed to a depth of several feet from the surface by the weight of bowlders and large trees.

In many instances there occurs a crumpled strip of clay between layers which are entirely undisturbed; this has been actually observed by the writer to have been caused by slipping of the clay.

Clay concretions.— These are of common occurrence, especially in the yellow clay. They are of varying form and size. Many of them have a cylindrical hole in the center, which is lined with carbonaceous material. The flat concretions are found parallel to the layers of the clay, and in many instances at a depth from the surface to which the roots penetrate.

Those found at a greater depth did not have the central cylindrical cavity. They are very abundant in the yellow clay at Haverstraw. Roots penetrating the clay at this locality were surrounded by lumps of clay in the form of concentric rings. These might seem to indicate the method of formation described by Prof. J. D. Dana (Manual of Geol., p. 628). Again in the yellow clay near the surface at Coxsackie were found some forms which were similar in appearance to what Dr J. I. Northrup has described as rhizomorphs.* They may be due to the roots which penetrate the clay, absorbing water from it and rejecting the contained lime, which deposits itself around the root forming the hard rhizomorph. Their interior structure was crystalline.

Another form of concretion is found in the delta sands at Croton Point. It consists of botryoidal masses of sand, cemented by oxide of iron. Some of them show the layers of deposition of the sand. The concretions are usually small, but one mass was noticed fully six feet long and four feet wide.

Concerning the origin of these concretions various opinions are expressed by different geologists.

Organic remains are extremely rare in these clays. The writer has discovered sponge spicules, probably referable to *Hyalonema* or an allied genus, and which are figured. The following

* Trans. N. Y. Acad. Sci., Oct. 13, 1890.

diatoms were also found: *Navicula Gruendleri*, A. S.; *Navicula permagna*, Edw. (fragments); *Melosira granulata* (Ehr.) Ralfs; *Nitzshia granulata*, Grun. All fresh water species. At Croton Landing a number of impressions were found in the blue clay and these on being submitted to Prof. Hall were pronounced to be worm tracks. Mather in his report* mentions the finding of leaves in the clay beds back of the medical college at Albany, and states that they resemble those of an aquatic plant.

The Clays of the Champlain Valley†

The clays of the Champlain valley are estuary formations and of the same age as the Hudson River clays. They underlie terraces along the lake which have been elevated to a height of 393 feet above sea level. These terraces may be traced almost continuously from Whitehall, at the head of Lake Champlain, to the northern end of the lake and beyond it, but on account of the extensive erosion which has taken place they are usually narrow, and it is only at sheltered points like Port Kent and Beauport that they become specially prominent. The section involved is yellowish brown sand, yellowish brown clay and stiff blue clay, the latter being rather calcareous. The upper clay is somewhat siliceous, and its coloring is due to the weathering of the lower layer. This formation has a thickness of about 15 feet, but sometimes, as at Burlington, it reaches a thickness of 100 feet. Isolated bowlders are occasionally found in the clays, and are considered by Emmons to have been dropped there by icebergs. The clays are usually horizontally stratified, and contortions of the layers are extremely rare. Numerous fossils have been found in the overlying sands, among them being *Saxicava rugosa* and *Tellina groenlandica*, which are very common; *Tritonium anglicum*, *Tritonium fornicatum*, *Mytilus edulis*, *Pecten islandcus*, *Mya truncata*, *M. arenaria*, *Nucula portlandica;* the skeleton of a whale has also been found in these deposits.**

Openings have been made in them for the purpose of obtaining brick clays at Plattsburg and a few other localities, but owing to the lateness of the season when I visited them information was hard to obtain.

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* Geol. 1st, Dist. N. Y., p. 123.

†Compiled largely from Emmons Report, Geol. N. Y. 2nd Dist.

** The writer has found one species of diatom belonging to the genus *Diatoma* in the clay from Plattsburg.

Long Island Clays

Long Island is made up of a series of sands, gravels and clays, which form two parallel ranges of hills in the northern half of the island, while the southern half is a flat plain. The most southern of the ranges represents the limit of the drift.*

The clay beds are exposed along the north shore of the island and at several points along the main line of the Long Island railroad. In describing them I have gone east along the north shore and come back through the center of the island.

In a paper on the geology of Long Island, (previously cited) Dr. F. J. H. Merrill describes in detail the formations exposed on the island, and mentions the insufficiency of data necessary to afford definite conclusions concerning the sequence of geological events. Examinations of the various clay outcrops on the island made since show that eight years has made considerable changes; permitting the collection of additional data and obliterating many localities described by him. With the exception of four similar deposits on the north shore, all the clay beds as exposed at the brick yards are rather unique in appearance.

The most western clay outcrop on Long Island, of which the writer has any knowledge, is on Elm Point near Great Neck.‡ There is here a bed of stoneware clay over 30 feet thick and overlain by 15 to 20 feet of yellow gravel and drift. The clay is dark gray and contains streaks of lignite in a good state of preservation. In appearance the clay resembles the Cretaceous ones of New Jersey and will doubtless prove to be of the same age. The overlying yellow gravel contains sandstone concretions and also sandstone fragments containing Cretaceous leaves.**

There is an outcrop of clay at Glen Cove on the east shore of Hempstead Harbor and at the mouth of Mosquito Inlet. This has long been considered of Cretaceous age from the plant remains found† in sandstone fragments embedded in the clay. The layers of the latter are blue, red, black and yellow, and dip northeast 10°–15°. Near this locality and on the south shore of Mosquito Inlet is an outcrop of pink clay, belonging to Carpenter Bros. and used for fire-brick and stoneware. Dipping under it to the

* For a detailed account of the topography of Long Island see Mather, Geology of New York (1st Dist.) 1843; W. Upham, A. J. S. 111, 18.; F. J. H. Merrill, Geology of Long Island, Ann. N Y Acad. Sci, 1884.

‡ H. Ries. Notes on the clays of New York State.—Trans. N. Y. Acad. Sci., XII.

** C L Pollard, Note on Cretaceous leaves from Elm Pt., L. I.—Trans. N. Y. Acad. Sci., XIII.

† A. Hollick, Trans. N. Y. Acad. Sci., XII.

north at an angle of 30° is a bed of alternating layers of quartz pebbles and clay. The pebbles crush easily to a white powder. Associated with this clay is a bed of kaolin, but the exact relations of the two deposits are not known. Kaolin also crops out from under the gravels on the west shore of Hempstead Harbor. Carpenter's clay resembles that of Cretaceous age found on Staten Island, but its age has yet to be proven. The sandstone fragments found in the clay across the inlet are found along the shore of it to Carpenter's clay, but none are found in it. Dr. Merrill has found plant remains in this clay, but they were not sufficiently well preserved for identification. (See paper previously cited.) A microscopic examination of the clay revealed the presence of the following diatoms; all freshwater forms.

Melosira granulata (Ehr.), Ralfs.
Stephanodiscus Niagaræ (Ehr.),
Diatoma hyemale (?) K. B.

On Center Island in Oyster Bay we find the most western of a series of clay beds which bear a great similarity to each other. The others are on West Neck, at Fresh Pond and on Fisher's Island. The clay on Center Island consists of two kinds, a lower bluish clay and an upper brown sandy clay. Overlying this latter is a stratified sand. The layers of clay undulate in several directions. Dr. Merrill mentions the occurrence, one mile north of this clay pit, of a bed of white fire clay at a depth of 25 feet under the drift and sand. The only organism thus far met in this clay is one species of diatom, viz.: *Stephanodiscus Niagaræ*; and a curious spiny hair.

At Jones' brick yard on the east shore of Cold Spring Harbor is a thick deposit of clay. The lower portion is tough and contains little sand. The upper portion is much more sandy and of a brown color. The clay bank is over 100 feet in height and the layers have crumpled on a large scale by the pressure of the advancing ice sheet. A layer of diatomaceous clay occurs in th upper portion of the clay bank, and its position is shown in the following section given by Merrill: (l. c.)

"Till" and stratified drift	10 feet.
Quartz gravel	45 "
Red and blue "loam" or sandy clay	20 "
Diatomaceous earth	3 "

Yellow and red stratified sand	20 feet.
Red plastic clay	20 "
Brown plastic clay	25 "
Total	143

"The bed of diatomaceous earth is of undetermined extent, and appears to be replaced a little to the east by a blue clay, which, however, contains some diatoms. It is undoubtedly equivalent to the bed of ochre which overlies the sand throughout the remainder of the section."

The following diatoms, all fresh-water species, occur in it :

Melosira granulata (Ehr.) Ralfs.
Stephanodiscus Niagaræ (Ehr.)
Epithemia turgida (Ehr.) Kutz.
Encyonema ventricosum, Kutz.
Cymbella delicatula, Kutz.
Cymbella cuspidata, Kutz.
Navicula viridis, Kutz.
" *coconeiformis*, Greg.
" *major*, Kutz.
" *varians*, Greg.
" *lata*, Breb.
Eunotia monodon, Ehr.
Gomphonema capitatum, Ehr.
Stauroneis Phœnecenteron, Ehr.
Fragilaria construans, Grun.
Synedra affinis, K. B.
Campyloneis Grevillei var. *Regalis.*
Triceratium trifoliatium.

The *Melosira* and *Stephanodiscus* are present in countless numbers. Only two specimens were found of the *Triceratium*, and Dr. D. B. Ward, of Poughkeepsie, who has also given me much aid in the identification of my material, informs me that this species is very common in the diatomaceous earth from Wellington, New Zealand, but he has never heard of its occurrence before in America.* Sponge spicules are not uncommon in Lloyd's Neck diatomaceous earth, and several forms are figured. Samples of the red and brown clay from the section given above were examined, but no organic remains were found in them.

* Since this report was sent to press the writer has been informed of the discovery by Mr. Lewis Woolman of this same species in certain New Jersey deposits.

(Magnified 500 diameters, except Fig. 1, which is enlarged 250 diameters.)

FIGS. 1–13. Sponge spicules. Croton Point.

FIG. 14. *Melosira granulata* (Ehr.) Ralfs. Croton Point.

FIG. 15. *Navicula Gruendeleri*, A. S. Croton Point.

FIG. 16. *Diatoma* sp? Plattsburg.

FIG. 17. Diatom fragment from Croton Point.

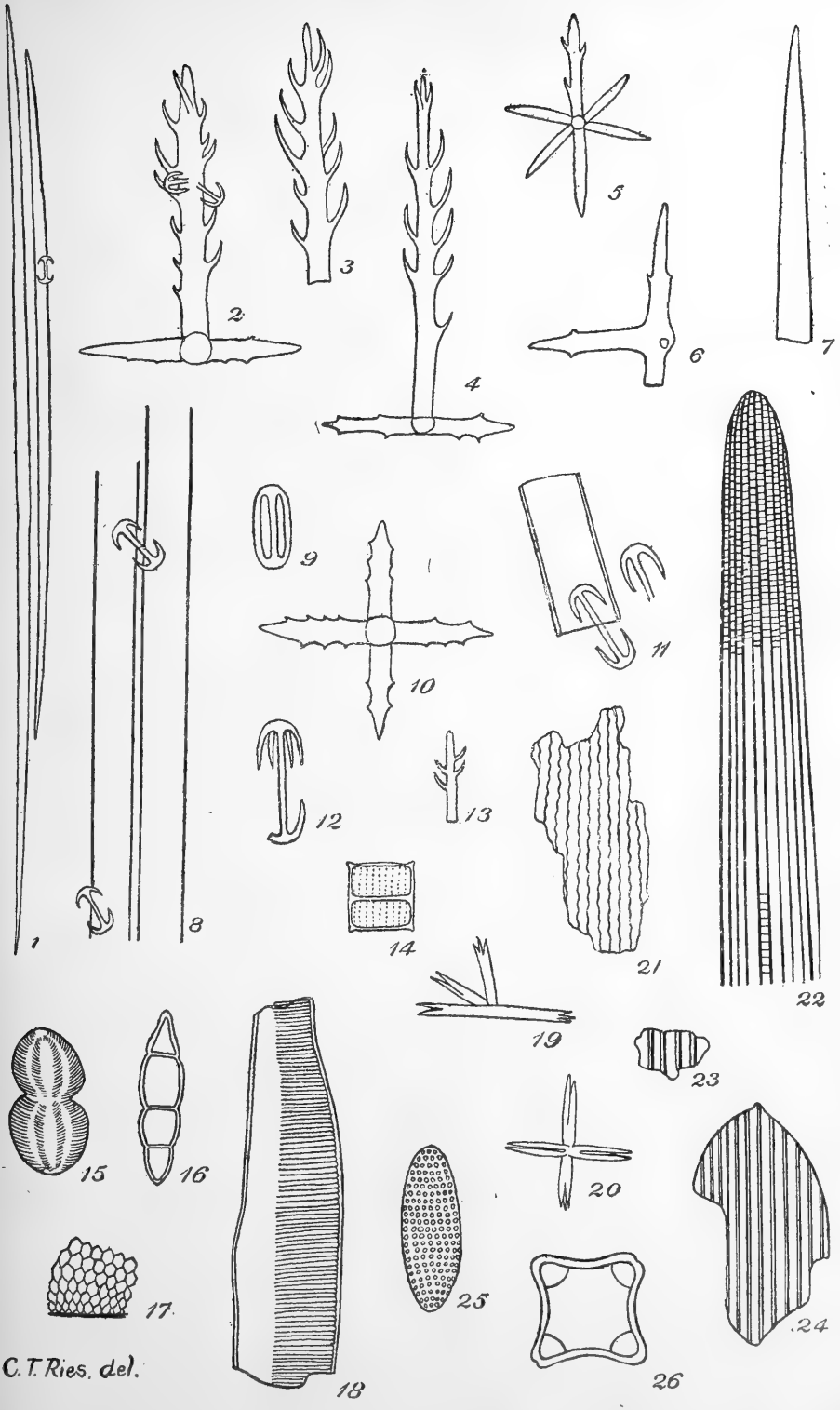
FIG. 18. *Navicula permagna*, Edw. Croton Point.

FIGS. 19, 20. Sponge spicules. Kreischerville, S. I.

FIGS. 21, 22, 23, 24. From clay at Verplank.

FIG. 25. *Nitszchia granulata*, Grun. Croton Point.

FIG. 26. From clay at Croton Point.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(Magnified 500 diameters.)

FIGS. 1, 2. Jointed hair. Wyandance, L. I.

FIG. 3. Ridged tube from stoneware clay. Glen Cove, L. I.

FIGS. 4, 5. Spicules from cretaceous clay at Glen Cove, L. I.

FIGS. 6, 7, 8. Spicules from Lloyd's Neck, L. I.

FIG. 9. Spicule fragment? Farmingdale, L. I.

FIG. 10. *Diatoma hyemale.* Glen Cove, L. I.

FIG. 11. *Navicula viridis,* Kutz. Lloyd's Neck, L. I.

FIG. 12. *Cymbella cuspidata,* Kutz. Lloyd's Neck, L. I.

FIG. 13. *Campyloneis Grevillei,* var. *Regalis.* Lloyd's Neck, L. I.

FIG. 14. *Cocconema parvum,* W. Smith. Northport, L. I.

FIG. 15. *Triceratium trifoliatum.* Lloyd's Neck, L. I.

FIG. 16. *Eunotia monodon,* Ehr. Lloyd's Neck, L. I.

FIG. 17. *Navicula lata,* Breb. Lloyd's Neck, L. I.

FIG. 18. *Encyonema ventricosum,* Kutz. Lloyd's Neck, L. I.

FIG. 19. *Synedra affinis,* K. B. Lloyd's Neck, L. I.

FIG. 20. *Fragilaria construans,* Grun. Lloyd's Neck, L. I.

FIG. 21. *Gomphonema capitatum,* Ehr. Lloyd's Neck, L. I.

FIG. 22. *Epithema turgida* (Ehr.) Kutz. Lloyd's Neck, L. I.

FIG. 23. *Navicula cocconeiformis,* Greg. Lloyd's Neck, L. I.

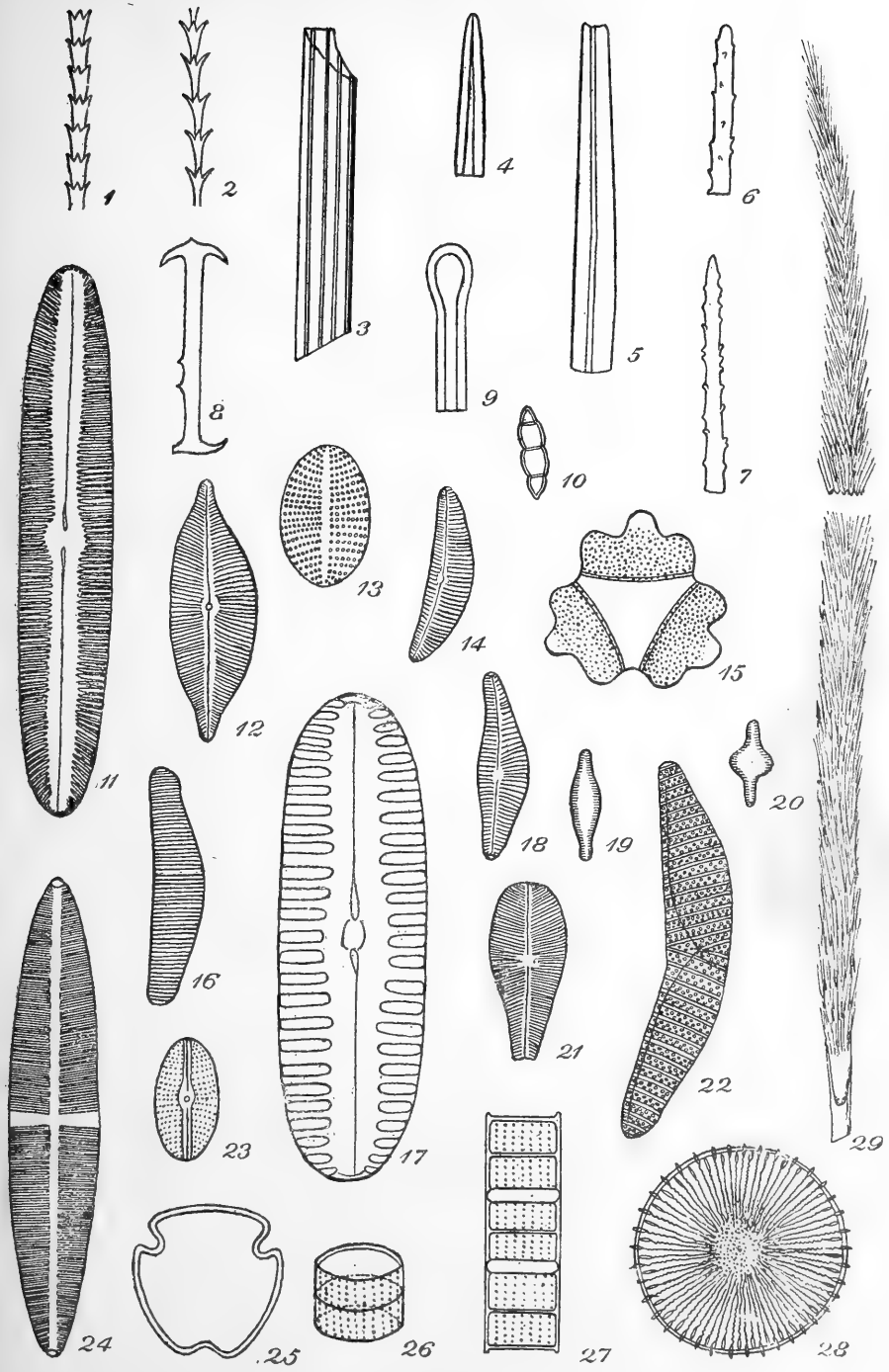
FIG. 24. *Stauroneis Phœnecenteron,* Ehr. Lloyd's Neck, L. I.

FIG. 25. From clay at Northport, L. I.

FIGS. 26, 27. *Melosira granulata* (Ehr.) Ralfs. Lloyd's Neck and Glen Cove, L. I.

FIG. 28. *Stephanodiscus Niagaræ,* Ehr. Lloyd's Neck and Glen Cove, L. I.

FIG. 29. From clay at Oyster Bay.



C.T. Ries. del.

Concretions are abundant in the clay on Center Island and West Neck. Those found at the latter locality are disc-shaped, while those found on Center Island are more or less botryoidal.

Silicified yellow gravel fossils have been found by the writer in the sands on West Neck,* and more were subsequently found in other localities by Mr. Hollick.†

On Little Neck, in Northport Bay, is an extensive deposit of stoneware clay and fire sand, which has been worked for a number of years. The clay is stratified, the layers being separated by laminæ of sand. In color the material varies from black to brown and yellow, and it becomes sandy in its upper portion. There is a dip of 15° S. E. due to a slipping of the clay bank. Overlying the clay is cross-bedded fine sand and gravel, the latter containing much coarse material near the surface. Very little till covers the whole. Much fine, white fire sand occurs in portions of the bank. A careful examination of the section showed a brownish-black seam of the clay, two feet thick, containing numerous fragments of plant remains, of which a number were sufficiently well preserved to determine the Cretaceous age of the clay beyond doubt. The species were identified for me by Mr. Hollick as follows:

Protaeoides daphnogenoides, Heer.
Paliurus integrifolia, Hollick.
Laurus angusta, Heer.
Myrsine sp.
Williamsonia sp.
Celastrophyllum sp.
Paliurus sp.

The latter resembles *Paliurus Columbi* (Heer); a Tertiary species (Fl. Foss, Arct. I, 122, pl. XVII, Fig. 2d,) but is much smaller and very probably a new species. The above species are the same as those found in the middle cretaceous clays of Staten Island, N. Y., and Perth Amboy, N. J.

Three species of diatoms, all fresh-water forms, were also discovered in this clay.

Melosira granulata, (Ehr.) Ralfs.
Diatoma hyemale, K. B.
Cocconema parvum, W. Smith.

*Trans N. Y. Acad. Sci., XII.
† Trans. N. Y. Acad. Sci. Vol. XIII.

The occurrence of these diatoms is a matter of great interest. While diatoms are abundant in the Tertiary, their only known occurrence in the Cretaceous, is the chalk* which is upper Cretaceous. This being the case, their occurrence at Northport extends the known geological range of diatoms.

At Fresh Pond the clay crops out along the shore for distance of half a mile. It is brownish and red in color, the red being more sandy. Sand and gravel overlies it, and at Sammis' yard the sand, which is stained by limonite, shows a fine anticlinal fold.

One of the most interesting clay banks is that on Fisher's Island. The clay is of a reddish color similar to that on West Neck and Center Island, and in its original condition was horizontally stratified and overlain by 20 to 30 feet of laminated sand. But the whole deposit has been disturbed by the ice sheet passing over it, and the layers have been much crumpled to a depth of about 30 feet, while below this they are undisturbed. The till overlying it is in places 30 feet thick and contains large bowlders.

Dr. Merrill mentions the presence on Gardiner's Island,† of extensive beds of brick clay together with their associated sand beds, (they are not being worked,) and notes the occurrence of a fossiliferous stratum.

Clay is also said to outcrop near Sag Harbor and around the shore of Hog Neck in Peconic Bay.

Between Southold and Greenport are several deposits of a red glacial clay which is being used for brick. The clay contains angular stone fragments and runs from 50 to 60 feet in thickness. About one and a half miles east of Southold is a bed of mottled blue pottery clay which has been used for a number of years in making flower pots. The depth of this deposit is not known.

At West Deer Park is a clay bank of unique appearance. In July 1892 the section showed

	Yellow gravel	6 feet
Containing concretions	Flesh colored clay	6 "
	Red clay	1 "
	Black clay with pyrite	4 "
	Black sandy clay	4 "
	Red sandy clay	3 "
	Total thickness	20 "

*Nicholson, Manual of Palaeontology, II. †Previously cited.

Lenticular masses of gray sand are sometimes found in the black clay. The black clay also contains furstules of *Melosira granulata*, (Ehr.) Ralfs, and numbers of a jointed yellowish brown hair, resembling those of a crustacean. The black clay burns to a white brick. About four miles west of this locality near Farmingdale the section in Myers' clay pit is

Sand and gravel	6 feet
Red sandy clay	6 "
Yellow and red sand, wavy lamination	2 "
Reddish yellow clay	6 "
Reddish blue clay	20 "
Micaceous sand, cross-bedded	.. "
Total thickness	40 "

About one-quarter mile south of Myers' brick yard is that of Stewart. The section at this locality (now obliterated) as given by Dr. Merrill is *

Surface stratum yellow micaceous clay	35 feet
Reddish and sandy clay	5 "
Blue black sandy clay with nodules of white pyrites	25 "
White sand	.. "
Total thickness	65 "

A local deposit of grayish blue sandy clay occurs at E. Williston. It varies in depth from six to 20 feet and is underlain by sand. On my last visit to this locality I found a number of stems and leaf fragments in the clay but none of them sufficiently well preserved for identification.

There is still some doubt as to the exact conditions under which the beds of clay and gravel which form the greater portion of Long Island were deposited, but it is probable that the clays represent shallow water marine deposits of Cretaceous and Tertiary age. The overlying sands and gravels have in most instances a cross-bedded structure, with a south dip, and were probably deposited by swift currents as stated by Dr. Merrill.

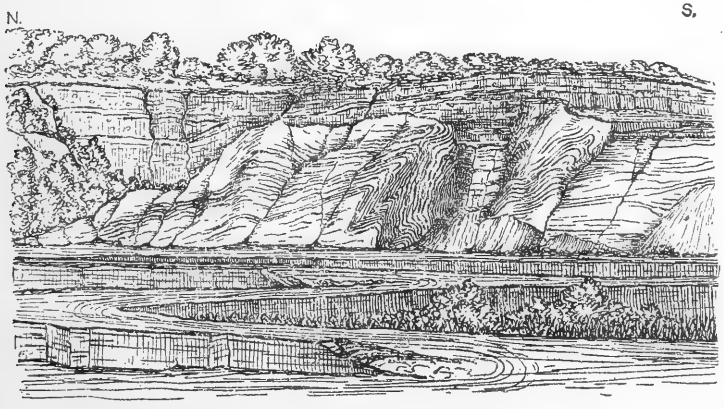
The age of the clays is still largely a matter of speculation, and will probably remain so in many cases unless palæontologic evidence is forthcoming. Those on Gardiner's Island are quite

* Geology of L. I., Ann. N. Y. Acad. of Sci., Nov. 1884.

recent, as shown by the contained fossils, and the clay on Little Neck near Northport is Cretaceous as previously noted. The proof of the age of the Glen Cove clay is not absolute.

Cretaceous leaves in fragments of ferruginous sandstone have been found along the north shore of Long Island from Great Neck to Montauk Point,* but they are usually much worn and scratched and have evidently been transported from some distant source. The clays at Center Island, West Neck, Fresh Pond and Fisher Island are very similar in appearance and composition, are very probably of the same age, possibly Tertiary,† but we lack palæontologic or stratigraphic evidence. At West Neck the clay underlies the yellow gravel and the latter is covered by the drift, so that is pre pleistocene.

The theory has been put forth that the Cretaceous formation on Long Island would be found north of a line joining the southern border of the Cretaceous formation of New Jersey and Martha's Vineyard,‡ and that outcrops south of this might be Tertiary; in view, however, of determining the clay at Little Neck near Northport to be Cretaceous, we must abandon this theory.



Folded clays, West Neck, L. I.

An interesting phenomenon is the tilting and crumpling of the strata on the north shore of Long Island. This disturbance is especially well shown on West Neck and was considered by Dr. Merrill to be due to the pressure of the advancing ice sheet,§ which excavated the deep narrow bays and pushed the

* A. Hollick, Notes on Geology of North Shore of Long Island, Trans. N. Y. Acad. Sci., XIII.
† This idea is also expressed by Dr. Merrill.
‡ A. Hollick, Notes on Geology of North Shore of Long Island, Trans. N. Y. Acad Sci. XIII.
§ Geology of Long Island, Ann. N. Y. Acad. Sci. 1884.

excavated material into high hills at their head. Dr. Merrill's views have been recently corroborated in a paper on "The deformation of portions of the Atlantic coast plain," by A. Hollick,* who, in disputing the possible orogenic origin of these

Sand and Gravel West Shore of Hempstead Harbor.

Stratified Sands and Gravels at Port Washington.

folds, calls attention to the fact that they are found only along the line of the moraine, and that the beds are disturbed only to a certain depth. The disturbance is well shown at Glen Cove,

* Trans. N. Y. Acad. Sci., XIV.

West Neck, Fresh Pond and on Fisher's and Gardiner's islands. It is important, however, not to confound tilting of the layers, due to slipping, as is the case on Little Neck near Northport, with that produced by the ice-thrust.

Both Dana and Merrill consider Long Island Sound to be of preglacial origin; the former calls attention to a channel in the southern part of the sound, which probably was that of a river draining Connecticut in preglacial times, and which emptied into Peconic bay. The latter points to the absence of till along the north shore of Long Island where the sound is wide, as evidence of the fact that most of the drift was dropped into the sound by the ice in its passage across it.

On the other hand Hollick* considers that Long Island Sound was dry land until the glacial period, and that the continental glacier upon its arrival on the Connecticut shore plowed up the material from the space now occupied by the sound and pushed it ahead to form the range of hills along the northern part of Long Island. It seems to the writer however that the facts do not support this theory. If we suppose the northern range of hills to be composed of material pushed up out of the area now occupied by the sound, it should everywhere show signs of disturbance. This it does not do. The high hills of sand and gravel at Port Washington for example show no signs of disturbance.

Mention should be made of a yellow gravel formation. This is found almost everywhere on Long Island, and sections in the railway cuttings frequently show a thickness of 30 or 40 feet.

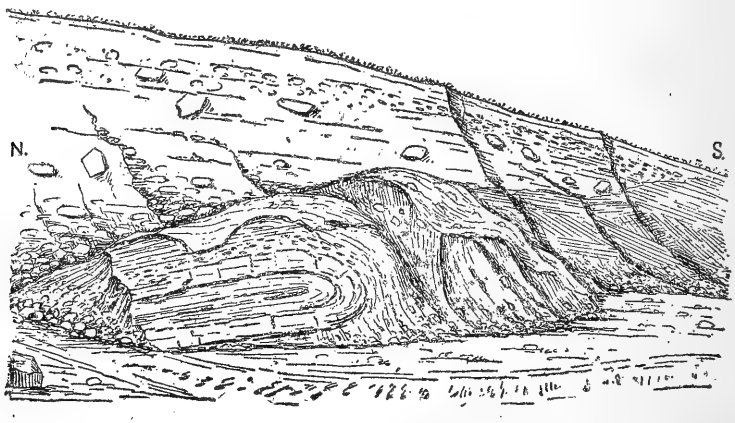
Staten Island clays

The clays of Staten Island are chiefly Cretaceous, as proven by the fossils found in them. (A. Hollick, Trans. N. Y. Acad. Sci., vol. XI.) The chief outcrops are at Kreischerville, Green Ridge and Arrochar. Besides the clay there are several "kaolin" deposits.

In many instances the clays and overlying yellow gravels have been much disturbed by the passage of the ice over them, and in some cases the sections show overthrown anticlines, as on the fingerboard road at Clifton.

* Notes on Geology of North Shore of Long Island, Trans. N. Y. Acad. Sci., XIII.

Mr W. Kreischer informed me that the clay at Kreischerville occurs in isolated masses or pockets in the yellow gravel and sands. If such is the case, and if these beds, as is usually supposed, are a continuation of the New Jersey ones, they must be explained as follows: Either the original beds have been torn



Overthrown anticline of Yellow Gravel, Fingerboard Road, Clifton, S. I.

apart by the ice which bore down on them, or else they have been deeply eroded by the currents which deposited the overlying sands and gravels.

The writer favors this latter view.

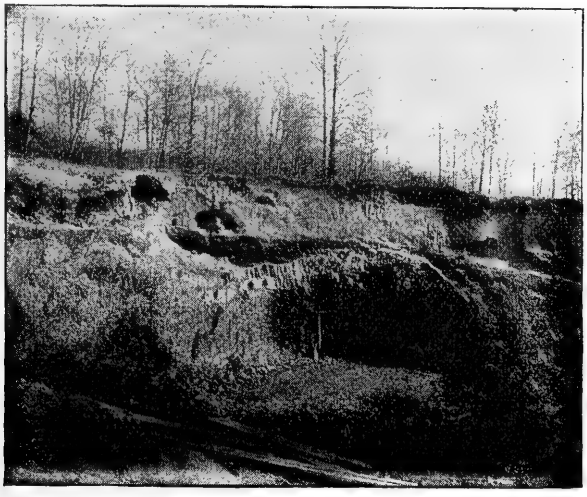
A boring made on the site of Kreischer's fire brick factory showed

Sand and soil	30	feet.
Blue clay	90	"
White sand	2	"
Sand and clay alternating	78	"
Total thickness	200	"

Next to the church at Kreischerville is a bank of stratified sand standing some 40 feet back from the road. It appears to have been dug away considerably, but Mr Kreischer informed me that there was once a large mass of clay at this spot which was surrounded by the sand. To the north of this near the shore is a bank of blue stoneware clay overlain by yellow laminated sand, and southeast of the church is a similar bank, but the clay is of a more sandy nature. A third opening is opposite Kilmeyer's

hotel at Kreischerville, and from this a yellow mottled fire clay is obtained. This latter bed is overlain by about 20 feet of sand and yellow gravel and underlain by a white sand.

A fourth opening on the shore is in a blue clay. It has always been an interesting question as to what extent Staten Island was underlain by the Cretaceous formation, and the following record



CLAY PIT, KREISCHERVILLE, N. Y.
(Yellow gravel over Cretaceous clay.)

of a well bored for Bachman's brewery at Annandale, S. I., seems to throw some light on the subject:

At a depth of 200 feet a bed of yellow gravel containing shells was struck. The gravel was 36 feet in thickness and beneath it was a bed of clay 10 feet thick. This latter was of a white and blue color and was said to resemble a fine pottery clay.

The above may very possibly be some of the Cretaceous clay overlain by the yellow gravel. Borings made at various points along the shore of Arthur's Kill, between Kreischer's factory and Wood & Keenan's brickyard, penetrated a blue clay at a depth of three or four feet. This latter is no doubt of very recent origin.

At the Anderson Brick Company's pit near Green Ridge, the lower clay, which is of a black color, shows signs of disturbance, and slicken sided surfaces are common. The upper portions of

the bank are of blue and gray colors, and at one spot there is a thick seam of lignite. The clay is not sufficiently refractory for fire brick. Fragmentary plant remains were found by the writer in this pit, but they are not nearly so perfect as those found in the fire clay pit at Kreischerville, and which have been figured and described in minute detail by Mr. Arthur Hollick of Columbia College, New York City.

Spicules have been observed in the fire clay at Kreischerville, Staten Island. In the kaolin found near Kreischerville were discovered a number of diatoms, which Dr. Ward informs me are either *Cocconeis placentula*, Ehr., or *Cocconeis pediculus*, Ehr. Their occurrence is also of great interest, as these kaolins are known to be middle Cretaceous beyond doubt.

Stony glacial clays occur also underlying the flats at Green Ridge, Staten Island.

One mile and a quarter northeast of Kreischer's fire brick factory an excavation has been made for obtaining a micaceous kaolin. About 15 feet of it are exposed. A quarter mile north of this locality is the pit of the Staten Island Kaolin Co. The kaolin is evidently a continuation of that exposed in Kreischer's pit, but is apparently not as thick. The deposit has suffered disturbance by the ice sheet and the layers are intermixed with the till. At the northeast side of the excavation a bluish sandy clay containing fragments of lignite is found to underlie the kaolin.

As the Cretaceous clays, kaolins and yellow gravels area continuation of the belt extending across New Jersey, the history of their deposition is the same.*

The following analysis of kaolin from Campbell's pit on Staten Island, is given in the New Jersey clay report cited above:

Silicic acid and sand	92.70
$Al_2 O_3$ and $F_2 O_3$	5.70
$H_2 O$	.70
$K_2 O$	.35
	99.45

*Report on clays, N. J. Geol. Surv. 1878.

General remarks on clay

Clay is a hydrated silicate of alumina, having the formula Al_2O_3, $2SiO_2 + 2H_2O$, or silica 46.3 per cent., alumina 39.8 per cent., water 13.9 per cent. This is the mineral kaolinite, and it generally results from the decomposition of granite or other feldspathic rocks. The three essential component minerals of granite are quartz, feldspar and mica, and of the feldspars, orthoclase or the potash feldspar is most commonly present. The surface waters in percolating through the rocks attack the feldspar and leach out the potash as carbonate, or possibly as a silicate if the amount of carbonic acid is small. This breaking up of the feldspar destroys the bond for the quartz and mica and the rock begins to crumble. As a further result of the leaching some silica is set free and left in a hydrated condition. The alumina of the feldspar, the hydrated silica, and some water unite forming kaolinite, the basis of all clays. A deposit of this kind formed in place is a residual clay and its purity is largely influenced by the composition of the parent rock and mechanical conditions, both of which vary. Usually many accessory minerals are present, and destroy the purity of the clay or kaolin. In the general erosion of the land the kaolin together with other minerals composing the rocks are washed into the lakes or ocean, the coarser material transported by the streams being dropped at their mouths to form deltas, while the fine aluminous mud settles in the quieter waters forming a bed of clay. Such deposits of clay are called "sedimentary" to distinguish them from the "residual" ones.

Beds of clay of vast extent are thus deposited in the ocean. With further deposition they become buried far beneath the ocean floor, where subjected to the action of dynamic agencies such as heat and pressure these beds of clay become converted to shale. With subsequent elevation of the sea bottom, and erosion of the new land surface the shale becomes exposed as we now find it over a large portion of the state. The disintegrated outcrops of shale have often been used for brickmaking, having been mistaken for deposits of sedimentary clay. Much aluminous rock flour was produced from the erosion of the shales by the North American ice sheet. This was held in suspension by the

glacial streams and finally deposited as beds of clay in the numerous lakes which occupied the valleys during the early Pleistocene period The erosion of the sandstones has added to the grittiness of the clays. The extensive deposits of plastic clay found on Long Island were elevated above sea level within probably a comparatively short time after their deposition.

Pure clay is of a white color and is very rare. The purest clays known are the China clays, which have about the theoretical composition of kaolinite.

Clays suitable for the manufacture of common brick are by no means uncommon. The impurities in them often run quite high, still in many cases they make a most excellent common brick. The use of a clay for one thing or another is largely determined by the impurities. The clay should be plastic, work easily and burn to a good red color, giving a hard ringing product.

Plasticity is the property which clay has of forming a pasty mass when mixed with water, and changing to a hard mass when subjected to a high heat. Burned clay if ground and mixed with water is not plastic; in fact clay loses its plasticity when the water of combination is driven off. This property of clay is largely due to the kaolinite base which occurs in the form of minute hexagonal tablets.

Dry kaolin is not plastic, and water seems therefore to likewise influence plasticity. Prof. G. H. Cook found that it was also influenced by the degree of fineness of the kaolin. In clays which are very slightly plastic the plates of kaolinite were found to be collected in bunches, and a subsequent thorough grinding in order to break up these aggregates increased the plasticity.

A tough plastic clay is termed by the brickmakers "fat;" on the other hand a clay of loose texture and possessing little plasticity is said to be "lean" or "poor."

Sand consisting of quartz, feldspar or mica destroys the plasticity of clay and is one of the commonest impurities. The others are lithium, titanium, iron, lime, magnesia and the alkalies potash and soda. Sulphur is sometimes present, it having been found in some of the Hudson River clays.

Page* states that "the admixture of a proportion of siliceous sand, which results in a combination containing as much as 90

* Economic Geology, p. 186.

per cent. silica is not incompatible with the formation of a good brick. Uncombined silica, if not in excess, is beneficial, as it preserves the form at high temperatures; in excess it destroys cohesion and makes the brick brittle and weak. Fire clays should not contain over three to four per cent. of fusible impurities.

The fusibility of a clay usually increases with the amount of impurities present. Richter* found that potash rendered a clay more fusible than any of the other impurities; iron is said to come next, then lime and lastly magnesia. Phosphates also increase the fusibility of clay slightly.

Iron is usually present in clay in the form of a lower oxide, and in burning is converted to a higher one, coloring the brick red. According to Seger† the shade of color produced by iron is influenced by the amount of iron oxide present, the chemical composition of the clay, and the mechanical division of the coloring substance, the degree of burning, and whether the fires of the kiln are reducing or oxidizing. The intensity of the coloration increases with the amount of peroxide of iron from four to eight per cent. From this up to 21 per cent. no change in the color was noticed.

Carbonate of lime counteracts the color produced by iron due to the formation of a light colored double silicate of iron and lime. This fact is often made use of in the manufacture of cream-colored brick, a certain proportion of lime being added to the clay. Clays rich in carbonate of lime burn yellow in a reducing atmosphere. If there is an excess of lime the bricks get flesh colored in the oxidizing flame.

If iron is present in the form of sulphate it usually decomposes at the point of fusion, giving a lower oxide which fluxes and produces a distortion of the brick. A reducing flame is detrimental to the formation of sulphate.

It has been stated that a clay containing over three per cent. of lime is not fit for making brick, but this limit is too low, as clays with five and six per cent. of lime will often make a very good product and the celebrated Milwaukee brick have 23 per cent.

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* Brickmaker, Oct. 1892.

† Brickmaker, Oct. 1892.

Magnesia also tends to prevent the development of a red color in bricks.

A white or light-colored brick is sometimes produced if the clay contains a large amount of organic matter which will reduce the iron. Efflorescence is due to the dissolving of the sulphates of magnesia and the alkalies by permeating water, and their deposition on the face of the brick when the water evaporates.

A similar whitish coloring noticed on brick freshly burnt may be due to the reduction of the iron by smoke from the arch fires.

Titanium and lithium are never present in quantity. The latter occurs as titanic acid. Lithium occurs in the clay in a similar form and its presence was first detected in the Cretaceous clays of New Jersey.

Clays weigh 110 to 125 pounds per cubic foot. They have a specific gravity of from 1.75 to 2.00.

Clays may be divided into three kinds:

1 Clay. Mostly alumina and silica in varying proportions, with a small percentage of salts of iron, lime, magnesia, potash, etc.

2 Loams or sandy clays.

3 Marls. Clays containing a large amount of lime.

The refractoriness of a clay is not alone dependent on its composition but is also influenced by its density and fineness of grain.* When two clays are of the same density and fineness, their refractoriness is inversely proportional to the detrimental impurities present, when the latter are equated as to their proper fluxing values. This Professor Wheeler calls the "Fusibility factor" and deduces the formula:

$$\text{F. F.} = \frac{N}{D+D'} \text{ (A.)}$$

N being the sum of the non-detrimentals or total silica, alumina, titanic acid, water, moisture and carbonic acid gas.

D = sum of detrimental impurities as iron, lime, magnesia, alkalies, sulphuric acid and sulphur.

D' = sum of the alkalies. This latter is added because the alkalies have about twice the fluxing power of the other detrimentals. The effect of FeO is not considered as it is quickly

*H. A. Wheeler, "Calculation of the Fusibility of Clays." Eng. and Min. Jour., March 10, 1894.

changed to $Fe_2 O_3$ when the clay is heated. This formula gives a good comparative value of the refractoriness of two similar clays whose specific gravity does not differ by more than .2.

When the clays to be compared differ in fineness, the formula (A.) is modified by the constant C.:

$$F.\ F. = \frac{N}{D + D' + C} \text{ (B.)}$$

C = 1 when the clay is coarse grained and sp. gr. over 2.25.
C = 2 when the clay is coarse grained and sp. gr. 2.00–2.25.
C = 3 when the clay is coarse grained and sp. gr. 1.75–2.00.
C = 2 when the clay is fine grained and sp. gr. is over 2.25.
C = 3 when the clay is fine grained and sp. gr. 2.00–2.25.
C = 4 when the clay is fine grained and sp. gr. 1.75–2.25.

The value of C is to be considered only approximate.

The temperature of fusion of a clay is usually determined by means of a pyrometer. Two kinds have been more or less used for this purpose, viz., the Lunette pyrometer and Le Chatelier's thermo-electric pyrometer, which is far more accurate. These pyrometers have also been used to determine the temperature of kilns.

Method of analyzing clays

By Dr. H. T. Vulte.

One grain of the dried and finely pulverized clay is fused in a platinum crucible with five to 10 times its weight of a mixture of 11 parts of dry sodium carbonate and 14 parts of dry potassium carbonate, the amount of fusion mixture necessary depending on the more or less refractory character of the clay. The fusion is transferred to a porcelain casserole, dissolved in water, and the solution acidified with hydrochloric acid; the solution is then evaporated to dryness, and the casserole with its contents placed in a drying oven at 105° to 110° C., and allowed to remain until all the hydrochloric acid is expelled. The silica present is thus rendered insoluble. Hydrochloric acid and water are now added; the casserole is warmed for a few minutes on the water bath and the solution filtered, the silica being washed with hot water until the washings are free from chlorine. The silica is then ignited and weighed, and as it is likely to retain small quantities of alumina, it is treated with hydrofluoric and sulphuric acids and heated, the silica being thus volatilized as

silicon tetra fluoride. The residue from this treatment is weighed, and its weight added to that of the alumina subsequently found.

If the original fusion of the clay showed little or no green color, the filtrate from the silica is treated with a slight excess of ammonia, and the solution boiled for a short time to expel the excess. The solution is then filtered, the precipitate dissolved in dilute hydrochloric acid, and reprecipitated in the same way; filtered out, washed and then ignited and weighed, giving the amount of alumina and iron (as Fe_2O_3) present. The combined filtrates from the iron and alumina, which should be concentrated to about 200cc., are heated to boiling and about 25cc. of sat. sol. of ammonium oxalate added, and the boiling continued for two or three minutes longer, when the heat is removed and sufficient ammonia added to render the solution strongly alkaline. The precipitate is allowed to settle, and the supernatant liquid decanted off as closely as possible through a filter; hydrochloric acid is then added to the precipitate to dissolve it, and then sufficient ammonia to reprecipitate it. It is then washed on to the filter; washed; ignited with sulphuric acid, and weighed as calcium sulphate. The filtrate receives a further addition of ammonia and of hydrodisodic phosphate, is well stirred, allowed to stand for some hours in the cold, when the magnesium precipitate is filtered out, washed with ammonia, ignited and weighed.

In case manganese is present, the filtrate from the silica is neutralized as closely as possible, sodium acetate solution added, the solution diluted largely, and boiled for about a minute and filtered as rapidly as possible, the precipitate washed with boiling water, redissolved in dilute hydrochloric acid and reprecipitated in the same way, washed, ignited and weighed as Fe_2O_3 and Al_2O_3. The combined filtrates from the iron and alumina are evaporated to about 300cc., bromine water added and the solution boiled when the manganese is precipitated as MnO_2. This is filtered out, dissolved in a little dilute hydrochloric acid, a solution of microcosmic salt added, the solution heated to boiling and then ammonia added to exact neutrality, any excess of ammonia being removed by heating on the water bath. The precipitate of manganese ammonium phosphate is filtered out, ignited and weighed as $Mn_2P_2O_7$. The filtrate from the manganese precipitation is acidified with hydrochloric acid, boiled

for a short time, and then treated in the same way as when manganese was absent, for the determination of lime and magnesia.

For the determination of alkalies one grain of clay is mixed by grinding in an agate mortar with one grain of granular ammonium chloride and eight grains of pure calcium carbonate, the mixture transferred to a platinum crucible with a well-fitting lid and slowly heated to decompose the ammonium chloride, then heated to redness and the bottom of the crucible kept at a bright red for about an hour. The contents of the crucible are transferred to a porcelain casserole with about 80cc. of water and heated to boiling; this is then filtered and to the filtrate after evaporation to small bulk about one and one half grams pure ammonium carbonate added and the solution heated nearly to boiling and filtered into a platinum dish, evaporated nearly to dryness, a little more ammonium carbonate added and the evaporation finished on the water bath. If the last addition of ammonium carbonate produced a precipitate the residue in the dish is dissolved in a little water and filtered into another platinum dish where it is evaporated into dryness and ammonia salts driven out by heat. The residue is dissolved in water filtered into a weighed platinum dish, evaporated, dried and weighed as Na Cl + K Cl. If the last addition of ammonium carbonate failed to produce a precipitate the transfer to another dish may be dispensed with and the ammonia salts driven off at once.

Prospecting and exploiting

In prospecting for clay the topography is often of much help. In the northern and western portions of the state the clay is generally found in the bottoms of broad valleys. An example of this is the Genesee Valley. Again at other localities the clay is found underlying terraces along the sides of the valleys as in the Hudson valley and along Lake Champlain. Deposits of a similar character will be found along the Delaware and Susquehanna Rivers. A terrace however does not necessarily indicate the presence of clay, for some of the Hudson valley terraces are underlain by till.

On Long Island for example the clay is found almost entirely along the north shore; it no doubt underlies most of the island, but on the southern side there is in most instances such a covering of sand as to make it useless. The presence of clay can often be detected in railroad cuttings, in the sides of gullies or ravines. In many instances however the occurrence of clay is only suspected, and then borings must be made with an auger to determine its presence. As a deposit of clay is seldom of uni form thickness throughout its extent, a sufficient number of borings should be made in order to fully determine this point; a bed of clay may be 40 feet deep at one point and thin out to five or six feet within a distance of 15. The writer has seen several instances in which expensive plants have been erected and come to a speedy end simply because the clay gave out, whereas the disaster might have been avoided by previous exploitation. Another important point to determine is the presence of sand for molding and tempering. Many of the clays in this state can not be made into brick without the addition of sand. Along the Hudson River and on Long Island tempering sand is a much needed article, but fortunately it is near at hand. With molding sand it is different, for wherever soft mud machines are used it is necessary. Very often it can be obtained from some neighboring hill, but sometimes it has to be brought long distances.

The presence of a large deposit of clay is not the only fact necessary to be determined. The question next arises, is the material available for the purpose for which it is to be used, and what sort of machinery will be the best suited to work it. By far the best way is to take several barrels of clay and have it made into the desired product by different methods. There are brickyards where this can be done, or even the manufacturers of different machines offer to do this at their works. Crushing a lump of clay between the fingers or tasting it will give some idea of grittiness, but it is impossible to tell by this method the quality of the clay or its availability for one purpose or another.

Having determined by boring or otherwise the extent and thickness of the clay at the locality where the brickyard is to

be established, the next step is to strip a portion of the surface to a sufficient depth to expose the clay.

The amount of stripping to be done varies. On Long Island it is sometimes as much as 20 or 30 feet. Along the Hudson valley it varies from a foot or two of loam, or three or four feet of sand up to 15 or 20 feet. In both these regions the sand can be used for tempering, though the quantity stripped is far in excess of the demand. At some points in the Hudson valley the surface is covered with scrubby trees which are troublesome to remove. In the northern and western portions of the state, there is at most places only a foot or two of soil covering the clay.

When a yard is first started, the stripping, whatever its character, can be used for filling.

Natural drainage is always an extremely desirable thing, for having to keep the clay pit clear of water only adds to the cost of production. Neighboring streams and springs are often a constant source of annoyance, especially if the clay deposit is situated in a valley. They are chiefly troublesome when the sand bed, which often underlies the clay, is struck and allows the water to run in and flood the workings.

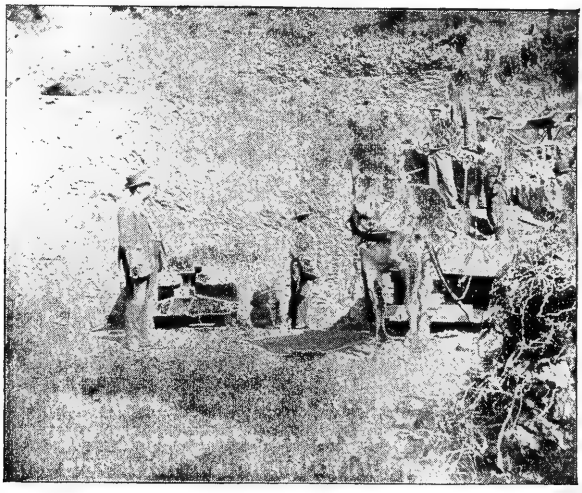
Working clay

Having uncovered the clay several methods are employed to work it.

1. The clay is dug at any convenient spot in the bank, usually at the base, working inward; thus in the case of a high bank eventually leaving quite a steep face. The bank is apt to slide sooner or later and the men begin again at the base of the slip and work inward. There is one disadvantage in this method and that is that the several qualities of clay, if it be in strata, become mixed, which is not desirable in all cases. It has, however, the advantage in the case of a bank of clay of making the haulage all on one level. Of course, in this method, haulage by cart is the most convenient. Costs 25–30c. per 1000 brick for about 500 feet of lead.

2. A second method, but one rarely used, is to loosen the clay by means of plows and bring it to the yard by scraper, provided of course the clay bank adjoins the yard. Very few yards employ this method. It costs about 20c. per 1000 brick to plow the clay and

bring it down with scrapers. To this must be added the price of getting the clay from the heaps to the molding machines, a distance of about 50 feet. In plowing clay the bank is usually worked at an angle of about 30 degrees. This method has no especial advantage. The clay is broken up more and exposed to the



Loading clay on cars.

weather for several days, but as far as I am aware this does not add materially to the quality of the brick when the molding is done in soft mud machines, which are used at all the yards digging their clay by plows.

3. *Working in benches.*— This method is the one most commonly used where the bank is over 25 feet high. The benches are six to eight feet wide and seven to nine feet high. Roads lead up to the separate benches, and each bench is worked in advance of the lower one.

Where the clay has streaks of quicksand the roads have to be planked. If the bank is below tide level there is the additional expense of pumping. This method is of importance along the Hudson River where many of the clay banks are of considerable height, and the use of benches often prevents a slide of the clay.

4. *Steam shovel.*— Although this method of mining has been successfully practised at many western localities the only place in this state where it has been tried is Croton Landing in the Hudson valley. These clays do not as a rule stand well with a

vertical face, and as a result the bank slid, burying the shovel. Where the clay bank contains several different layers of clay, which are mixed together for making brick, the steam shovel is a good thing, as it digs from bottom to top of the bank each time.

5. *Dredging.*— This method like the preceding is only practised at one locality, viz., Croton Point. The dredged clay is dropped into hoppers, which, when full, are run up inclined planes on shore and dumped. Costs 12–15c. per 1000 delivered on shore; then 12c. for haulage to ring pits.

6. *Undermining.*— Many brick manufacturers use this method of mining their clay, especially when the latter is tough. Wedges are driven in on the upper surface a foot or two from the edge; at the same time the face is undermined by picking to a distance of two or three feet. It is not advisable to work a

Shale bank covered by a shed.

bank over 20 feet high by this means, and in almost any case it is a rather dangerous method to employ.

7. *Blasting* is very often resorted to in banks of tough clay and always in the case of a shale bank. A small charge of dynamite usually suffices to bring down a large quantity of the material.

Haulage.— The brick manufacturer generally locates his plant near the supply of clay, so that the haulage distance is from 100 to 300 feet. Within these limits it is economical to use one-horse carts, but above 300 or 400 feet there are other means of haulage which will generally be found cheaper. There are exceptions where carts are used for hauling long distances; for instance, at Port Ewen on the Hudson the clay is carted 900 feet in some cases, and at Haverstraw some of the firms bring their clay a distance of a quarter of a mile in one-horse carts.

Cars.— As a rule where the haulage distance exceeds 500 feet cars are used. They are run on tracks and drawn by horses; if possible the track is laid down grade from the bank to the yard. Sometimes the loaded cars are run down to the yard by gravity, the horses being only required to draw them back when empty. Cost 10c. per cubic yard for about 500 feet lead.

Locomotive haulage.— This is a cheap method where the scale of operations warrants it; that is to say, for a yard having an annual capacity of 15,000,000 or upwards. The cost by this method is about 5c. or 7c. per 1000 brick (about one and one quarter to one and one half cubic yards of clay being reckoned to a thousand brick) for a distance of 600 or 800 feet. It is necessary, of course, to have cars filled with clay ready for the engine as soon as the empty ones are drawn back; otherwise the expense would become great if the engine had to spend much time waiting. The cost given above does not include wear and tear on plant.

Wire rope haulage.— A few yards use this method where the haulage distance is small; the winding drum is placed under the machine shed near the pug mill or crushers; side or bottom dumping cars are used.

Gravity planes may also be mentioned, but they are less used than they might be.

General remarks on bricks

Three kinds of brick are manufactured in New York, viz.: Common, front and paving brick.

Common brick. These constitute nine tenths of the clay products manufactured in the state. The following are the characteristics of a good building brick.

1. It should have plane surfaces, parallel sides, and sharp edges and angles. The regularity of form depends largely on

the clay from which the brick is made and the method of drying and burning.

2. It should be of fine compact and uniform texture, quite hard and give a clear ringing sound. The compactness and uniformity of texture, which greatly influence the durability, depends mainly on the method of moulding. Hand machines produce brick of homogeneous character. Tempered clay bricks are denser interiorly. Dry clay machines produce a thoroughly homogeneous and dense brick it is claimed.

3. It should not absorb over 10 or 15 per cent. of water. A simple method of testing this is to place the brick for 24 hours in a bucket of water, weighing it before and after immersion. The increase of weight is the amount of water absorbed. This applies only to hard burned bricks. A salmon or green brick will absorb much more.

4. It should have a specific gravity of 20 or more.

5. It should have a crushing strength of not less than 3000 pounds per square inch.

The manner of making crushing tests is described under the head of paving brick.

Building brick may be divided into three kinds, arch, red and salmon.

Common bricks run quite uniform in size. There is a difference of perhaps three sixteenths inch between a brick made in a new mold, and one made in a mold which has been used one or two seasons. The dimensions of an average sized common brick are about two and one quarter by three and three quarters by eight and one quarter inches. We give below a table of the sizes of common brick manufactured in this state together with the amount of water they absorbed when soaked for 24 hours.

	Size of brick.	Weight Before Soaking		Weight After Soaking.		Percentage of water absorbed	
		Lbs.	Ozs.	Lbs.	Ozs.		
East Williston	.....	4	$1\frac{1}{2}$	4	6	6.7	Soft mud.
Southold	$2\frac{1}{8} \times 3\frac{3}{8} \times 7\frac{1}{2}$	3	$12\frac{1}{2}$	4	3	10.7	Soft mud.
Farmingdale	$2\frac{3}{1\,6} \times 3\frac{1}{2} \times 7\frac{5}{8}$	3	$11\frac{1}{2}$	3	$15\frac{1}{2}$	7.0	Soft mud.
Croton, W. A. U.	$2\frac{5}{1\,6} \times 3\frac{5}{8} \times 8\frac{3}{1\,6}$	4	6	5	$\frac{1}{2}$	15.4	Soft mud.
Haverstraw	$2\frac{3}{1\,6} \times 3\frac{7}{1\,6} \times 7\frac{7}{8}$	3	11	....	....	.....	Soft mud.
Syracuse	$2\frac{2}{8} \times 3\frac{1\,3}{1\,6} \times 7\frac{6}{8}$	....	....	....	....	.....	Soft mud.
Warners	$2\frac{3}{1\,6} \times 3\frac{7}{8} \times 8\frac{3}{1\,6}$	5	11	5	17	6.3	Stiff mud.
Canandaigua	$2\frac{3}{8} \times 4 \times 8$	5	$\frac{1}{2}$	6	$4\frac{1}{2}$	24.8	Dry clay.
Rome	$2\frac{3}{1\,6} \times 3\frac{3}{8} \times 7\frac{6}{8}$	3	8	4	$1\frac{1}{2}$	17.9	Common.
Rome	$2 \times 3\frac{1\,5}{1\,6} \times 7\frac{1\,3}{1\,6}$	4	3	4	5	2.9	Stiff mud.
Owasco	$2\frac{1}{2} \times 4\frac{1}{4} \times 8\frac{3}{4}$	5	$\frac{1}{2}$	5	14	16.7	Repressed.
Saratoga	$2\frac{3}{1\,6} \times 3\frac{3}{4} \times 2\frac{3}{1\,6}$	4	$2\frac{1}{2}$	4	$8\frac{1}{2}$	9.0	Soft mud.
Buffalo	$2\frac{1}{4} \times 3\frac{1}{4} \times 8\frac{1}{8}$	4	$13\frac{1}{2}$	....	....	.....	Soft mud.
Dunkirk	$2\frac{3}{1\,6} \times 3\frac{1\,1}{1\,6} \times 7\frac{3}{1\,6}$	4	$3\frac{1}{2}$	4	14	15.5	Soft mud.
Jamestown	$2\frac{1}{2} \times 4 \times 8\frac{1}{4}$	4	11	5	$5\frac{1}{2}$	14.0	Soft mud.
Hornellsville	$2\frac{3}{8} \times 4\frac{1}{8} \times 8\frac{3}{8}$	7	2	7	4	1.7	Stiff mud.
Newfield (yellow)	$2\frac{3}{1\,6} \times 3\frac{7}{8} \times 7\frac{1\,3}{1\,6}$	5	$5\frac{1}{2}$	5	7	2.9	Stiff mud.
Newfield (cream)	$2\frac{3}{1\,6} \times 4\frac{1}{1\,0} \times 8\frac{1}{4}$	5	8	6	$5\frac{1}{2}$	15.3	Stiff mud.
Jewettville	$2\frac{3}{8} \times 4 \times 8\frac{1}{4}$	5	$11\frac{1}{2}$	6	1	5.4	Dry clay.

Permeability.—On account of the peculiar construction of the Croton aqueduct there are several points at which a considerable pressure is exerted on the bricks and a consequent permeation of the water through them. A number of tests have been made by A. W. Hale, engineer on the aqueduct, and a full description of the apparatus and method used is given in pp. 17 and 28, Eng. Record, 1890. The bricks tested were the Anchor brand of Croton Landing, N.Y. It was found that with 80 pounds pressure per square inch, the average percolation through a brick two and three eighths inches thick, was equal to 12 and 3-12 cubic inches per square inch of surface, per hour. The maximum percolation was 40.44, and minimum was 4.02 cubic inches. From these experiments Mr. Hale drew the following conclusions.

That the percolation through a brick under constant pressure, diminishes as the pressure is prolonged.

That the diminution of percolation under constant pressure is less and less rapid as the flow is continued and finally becomes constant.

Paving brick

The paving brick industry, although in its infancy, gives indication of rapid growth in the near future. In the western states many cities are paving their streets with brick. In this state brick pavements have been introduced in the following cities, Binghamton, Lockport, Buffalo, Rochester, Syracuse, Troy, Watertown, Ithaca, Corning, Elmira, Dunkirk, Jamestown, Tonawanda and Niagara Falls. There are only four factories in New York state which furnish paving brick, and up to the present time many of the pavers used in the state have been obtained from West Virginia and Ohio. It was formerly thought that only fire clays should be used in the manufacture of this product, but this idea is being abandoned, for there are many clays which are refractory enough for a fire brick which makes most excellent pavers.

In order to make a good paving brick the clay should be one which will hold its shape at a heat sufficiently high to cause thorough "vitrification", (as brickmakers call it.) It should shrink evenly in burning. It should be tough but not brittle, and withstand abrasion. It should also withstand considerable pressure;

10,000 to 12,000 pounds per square inch are probably sufficient. It should be homogeneous throughout. It should be dense and not absorb over two or at the most three per cent. of water.

In the manufacture of paving brick, the clay must be thoroughly drepared before being molded. Some clays can be ground, screened and pugged as soon as taken from the bank, while others have to be weathered or soaked before crushing. The machine used for molding depends on the clay. Some clays make a first-class paving brick by the dry press process, while others give the best quality with a soft mud machine. In any case the green brick should be as dense as possible. After molding, the bricks are dried in tunnels. The drying should not be hurried. Burning is usually done in down draft kilns. The kiln should not be too high in order to avoid the bricks in the lower part of it being crushed out of shape by the weight of those above, at the time the fires are hottest. In burning, the fires are raised till temperature of vitrification is reached, and they are held at this temperature for from 24 to 48 hours. Cooling is done very slowly, thus annealing the brick. The term "vitrification" is a misnomer. To vitrify a brick would be to convert it into a glass in which state it would be brittle and useless. What takes place is that the bricks are raised to a temperature sufficient to flux the potash, lime and iron with the silica and give a dense brick, and it is in order to thoroughly accomplish this, that the brick is kept for 24 or more hours at the point of fluxing or "vitrification."

Testing paving brick

1. Absorption. To determine the amount of water which a paver will absorb, it is soaked in water for 20 hours and weighed before and after. The increase in weight is the amount of water absorbed.

2. Abrasion. The bricks are weighed and then put in a rattler together with foundry shot and the rattler revolved for several hours at 52 revolutions per minute. The bricks are again weighed, the loss being due to abrasion.

Another method of making this test is to grind the brick on a horizontal stone, 14 feet in diameter and making 28 revolutions a minute. This is kept up for eight hours, the brick of course being weighed before and after.

3. Crushing tests. The brick to be tested is put on edge between the two plates of a crushing machine. The amount of pressure is noted at which the brick cracks, and also that at which it crushes. Before testing, the two sides of the brick on which the pressure is exerted should be ground perfectly smooth and be made exactly parallel. To further insure an even surface some material, such as paper or cardboard or plaster of paris, is put between the surface of the brick and plate of the machine. The following experiments made by Prof. I. O. Baker* show that for the same brick the results obtained vary with the method of preparing the surface. The bricks tested by him were prepared in the following manner:

1. Grinding as nearly flat as possible on convex side of emery stone and crushing between self-adjusting, parallel cast iron plates.

2. Removing the irregularities of surface and crushing between blotting paper.

3. Removing the irregularities of surface and crushing between straw boards.

4. Removing irregularities, coating with plaster of paris and placing under slight pressure until set (12–24 hrs.), and then crushing.

5. Coating with plaster of paris which was afterward ground down on a sand paper disk, to the surface of the brick so as to leave a minimum thickness with a perfectly flat surface and then crushing.

After a number of experiments no great difference was found between the first three, but difficulties connected with the last two rendered them worthless. With a uniform grade of brick the first three methods gave 7000 to 9000 pounds as crushing strength of cubes. Some samples of the same lot of brick were prepared on rubbing bed at marble works, and the strength of these carefully prepared cubes ranged from 16,000 to 21,000 pounds per square inch, showing that a very small difference in flatness of surface makes a great difference in the apparent strength.

* Clayworker, June, 1892.

Trautwine states that cracking and splitting usually commences under about one half the crushing load.

Front brick

Up to a few years ago in order to obtain a smooth, sharp-edged brick such as could be used for the outside of walls, the roofing of archways and other conspicuous places, the brick was first molded in an ordinary soft mud machine, or what was considered better, molded by hand. This green brick was then allowed to dry for a few hours and then put in a repressing machine. At the present day a smooth and sharp-edged "front" brick can be molded and made of sufficiently good appearance in one operation. The modern dry clay brick machine will do this. Repressing machines, however, are still extensively used. They are operated by hand power and one brick is treated at a time. Repressing machines run by steam power have recently been introduced and will undoubtedly be found to be more economical for those who have much use for this class of machines and work quicker than the hand power ones. As far as the writer is aware only one firm in this state, the Corning Brick Co., is at present using steam power repressing machines. Hand represses are in use at several localities. At the yard of T. B. Campbell at Newfield, near Ithaca, the bricks are first made on a wire cut machine and then repressed. W. W. Parry of Rome, N. Y., uses a similar method. The Hornellsville Brick Co. repress their paving brick. Some firms make a front brick on a soft mud machine and do not repress them. These latter machines do not, however, always exert sufficient pressure to produce a dense brick such as is required for fronts of buildings.

As stated above, a repressed brick should have smooth faces, sharp edges and square corners. For this class of product a clay is needed which will burn to a hard brick, having a good color and one which will also retain its shape and size fairly well in burning. The clay should be thoroughly pugged before molding, and very often better results are obtained by mixing two or more clays. Pressed brick usually take a longer time to burn and on account of their greater density have to be dried very slowly and carefully.

Method of manufacture

Bricks are usually made by one of the following three processes :

Soft mud
Stiff mud or wire cut
Dry clay

The processes are not wholly distinct from each other, for there are machines that may be used as well in connection with one as the other. For instance, in preparing the clay for molding in a stiff mud machine, we may use either a pug mill or a pan crusher, though the latter belongs preferably to the dry clay process. Whatever be the method, the manufacture of clay into brick involves the following steps, preparation, molding, drying, burning, and below is a classified arrangement of the stages in the process of brickmaking and machines used.

Methods

Mining the clay
- 1. Digging by pick or shovel at any portion of bank
- 2. Bench working
- 3. Undermining
- 4. Steam shovel
- 5. Plows and scrapers
- 6. Dredging

Machines used

Haulage
- Carts
- Cars on tracks, drawn by horses
- Steam
- Wire rope planes
  - Self-acting
  - Steam power

Preparing or tempering
- Barrel sieves
- Roll crushers
- Soak pits
- Ring "
- Pug mills
- Pan crushers
  - Wet pans
  - Dry pans

- Molding
  - Soft mud machines
    - Hand power
    - Horse "
    - Steam "
  - Stiff " "
    - Auger
    - Plunger
  - Dry clay
- Drying
  - Open yards, sundried
  - Covered yards, air dried
  - Pallets
  - Tunnels heated by
    - Steam pipes circulating within
    - Hot blast
    - Hot air from coal fire through flues underneath
- Burning kilns
  - Down draft
    - Rectangular
    - Circular
      - One or more chimneys according to make
  - Up draft
    - Scovekilns
    - Clamps

Soft mud process

Preparation of the clay.—This step in the manufacture of clay products is of great importance, and on it success or failure often depend. No fixed rule can be laid down for the preparation of all clays. Two clays may have a similar chemical composition and yet their physical condition may be such as to necessitate entirely different modes of treatment. A particular clay may give the finest quality brick by the soft mud process, while if molded in a dry clay machine it will produce a brick that is absolutely worthless. There are clays on the other hand which make a good brick by several methods. In any case, however, whatever the method or the clay, it should be prepared, and the more thoroughly this is done the better. Many advocate weathering the clay. This will break up the clay and thereby lessen somewhat the expense of mixing but does not add to the quality of the finished product.

In the soft mud process the clay is usually prepared either in soak pits, ring pits or pug mills.

Hematite is often added to the brick to give it a nice red color. It is either added to the clay while it is being tempered in the pug mill or else the powdered hematite is mixed with the molding sand. The former way is undoubtedly the best, for in the handling and rubbing which a brick gets before it is finally placed in a wall, much of the molding sand is rubbed off and with it the hematite.

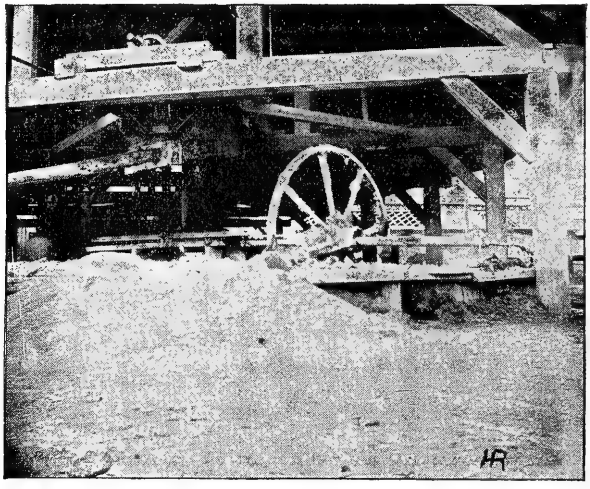
Soak pits.—These are the most primitive machines at present used for the preparation of clays. It consists of a rectangular pit about five feet deep and six feet square. The Long Island ones are usually rectangular in shape. Into this the clay and sand are dumped, water poured on and the mass allowed to soak over night, so as to thoroughly soften it. The following morning the softened material is shoveled into the machine. Two men — pit shovelers — do this, and it is highly important that they be men of intelligence and attend to their work, seeing that the right proportions of clay and sand are shoveled into the machine. From one third to one quarter is the amount of sand added. The operation of mixing the clay and sand is called tempering; the addition of sand is in most cases not necessary, as the majority of clays have sufficient of it admixed naturally. The object of the addition of sand is to counteract the effect of the alumina, by preventing a too great and uneven shrinkage of the brick. Coal dust is also added by some manufacturers and the advantage derived by its use will be mentioned under the head of burning.

When soak pits are used, two men dig the clay in the afternoon at the bank, while a third man levels off the material as it is dumped into the pit and also adds the requisite amount of water. He is called the temperer. In the morning the two diggers of the previous afternoon shovel the clay from the soak pit into the machine.

In many large brickyards separate gangs of men do the pit shoveling and digging of the clay.

Ringpits.—These temper the clay more thoroughly than soak pits, but are not so extensively used, possibly because it costs a trifle more to operate them. A ringpit, as its name implies, is circular, 25 to 30 feet in diameter, three feet deep and lined with boards or brick. In this there revolves an iron wheel, six feet in

diameter and so geared that it travels from the center to the circumference of the pit and then toward the center again. In this manner the clay is thoroughly broken up and mixed with the sand and coal dust, if this latter be added. The pitfull is



Ring pit for tempering clay

tempered in about six hours, and a pit holds sufficient for about 30,000 brick. The tempering is usually done in the afternoon so as to have it ready for the next morning. When the tempering is finished, a board is attached by ropes to the wheel and dragged round the pit a few times to smooth the surface of the clay; a thin crust forms on the surface and prevents the moisture in the underlying material from evaporating.

With ring pits there is a similar arrangement as with soak pits, the only difference being that the temperer previously mentioned is generally employed in the morning to wheel the clay from the ring pit to the molding machine.

As a rule there are two ring pits to a machine, so that while the clay is being shoveled from one pit to the machine, the other pit is tempering clay for the next day, or two pits and two machines are used, but each pit in this case holds enough material for the daily use of two machines.

Pug mill.—This machine, like the ring pit just described, is used for thoroughly mixing the clay, or clay and sand as the case may be, before introducing it into the machine. It consists

essentially of a semi-cylindrical trough, six to 10 feet long, in which there revolves a shaft, bearing knives set spirally around it, or a worm screw six or more inches wide. The material is put in at one end, and the knives or thread mix it up. At the same time it is worked along to the other end of the trough from which it is discharged into the machine. The pug mill may be closed or open; the former is better as there is a more uniform pressure on the clay while it is being tempered, and a more thorough mixing results. Water is also added from a faucet at the upper end of the trough until the clay is in the right condition. The angle of the knives with relation to the shaft can be changed so that the clay can be moved along slower or faster as it is desired. The trough of the pug mill is of iron or wood, usually the former. A pug mill, according to its size, will in 10 hours temper clay enough for from 25,000 to 60,000 brick. Pug mills take up less room than ring pits and do not require as much power to operate them. They will also, if desired, discharge the clay directly into the molding machine. They are used chiefly with stiff mud machines.

Molding.—Having prepared the clay by one means or another, according to its character, and somewhat according to the machine to be used, the next step is to mold it into bricks. The old-fashioned method of molding bricks by hand is rapidly dying out, yet every now and then we come across a yard where it is still in vogue. In New York the soft mud process is the most used. There are a number of different types of machines but the fundamental principal of them all is the same. A soft mud machine consists essentially of an upright box of wood or iron and generally of a rectangular shape. In this is a vertical shaft bearing several knives horizontally. Attached to the bottom of the shaft is a device such as a curved arm, which forces the clay into the press box. The molds are put in at the rear of the machine and fed forward underneath the press box automatically. The empty mold sliding into place shoves out the filled one. A boy sands the molds before placing them in the machine in order to prevent the clay from sticking. The clay is fed to the machine at the upper end of the box. Often there is a pug mill attached to the machine. In all these machines the material gets an additional amount of mixing by the knives on the vertical shaft. In

fact many brick manufacturers consider that the soft mud machine tempers the clay sufficiently to enable them to dispense with a pug mill or ring pit and use the old-fashioned soak pit. That they can make a very fair common brick thus is not disputed, but it is certain that with a thorough tempering of the clay, a better brick would be obtained in most cases. There is one type of machine, the Adams, used by several manufacturers on the Hudson River, which does not temper the clay, but simply forces it into the press box. Some form of tempering machine must, therefore, be used in connection with it. These soft mud machines have a capacity of about 5000 brick per hour, six being molded at a time.

Steam power is generally used to run the machines, but some of the smaller yards use horse power; this, of course, is much slower and not economical except for a yard of a small capacity. Some soft mud machines are more powerful than others, and indeed this is necessary. For instance a brick dried on pallets needs a much greater pressure applied to it, and has to be molded from stiffer material than one dried in the sun in the yard.

Four men are required to tend the machine. A "molder" who scrapes off the top of the mold as it is delivered from the machine and watches the consistency of the tempered clay, to see that it keeps uniform; a "mold lander" who takes the mold from the delivery table and places it on the truck; a "sander" who sands the molds before putting them in the machine, and a boy to watch the machine and stop it when necessary. Besides this there are four "truckmen" who wheel the bricks from the machine to the yard where they are dumped on the drying floor by two "mold setters." In the afternoon these men are emp oyed in hacking the bricks and wheeling the dry ones to the kiln.

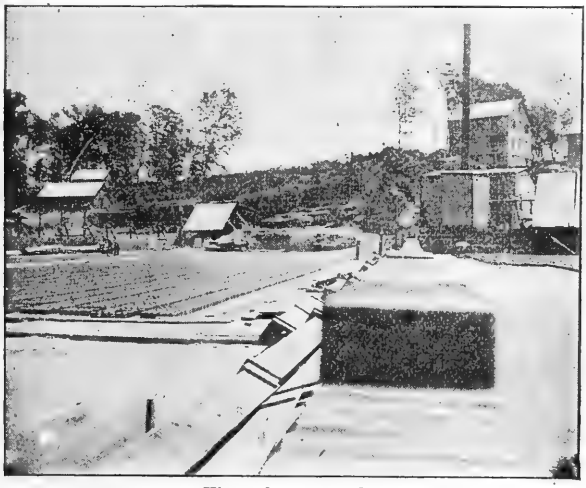
Drying — In New York State bricks made by the soft mud process are usually spread out on floors or set on pallets to dry. A few yards use tunnel dryers, but as these are more extensively used in connection with the stiff mud process they will be described there.

Drying should not be hurried. Bricks dried too quickly are apt to crack. They should also be well dried before setting in the kiln, and if this is not done the product is very apt to be poor.

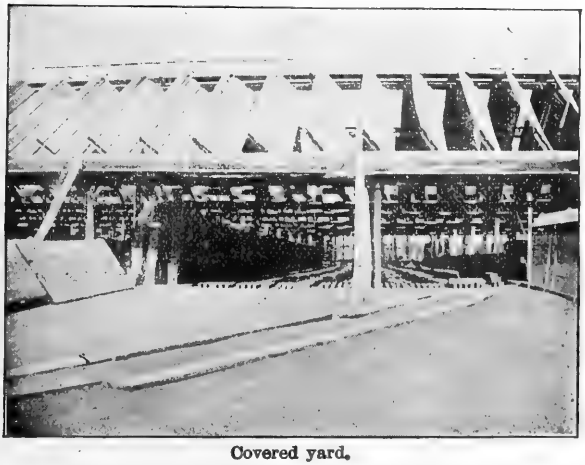
Bricks made by the soft mud process are usually dried in one of three ways viz.:

1. Open yards
2. Pallet yards
3. Covered yards

The first method is the most used, the second next and the third least. In the first method the bricks are spread out on a hard



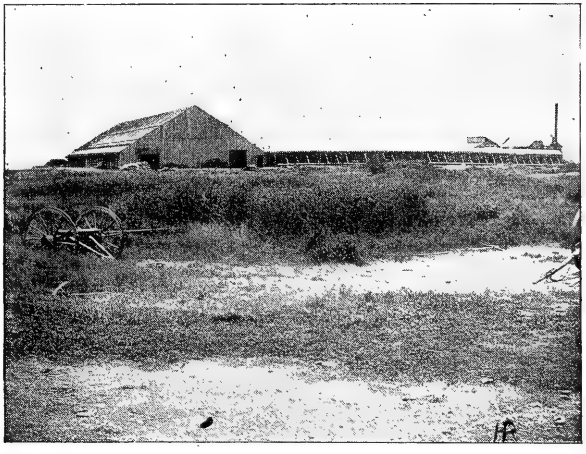
View of open yard.



Covered yard.

floor, in the open air. This floor, which is about 200 feet long, is of brick, with a thin covering of sand, and is the "yard" proper. At one end of it are the molding machines, at the other end the

kiln sheds. The yard usually drains toward one end, or from the center toward both. After a day's production has been spread out the boy who tended the machine in the morning goes along the rows and stamps them with a piece of board set on the end of a long handle. This is termed "spatting." After this the bricks are turned on edge by another boy who goes along the



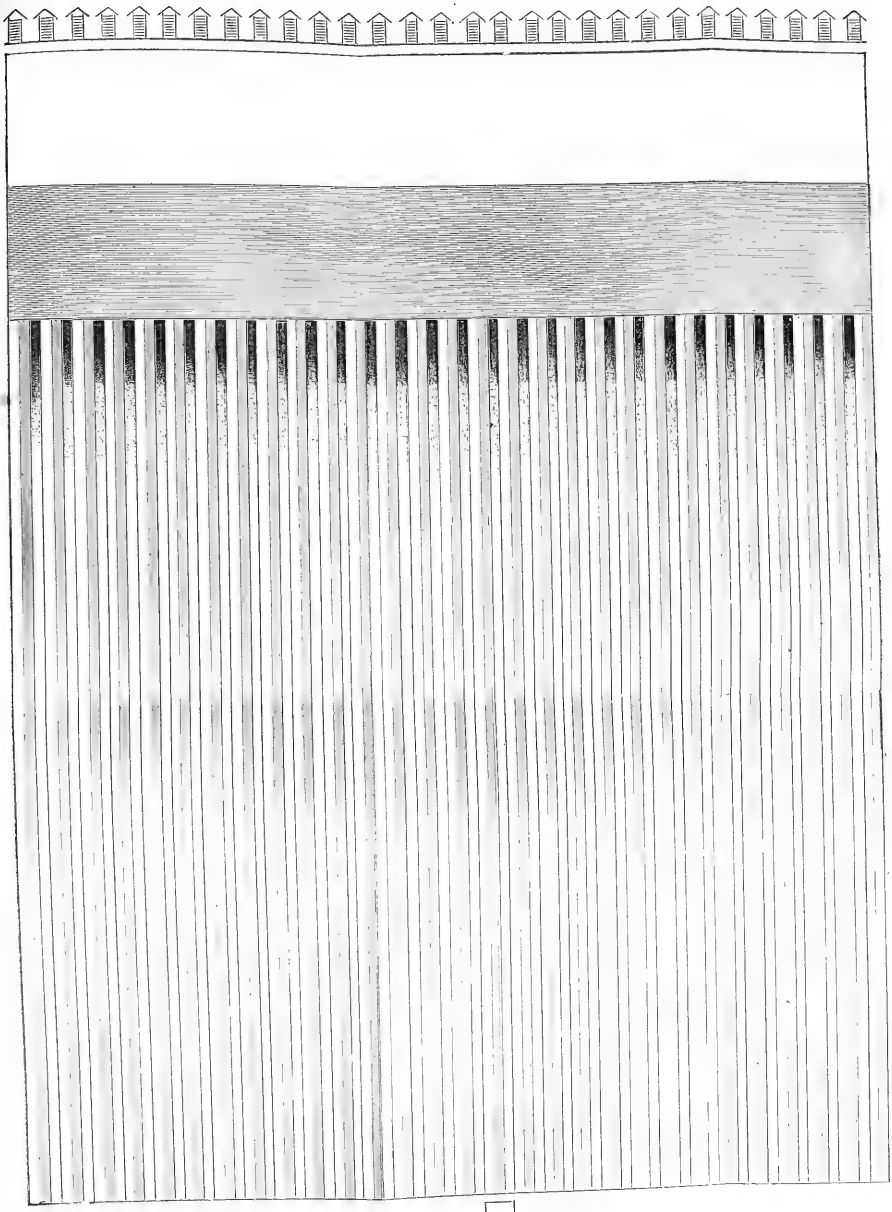
General view of brickyard, kiln sheds and drying rack.

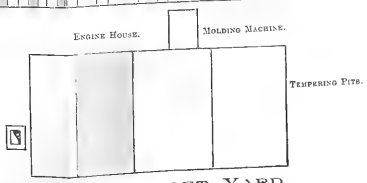
rows with a special tool, turning six bricks at a time. The next morning, if the weather has been pleasant, the bricks are "hacked," that is to say they are piled on each other in a double row 11 to 15 courses high along the sides of the yard and left till sufficiently dry to put in the kiln and burn. In case of rain the hacks are covered with planking.

The disadvantage of open yards is that the bricks are exposed to the rain, and if a shower comes while they are spread out on the yard, they become "washed," getting a rough, uneven surface. Washed brick are quite as strong as unwashed ones, but they bring 50 to 75 cents less a thousand. The washed brick amount to about 15 per cent. of the total production. *

Covered yards.—These differ from the former simply in the addition of a roof. This roof is in hinged sections, which on pleasant days can be opened upwards, allowing the sunlight to enter, and closed to prevent washing of the brick in case of rain. Washed bricks are of course avoided by this method of drying,

* Quite recently washed brick have been employed for the fronts of buildings. They givea unique effect.

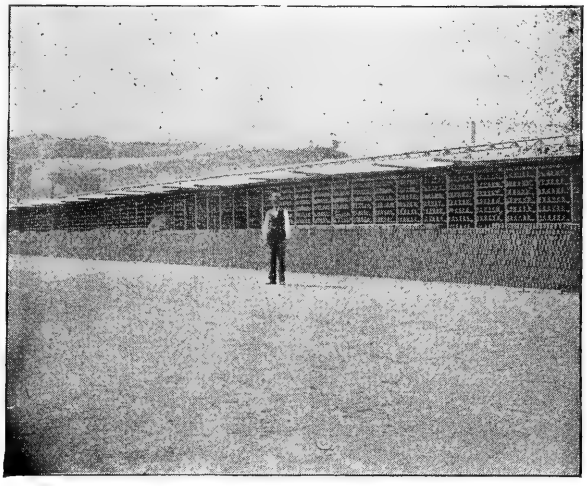




PLAN OF PALLET YARD.

but the bricks do not dry so fast, and, therefore, more drying room is needed for a yard of the same capacity. There is also the expense of erecting the sectional covering.

Pallet driers.— By this method the bricks are dumped directly on "pallets" as they come from the machine. These



Pallet racks.

latter are pieces of board long enough to hold six bricks. The pallets are then set on racks or cribs until the bricks are sufficiently dry to be set up in the kiln. There are both advantages and disadvantages to this method. As the bricks can not be spattered to keep them in proper shape, they must be firm enough to retain this themselves, consequently the clay must be molded stiffer, and to do this we must have strong machinery. Furthermore, a molding sand must be used which will allow the brick to slip readily from the mold, as it has been forced in tighter than a brick which is to be dried on an open yard. There is, of course, the expense of setting up the racks, but on the other hand the capacity of the yard is increased, the brick, though drying slower, are not subjected to a sudden drying, such as the sun of a hot summer's day is apt to give, and, therefore, perhaps warp or crack the brick. The brick are only subjected to one handling between machine and kiln. Some manufacturers claim that it is cheaper to make bricks on a pallet yard. A machine called a "pallet-squarer" has been invented by Mr. Swain of the Croton Brick Co. which is said to fulfil the

functions of a spatter (*See* detailed account of yards). All clays are not sufficiently strong to permit drying on pallets.

Burning.—This is one of the most important steps in the whole process of manufacture. Nine tenths of the manufacturers who make common bricks by the soft mud process, burn them in temporary, up-draft kilns, or scove kilns, as they are properly called. The other one tenth use an up-draft kiln which differs from the preceding in having permanent walls. The following description of burning applies directly to scove kilns, but the principle, whether it be a temporary or stationary up-draft kiln, is practically the same. When the bricks are thoroughly dry, they are set up and burnt in "arches," several of which go to make up a kiln. The number of bricks in an arch varies from 35,000 to 40,000. An arch is about 40 courses high, and about 15 arches make up a kiln. The open portion of the arch is about 14 courses high, and the bricks above the arch are set three one way and then three on top at right angles. They are kept slightly separated by putting small pieces of clay in between them. The first row of brick on top of the arch is called the tie course, and the first 14 courses, including the tie course, above the arch are called the "lower bench," and the rest of the courses above are called the "upper bench." When the arch and lower and upper benches have been set, brick are laid flat over the top of the kiln; this is the "raw platting," and then on top of this is laid burnt bricks at right angles to those of the raw platting; this is the "burnt platting" Hanging from the roof of the kiln shed at the same level are a number of bricks which serve as a guide for height in building the kiln. A wall of two thicknesses of "double-coal" brick is put around the outside of the kiln, scoving the kiln it is called, and this is "daubed" over with mud. The daub is to prevent any air entering except through the doors. These latter consist of an iron frame about 14 inches high, with an iron plate to close the opening; the frames are set in the courses of double-coal brick, at the bottom of the arch on both sides of the kiln. Double-coal brick have six or seven times as much coal dust in them as others, and are used for placing around the outside of

the kilns. The combustion of the coal in them, the manufacturer claims, supplies the necessary amount of heat to the outer portion of the kilns which are not sufficiently heated by the arch fires. Double-coal bricks sell for about $2.50 per 1000, and usually bear some distinguishing stamp, but they are not as strong as the other brick. It takes two setters and four wheelers about one day to set an arch of 35,000 brick; two men will daub the outside of a 15 arch kiln in one day.

Having "walled-up" the kiln with double-coal brick and daubed it over, the next step is to start the fires and burn the bricks. The principle of the process is essentially the same, whether wood, coal or oil are used as fuel.

First, every alternate brick of the "burnt platting" is stood on end to allow the "water smoke" or steam to escape as quickly as possible. A fire is then started in the mouth of each arch. When coal is used the fire is started on the windward side of the kiln so as to allow the smoke to blow through the arches.

The fire is also started from the other end of the arch, and the two fires are then built up slowly till they meet in the middle. The time of crossing the fires varies; with machine-made bricks the fires should not be crossed as quickly as with hand-made ones Along the Hudson the time of crossing is from 40 to 60 hours. The steam should escape evenly all around the top, and the upper limit of the fire should follow directly on it, the steam acting as a blanket, and its lower limit should be even. It is the duty of the foreman to watch the burning carefully, and increase or ease up the steam in any one arch, according as it is coming off too slowly or too rapidly. The fires are increased until the "water smoke" changes to a bluish black smoke, and at this point the fire can be seen at night time coming from the top of the kiln. The kiln is now "hot" and the bricks commence to shrink or "settle" and all the platting is turned down. Up to this point care must be used to gradually increase the heat. The bricks now get their heaviest heat, and the oxides of iron are changed to the anhydrous peroxide, giving the bricks their red color. If the heat in the arches is too great, the bricks run, stick together or become distorted and cracked. After the firing has been done the doors are all closed and plastered over to prevent any air from entering.

If the bricks are put into the kiln before they are sufficiently dried, or if they are heated too quickly, they are liable to crack.

In the case of coal, grates have to be put in a few inches above the level of the floor, and for oil, burners are needed.

After a kiln of bricks has been burned the ends of the arch bricks are often black, caused by the particles of dust and carbon which have been carried upward sticking to the brick when they were in a soft condition, due to the high degree of heat.

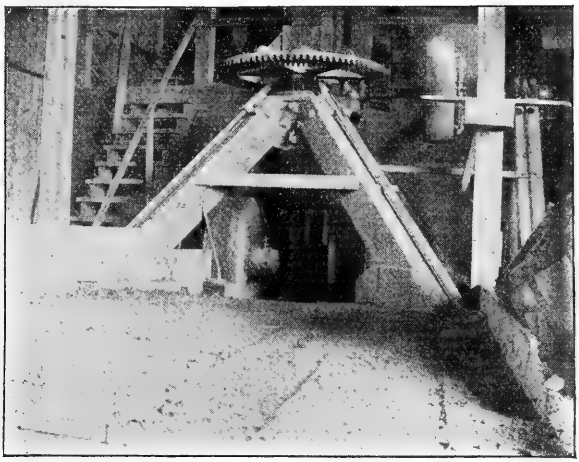
As to the action of the coal dust in the brick. At first while the brick contains water, there is no access for the air to the particles of coal. However, as the firing proceeds, the water is driven off leaving the brick porous, allowing the air to enter for the combustion of the coal. Particles of lime and lumps of clay cause a splitting of the brick. Insufficiently burnt bricks are called "pale" and sell for $3.75 per 1000.

The kilns take several days to cool, and, when cool, the bricks are put on wheelbarrows, and taken to the freight cars, or barges, and then shipped to the market. If the kiln shed is not situated along the dock, the barrows are put on a car, which is run down a track to the scow. The time of burning is from five to seven days with wood and four to five days with oil. The cost of burning with wood is 60 to 75 cents per 1000 brick, and with coal the cost of burning is 40 to 50 cents per 1000. Burning with wood is the cheapest method as far as implements are concerned. With coal there is the cost of grates and with oil there is a royalty of $160 to be paid on every burner. The latter is, however, the cheapest method as regards the price of fuel. The great majority of the yards along the Hudson use wood, a few use coal and two or three use oil. With coal and oil the heat can be better regulated than with wood. Another important point is the amount of pale brick produced. Most of the yards in New York burn their bricks in scove kilns. In these there is sometimes a loss of as much as 50,000 to 75,000 in a clamp of 500,000 bricks, while in a permanent kiln such as the Wingard or similar, the amount of pale brick is said to be not over 25,000 usually. Again in the case of permanent kilns, it takes no more, if not less, time to set the bricks and there is less daubing to be done. Regarding the amount of labor required in burning, one man is supposed to tend three arches.

Stiff mud process

This is so called from the fact that the clay is molded quite stiff, being forced from the machine in the form of a hard bar which is cut up into brick.

The clay is sometimes prepared in pug mills which have been previously described, but pan crushers are mostly used for this purpose in New York.



Pan crusher.

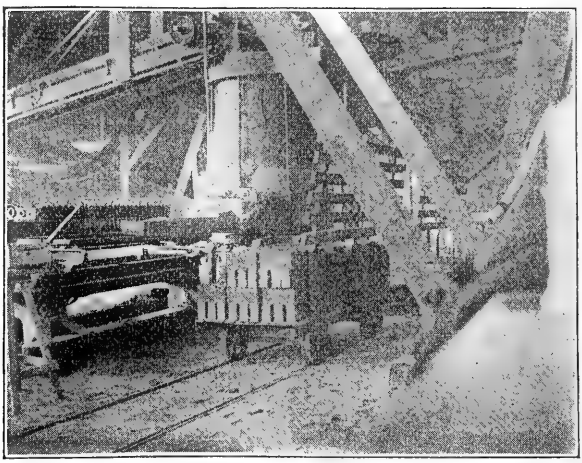
Pan crushers.— Of these there are two classes, viz : Dry pan crushers and wet pan crushers. The former pulverizes the material as it comes from the bank, the latter tempers it with water. In either case the crushers consist of a circular pan in which there are two iron wheels revolving on a horizontal axis. They are made to revolve by friction against the pan which is rotated by steam power. In a dry pan the bottom is perforated and the wheels weigh 2000 to 5000 pounds each. The wet pan has a solid bottom, in which there is a door through which the material can escape when sufficiently tempered.

A good dry pan will grind 100 tons in 10 hours through one-eighth inch screens.*

Two scrapers are placed in front of the rollers to throw the material in their path. In a wet pan water is added to the clay

* E. Orton, Jr., Clay Working Industries of Ohio, 1893, p. 142.

and when a charge is sufficiently tempered it is removed either through a door in the bottom of the pan, or else by means of a shovel attached to a long pole and pivoted on an upright support. Wet pans are more expensive than pug mills and require more power to operate, and they do not temper the material as evenly. They are, however, better adapted for tough and shaly clays.

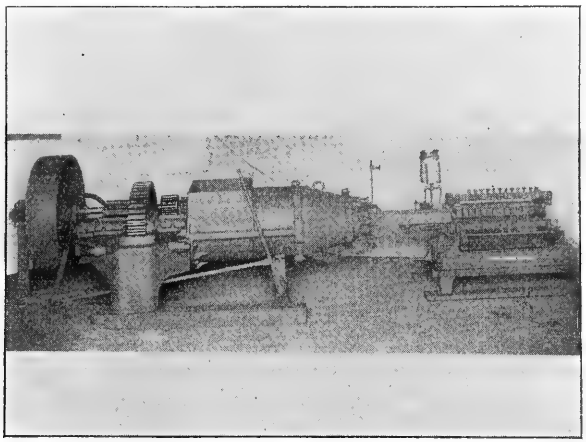


Stiff mud, wirecut machine.

Stiff mud or wirecut machines.— Their name indicates the nature of the process. The clay is tempered quite stiff, and charged into the machine from which it is forced in the form of a rectangular bar whose cross section has the same area as the greatest plane surface or end of the brick. The bar of clay as it issues from the machine is received on the cutting table, and is cut up into brick either by means of a series of parallel wires set in a frame which slides across the cutting table, in which case the machine stops when the bar has issued a certain length, or else the bar of clay issues continuously, and is cut up by means of wires on a revolving frame. The former method is usually employed in connection with the plunger type of machine and the latter with the auger type.

The plunger machine consists of a large iron cylinder into which the clay is charged, and from this it is forced out through the die.

The auger machine consists of a cylinder with a conical end. In this is a horizontal shaft bearing a screw or knife blades so set that their action will force the clay forward. At the forward end of the shaft is an iron screw which forces the clay out through the die. The clay is fed at the large end of the cylinder. It will thus be seen that the clay undergoes a large amount of compression and

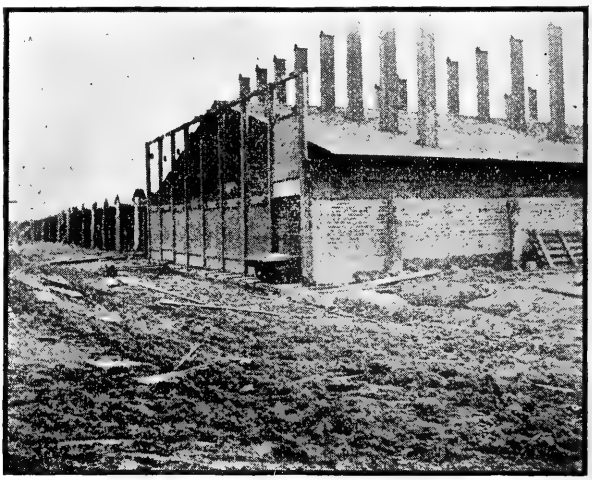


Auger machine.

that considerable power is required to force it through the die. Auger machines are either end cut or side cut according as the area of the cross section of the bar is the same as the end or side of a brick. The great objection to this form of brick machine is the spirally laminated character which the brick has, owing to the manner in which the clay is forced through the die. Nevertheless this machine is extensively used at the present day, especially in the manufacture of paving brick. It has a large capacity, 60,000 brick being not an unusual output for 10 hours. The capacity of the auger machine is often increased by causing two streams of clay to issue from it and certain machines are said to have produced 150,000 brick per day. Plunger machines have a capacity of 25,000 to 30,000 per day.

The green bricks are usually piled on cars and these are run into heated tunnels to dry. If soft mud bricks are dried in tunnels then the cars must have racks on which to set the pallets bearing the bricks. Stiff mud bricks can, however,

be set on each other setting the bricks of two successive courses at right angles to each other. Each car carries about 360 brick. Tracks are laid from the machines through the tunnels to the kilns. The tracks are laid in two directions only, at right angles to each other, and turn tables are placed at the points where tracks intersect. The tunnels are built of brick or wood. They are about five feet high and four feet wide. Several methods



Tunnel dryers.

are used to heat the tunnels. There may be a fireplace at one end and a system of parallel flues under the tunnel to conduct the heat. A second method is to use steam heat, the pipes being laid along underneath the floor of each tunnel or along the sides. Exhaust steam is used in the day time and live steam during the night. Another method is to heat the tunnel by a hot blast. In a good dryer the natural draft should be sufficient to draw the air through the tunnels. Six or more of these drying tunnels are usually set side by side. Artificial drying takes from 24 to 36 hours. The green brick are put in at the end nearest the machine and the cars with the dry ones drawn out at the opposite end. It is of importance that the capacity of the dryers should not exceed that of the kilns. Artificial dryers have the advantage of permitting a plant to be run all winter. The cost of flue dryers is set at 25 cents a thousand brick with coal at $2.50 per ton.

Scove kilns, clamps or down-draft kilns are used for burning the product. The principle of burning is much the same in all three, although many manufacturers claim that the burning can be better regulated in clamps and down-draft kilns, while others claim the opposite. In the latter the bricks in the upper portion of the kiln receive the greatest amount of heat, whereas in a

Down-draft kiln.

scove kiln or clamp the arch bricks, which have to bear the weight of the overlying bricks, are heated the most and often become crushed out of shape. Regarding the rectangular and circular down-draft kilns, the latter are bound easier than the rectangular ones, this being of course necessary in order to prevent a bulging of the walls during burning.

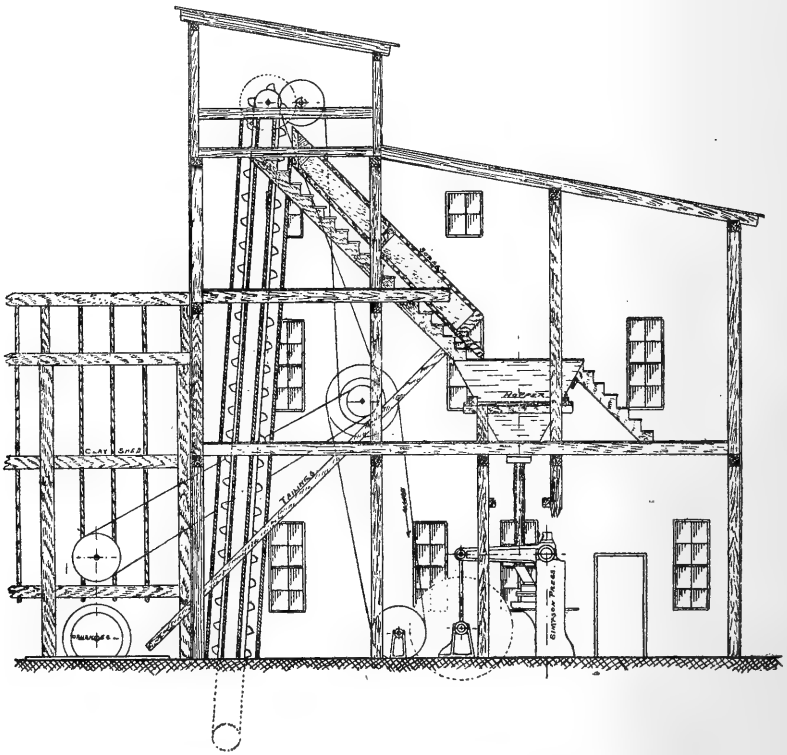
Roll crushers.— This type of machine is extensively used in the preparation of tough or stony clays. They consist of two or four steel rolls, which revolve at different velocities. They are usually enclosed and the clay is charged into a hopper above them. The crushed material passing out below is received on a traveling belt and carried to the pug mill. Crushers are objected to by many on the ground that they make the clay flaky, in which condition it does not make a good brick. Subsequent pugging, however, usually does away with this. By many manufacturers rolls are used as a means of breaking up the stones and thus avoid drying the clay and screening it. There is no

special objection to this unless the pebbles are limestone and then they should not be allowed to enter the brick. Several forms of machines have been invented which, it is claimed, break up the clay and separate the pebbles at the same time.

Barrel sieves are sometimes used to get rid of pebbles in the clay. In this case the clay has to be first dried and broken up.

Dry clay process

The introduction of this method in the United States dates back 15 or 20 years only, it having been first introduced at Louisville, Ky. In New York it has not been in use over five



Dry clay plant.

years, and there are only five machines in use in the state. The clay after being dug is usually stored in sheds to dry. When ready for use it is taken out and charged into the disintegrator or dry pan, preferably the latter. Dry pans have been described in connection with the stiff mud process; as to disintegrators the

New York brickmakers use a Steadman. It consists of a cylindrical flat box about three feet in diameter, within which two concentric wheels with iron arms revolve at a high rate of speed; the clay being thrown around between these is quickly broken up. If the clay is charged in too moist a condition it will not be thoroughly pulverized, at the same time it must not be charged too dry and thereby prevent the particles in the green brick adhering together. After passing from the disintegrator the powdered clay is carried by an elevator to the upper story where it is discharged onto a long screen inclined at an angle of about 45 degrees. The material which has been ground fine enough passes through the sieve and down into the hopper over the molding machine. The tailings fall into a hopper at the lower end of the sieve and are carried back to the disintegrator.

Now comes the molding, the manner in which it is done characterizing the process. The molding machine consists of a massive frame of forged steel about eight feet high. Three feet up from the ground is the delivery table, sunk into which is the press box. Connected with the hopper above the machine by means of two canvas tubes is the charger. This latter slides back and forth on the table. It is filled on the backward stroke and on its forward stroke lets the clay fall into the mold box. The charger then recedes to be refilled and at the same time a plunger comes down pressing the clay into the mold. As the upper plunger descends a lower plunger which forms the bottom of the mold moves upward, so that the clay receives pressure from above and below. The upper plunger then rises, and the lower plunger ascends until the lower surface of the brick is even with the table. Again the charger comes forward, shoving the green brick forward on the table, the lower plunger drops and the mold box is once more filled with clay. The faces of the mold are of hard steel heated by steam to prevent adherence of the clay. Air holes are also made in the dies, but are apt to become clogged up. The pressure from above is applied by a toggle-joint arrangement, and it is claimed by the manufacturers of the Boyd dry clay presses that the pressure exerted on each brick is 150 tons. One to six bricks can be molded at a time, according to capacity of machine. On a four-brick machine about 20,000 are molded in a day. As the

molded brick are shoved forward on the table by the charger they are placed on cars and either taken to drying chambers or set directly in the kiln The green brick require great care in handling as they are very tender. Drying must be done very slowly to prevent cracking. Burning is usually done in down-draft kilns. The manner of burning does not differ essentially from that followed for other makes of brick. By setting directly in the kiln without previous drying it takes longer to water smoke. This in any case should be done very slowly and the burning should not be pushed until water smoking is entirely finished. It is claimed by some that one sixth to one quarter more fuel is required to burn dry clay bricks than those made by other processes.

The type of kiln used varies.

Cost of production

This item varies considerably depending on a variety of circumstances, such as the method of manufacture employed, cost of labor, locality, etc.

Brick manufacturers are generally unwilling to give information on this subject, and the figures given, therefore, can only be considered approximate.

The use of improved machinery and methods will often lower the cost of production considerably, but this generally requires a much greater outlay of capital than seems to be in most instances available.

By the hand power method the cost of manufacture is $3.75 to $4.00 per 1000 delivered at the yard. On Long Island where the soft mud process is almost exclusively used the cost is said to be $3.00 per 1000 delivered at the yard. Hudson river manufacturers quote the cost at $5.00 per 1000 delivered in New York city; this figure includes $1.25 for transportation and 25 cents per 1000 for commission.

The brick yard is usually owned by the manufacturer but the clay bank is worked on one of the following bases:

1 The manufacturer owns the bank. This is by far the best and most profitable arrangement.

2 The brickmaker pays a certain rental, usually nine or 10 per cent.

3 The owner of the clay bank gets so much per 1000 brick. At Haverstraw this varies, for instance, from 25 cents to $1.25 per 1000. With this arrangement the manufacturer is bound to a certain amount of production.

Of the three methods for manufacturing brick, the soft mud process is the cheapest as far as first cost of plant is concerned, but it is probably not the cheapest to operate, as more labor is required. The other two methods used, the stiff mud and dry clay, require considerable outlay of capital. Less labor is required for operating either of the last-mentioned plants. The actual cost of production by either of these methods I have not been able to obtain. It is doubtful if the dry clay process is the cheapest, as the manufacturers of this class of machinery claim, for the economy gained, due to the shortness of the method, is probably counterbalanced by the increased time of burning and consequently greater amount of fuel used. With the soft mud process one man per 1000 brick is what the manufacturer figures, that is, if the yard has a capacity of 50,000 per day, a force of 50 hands is required to operate the yard.

As regards fuel, for instance, a saving of 30 cents can easily be made by using coal instead of wood, and gas is considered about 25 cents cheaper per 1000 than coal. Further economy may be made by the use of the proper class of machinery for haulage. Carts can usually be used economically up to 400 feet, beyond this it will usually pay to lay tracks and use cars hauled by horses. Above 600 feet steam haulage has been found economical. Self-acting planes and cable haulage have been used to advantage in a few instances.

Detailed account of brick yards

As the brick yards are scattered all over the state, a division of them into groups for convenience is more or less arbitrary. However, the following classification has been made.

Brick yards of eastern New York
" " " central New York from Schenectady to Buffalo
" " " Oswego, Jefferson and St. Lawrence counties
" " " southern New York
" " " Long Island
" " " Staten Island

Most of the bricks manufactured are sold in local markets. The greatest proportion of the Hudson river ones, as well as some of those made on Long Island and Staten Island are sold in New York city. Other large markets are Buffalo, Rochester, Syracuse and Albany.

Croton Landing, Westchester Co. There are three yards, all situated on Croton Point and having a yearly capacity of 61,000,000 brick. The yards of the Anchor Brick Co. are situated at the base of the point, a short distance south of the station and along the railroad track. One yard is situated a few feet above river level, the other 90 feet above it on a delta terrace. The clay deposit adjoins this yard. It is basin-shaped, and varies in depth from 40 to 70 feet. The clay is mostly blue, and is underlain by hard pan, the pebbles of which are cemented by clay stained with limonite. The present excavation is about 40 feet deep; the bottom of it is 40 feet above mean tide. Borings show an additional depth of 35 feet in the center, and the engineer who made them calculates that at their present rate of manufacture there is sufficient material in sight for 15 more years. The stripping amounts to about 10 feet of loamy clay and sand. Streaks of gravel are not uncommon in the clay.

The deposit is worked in benches having a long working face and these benches converge to one point at the eastern end of the pit, from which a single track is laid up to the tempering machine. Tracks are also laid along the benches, and as the working face recedes the tracks are shifted with crowbars. The cars are brought down to the working face by gravity, or a small engine which is chiefly used to draw them to the tempering pits. A temporary track is laid over the ring pits, upon which the cars can be run to facilitate dumping. Those cars containing clay for the lower yard are run on to a self-acting inclined plane, and on this the empty cars, and tempering sand for the upper yard are also brought up. The tempering sand is dug by a steam shovel, at the base of the terrace escarpment The bricks are dried on covered yards and burnt in a special type of kiln. It consists of two walls of best quality brick, about 15 feet high and 14 inches thick. The lower portion containing the doors are two feet thick, and the two walls are about 20 feet apart. The two ends have to be walled up with double coal

bricks after the kiln is filled. Coal is the fuel used. The bricks when burnt are loaded on cars and run down to the dock, those from the upper yard going on the gravity plane. The tempering sand is discharged by the shovel into small cars which are drawn up an incline to the top of a framework and dumped, the sand falling through a series of screens into cars below.

The Croton Brick Co. has two yards; an open and a pallet yard. They obtain all their clay from the river with a scoop dredge. It is dumped into cars on a scow, which when full, are run up an inclined plane on the shore and dumped. The clay is thus exposed to the weather for several months before it is used. It costs about 15 cents per cubic yard to deliver the clay on shore and 10 cents per cubic yard to haul it to the pits. Tempering sand is obtained from the escarpment of the delta terrace just south of the yard. At the pallet yard they use a hand machine to square the green bricks on the racks. It consists of two plates of steel, attached to which at right angles and on the same side of the plates, are 12 smaller ones, the height of a brick. Attached to the large plates are two handles. The two large plates slide back and forth on each other and so that the small plates can be brought together. This machine is set on six bricks at a time and by moving the handles the plates press against the brick, squaring the corners. It is said a boy can square a pitful of brick (35,000) in a day. The molding machines have an endless chain with buckets attached to them for feeding the sand. This leaves only the clay to be shoveled into the machine, and the feeding of the two uniformly and continuously gives a more evenly tempered mixture. It will be seen in this case that no soak pit or ring pit is used and the molding machine does all the mixing. The molding sand is dried by spreading it out on the kiln floor, it being claimed that it dries quicker this way than if it were banked up against the kiln as is commonly done.

The W. A. Underhill brick yards are situated midway between the base and end of Croton Pt. They have two yards, both covered ones. The brick made at this yard are sold mostly for fronts, selling for $14 a 1000. The clay bank lies between the two yards; it has a height of 40 feet above mean tide and extends 15 feet below it. At this last-mentioned depth the blue clay stops and is followed by two feet of yellow clay, several inches of quicksand and through which spring water enters and

finally hardpan. There is a stripping of fine sand, which varies from 10 to 20 feet in thickness. Some portions of this sand are found to make a better brick when mixed with the clay than others. The clay is mined in benches, and narrow tracks are laid along the working face. Side dump cars are used to haul the clay, being run in trains of three, drawn by four mules. The tracks are laid around the ring pits, so that the clay may be easily discharged into them.

Below are given two partial analyses of clay from this bank:

	Upper Blue clay.	Lower Blue clay.
Silica	62.30	57.74
Alumina	14.663	26.31*
Peroxide of iron	9.2	4.6
Lime	3.98	2.93
Magnesia	1.05	1.4

Crugers, Montrose and Verplank, Westchester Co.—These three localities lie so connected and their clay banks are so similar that they are best described together. The clay is extremely variable in depth, due to the great irregularity of the face of the underlying rocks; it is both blue and yellow. No special method is used in mining the clay, it being dug at any convenient spot till the underlying rock is reached and then the bank is attacked at another point. At Montrose and Crugers the clay is overlain in places by a moderately fine sand and gravel, crossbedded in places. The clay varies from six to 50 feet in thickness. It extends in places to an altitude of 90 feet, as at McConnell and O'Brien's bank, while at others as McGuire's bank it only reaches a height of six feet above mean tide. At this latter locality the clay is overlain by 10 feet of sand and coarse gravel and has been excavated to 10 feet below mean tide.

A partial analysis of the buff clay from McConnell and O'Brien clay bank at Verplank is given below:

Silica	50.92
Alumina	26.87*
Peroxide of iron	4.90
Lime	2.52
Magnesia	1.56

* Alumina is probably too high.—*H. Ries*

King and Lynch's yard is situated on George Point near Montrose. The bank is about 700 feet distant, and the clay is hauled in cars drawn by horses. At most of the yards the haulage is down grade. Fisher's clay bank at Crugers is overlain by two feet of loam. This is used to supply part of the tempering material and the rest is obtained from Jones' Point. At the yards on Verplank Point horse power is chiefly used to operate the machinery. Most of the yards at this locality obtain their clay from the pits of the Hudson River Brick Co. This clay bank is worked in benches. The haulage distance is about one half mile. It is done either in carts or else in cars run on tracks and drawn by horses.

Along the New York Central Railroad tracks a short distance south of Montrose station are the yards of C. Hyatt and J. Morton. Mr. Morton also has a covered yard on Verplank Point where front brick are made. Their banks are practically a continuation of each other. The clay is both blue and yellow and is overlain by several feet of coarse sand. Hyatt uses steam power and Morton horse power to run his machinery. The bricks are loaded on cars and shipped to various points along the Central Railroad.

Peekskill, Westchester Co. Bonner & Cole's brick yard lies between the river and the railroad about three quarters of a mile south of Peekskill. The clay lies below tide level. It is claimed that borings have shown a thickness of 50 feet. There is on the average a stripping of five feet of gravel and cobble stones.

South of this yard are two others, viz., Oldfield Brothers and the Bonner Brick Co. Their clay is similar to Bonner & Cole's, but rises to a greater height above tide level.

Haverstraw, Rockland Co., is one of the great brick manufacturing centers of New York state, there being forty-two brick yards, with a yearly capacity of 238,000,000 bricks. The yards are situated in a line along the river stretching from the lower end of Haverstraw Village northward around Grassy Point, to Stony Point. A few of them are situated along Minisceongo Creek. Most of the yards along the river are digging their clay below tide level. At the south end of the village a dam was built

at an expense of $30,000, reclaiming thereby 12 acres of clay land from the river. This last-mentioned bed of clay is underlain by till and modified drift, from which tempering sand is obtained. The clay within this enclosure has been excavated to a depth of 20 feet below mean tide. In the pits of the Excelsior Brick Co. they have reached a depth of 35 feet below river level; in Donnelly & Son's pit, 45 feet, and west of Washburn's yard, 40 feet. A pipe well was sunk from mean tide level 100 feet through blue clay, in the Excelsior Co.'s clay, and at this depth struck bed rock or a large bowlder.

The clay in these pits is rather sandy on top, but is said to improve with the depth. It is mostly blue. Streaks of quicksand are always liable to be encountered. In those pits situated along the river and to the rear of the yards, there is no expense of stripping unless the excavation is widened, but there are two important items of expense, viz.: pumps to keep the water out of the pits, and the maintenance of corduroy roads leadingd own into the pits. The clay is dug at any convenient point within the excavation and hauled in carts to the yard. About one quarter mile west of the river, where the terrace is 40 to 50 feet high, clay is being dug from the escarpment to supply the yards of J. D. Shankey, Buckley & Carroll, Phil. Goldrick, R. Malley, and J. Brennan. Some of the yards situated on Minisceongo Creek have to haul their clay 400 to 500 yards. Where the clay is obtained from the terrace escarpment there is in most cases a stripping of from six to 10 feet of sand and gravel. This is screened and used for tempering. The Excelsior Co. has tried to use clay dredged from the river, but gave it up after one season's trial for reasons unknown. Most of the brickmakers at Haverstraw temper their clay in soak pits and burn their bricks with wood. They all use open yards for drying except the Diamond Brick Co. which has recently put in a tunnel drier. The Excelsior Co. have a covered yard and Bennett, Rowan & Scott used pallet dryers. At most of the yards the barges can be brought to within a few feet of the kilns, and those yards not situated directly on the water, put the barrows loaded with brick on flat cars and run them down to the dock.

Stony Point, Rockland Co. This is practically a part of Haverstraw. There are four yards here. They obtain their clay from one large shallow excavation on the west side of the West Shore Railroad track and 500 feet north of Stony Point railroad station. The clay has to be carted from 100 to 300 yards, and when the excavation is widened there is a stripping of three to six feet of sand and cobblestones. Corduroy roads have also to be used. The four yards are situated along the water front. One of them, Riley & Clark, uses stationary kilns. Riley & Rose have a covered yard, the other three firms dry their bricks on open yards. The clay bank is owned by T. Tompkins & Son.

The following are some tests of Haverstraw brick made by M. Abbott at the time the East River bridge was being completed. No packing was put between the brick and plate of testing machine.

		Crushing strength per square inch. Pounds.
Whole brick tested on end	Maximum	3060
	Minimum	1600
	Average	2065
Half brick tested on flat side	Maximum	4153
	Minimum	2669
	Average	3371
Half brick tested on edge	Maximum	6400
	Minimum	2900
	Average	4612

Had the surfaces been ground parallel and cardboard or blotting paper been put between the face of the brick and plate of machine, higher results would have no doubt been obtained.

Thiells, Rockland Co. About two miles south from Haverstraw and half way between the stations of Ivy Leaf and Thiells, on the New York and New Jersey Railroad, is the brick yard of Felter & Mather. The clay deposit is basin-shaped, about 15 feet thick, as determined by boring, and has a slightly elliptical outline The clay is chiefly of a blue color, the upper portion being weathered to yellow. It is overlain by a few feet of drift containing small bowlders and underlain by similar material. The tempering sand is obtained from a bank on the opposite side

of the railroad track about 1000 feet from the yard. Tempering is done in ring pits; the bricks are molded in soft mud machines and dried on an open yard. Burning is done in scove kilns. The product is shipped to various towns along the line of the railroad in New Jersey.

Cold Spring, Putnam Co. A brick yard was in operation north of this town for a number of years, but has been shut down on account of the clay giving out.

Storm King, Dutchess Co. About 1000 feet north of the station is a clay deposit, chiefly yellow clay. It is worked by Mosher Bros. The bank has slid considerably; it has a vertical height of 50 to 60 feet.

Cornwall on Hudson, Orange Co. C. A. & A. P. Hedges are the only brick manufacturers here. Their yard is situated on the West Shore Railroad about a mile north of Cornwall station. They have 27 acres of clay land. Blue and yellow clay are found in the bank, the main portion of which is covered by delta deposits of Moodna River. The clay layers are much compressed in places, making it difficult to excavate and necessitating the use of picks. The bank is worked in benches and the clay has to be hauled about 300 feet to the machines. The stripped sand can be used for tempering. Many bricks are shipped to points on the New York, Ontario and Western Railroad.

New Windsor, Orange Co. There are six yards here. They obtain their clay from the escarpment of a terrace 110 feet high. Their clay is both blue and yellow. Streaks of quicksand occur in the blue. The yellow is dry and tough, and has to be worked by undermining. In thickness the clay varies from 20 to 60 feet; the layers are in many places contorted, and in some cases the stratification has been obliterated. Overlying the clay is gravel and sand; the latter is used for tempering. Most of the New Windsor clay permits the addition of very little water in tempering. Ring pits and Adam machines are used at these yards. The yards are all situated along the river and ship their product on barges or by the West Shore Railroad.

Dutchess Junction, Dutchess Co. There are several brick manufacturing firms having yards along the river south of Dutchess Junction (*see* table No. 1). They obtain their clay from the escarp-

ment of an 80-foot terrace which extends from a short distance north of Storm King to Dutchess Junction. The clay has a fairly uniform thickness; the upper four to eight feet are yellow, the rest blue. The greatest thickness of clay known for this locality is at Aldridge Bros.' yard, where a well was sunk 65 feet through the clay, which added to the height of the bank (65 feet), gives us a total thickness of 130 feet at this point. The clay is usually covered by gravel, and by sand in some cases sufficiently fine to be used for tempering or even molding. It is worked in benches, and the haulage distance is 200 to 300 feet. At Timoney's clay bank there is some extra labor in stripping the scrub oaks and other bushes which cover the surface of the terrace.

Fishkill, Dutchess Co. Harris & Ginley's yard is situated about one quarter mile below the town The clay bank is leased from the New England Railroad Company. It was formerly quite thick, but clay having been dug for 50 years but a small portion of the bank remains. The clay has a maximum thickness of 45 feet. Streaks of quicksand occur throughout the clay; it is underlain by hardpan and shale.

The other yards at this locality are situated along the river from a point about one half mile above Fishkill up to Low Point station. One of the yards is just north of Low Point. The most southern one is that of Aldridge & Sherman, with 600 feet water front. The clay land of these two firms belongs to the W. E. Verplank estate. Next on the north are the works of the Brockway Brick Co., with 1200 feet of water front. This firm owns its clay bank. The bricks are dried on pallets. The next two yards belonging to Lahey Bros., (650 feet water front) and Dinan & Butler (475 feet water front), respectively, lease their clay bank from the W. E. Verplank estate. Dinan & Butler have a pallet yard. The five above-named firms obtain their clay just east of the yards from the escarpment of a 90-foot terrace; it is both blue and yellow and overlain by four to six feet of loam, sand and gravel. A short distance north of Dinan & Butler's yard is that of J. V. Meade. About 20 feet of clay are exposed in the bank, which adjoins the yard. The clay is overlain by four to six feet of sand and cobblestones. The sand is screened and used for tempering.

C. G. Griggs & Co.'s brick yard is located along the river about one half mile north of Low Point station. An opening has been made for clay about 800 feet east of the yard; the clay as exposed at present is 20 feet thick and overlain by two feet of loam. One hundred feet farther east, and at a slightly higher level, sand for tempering has been dug to a depth of eight feet without finding clay. The clay is hauled in carts to the yard.

Roseton, Orange Co. There is a remnant of a terrace at this locality 120 feet high. From this J. J. Jova and Rose & Co. obtain their clay. The former has 80 acres, the latter 40. The clay is mostly blue and rises to a height of 100 feet above the river. At Jova's upper yard it is underlain by limestone and overlain by sand. On top of the clay at his lower yard are 10 to 15 feet of sand and gravel.

A well was sunk from river level at Jova's and passed through the following:

Blue clay	80 feet.
Quicksand	25 "
Loose sand and gravel	75 "
	180 feet.

Adding to the above section 100 feet of clay above river level gives us a total thickness of 180 feet of clay. At Rose & Co.'s yard, which adjoins Jova's on the south, a well was sunk 135 feet through blue clay, it is claimed. Adding to this 108 feet of clay above mean tide gives us a bed of clay 243 feet thick. The terrace which the clay underlies at Roseton extends back from the river several hundred feet into a reëntrant angle of the hill. The clay contains little sand and is worked in benches. Carts are used to haul the clay. South of Roseton station is a bank of sand of alternating yellow and grayish black layers, which has been used for tempering, but is said not to give as good results as that on Jover's premises.

Port Ewen, Ulster Co. S. D. Coykendall's yard lies near the junction of Rondout Creek and Hudson River. The bank is

just west of the yard. There is a considerable stripping of fine sand and the clay slides quite easily. It is dug at any convenient point of the bank. The overlying sand can be used for tempering and molding. Oil is used for burning the bricks. A short distance farther south along the river is J. Kline's yard. He obtains his clay from various points in the terrace escarpment and in some cases hauls it nearly a quarter mile. Mr Kline has made borings at various points along the river and the terrace and in the escarpment in the vicinity of his yard and claims that at none of them has he found over 18 feet of clay. Beneath it was hardpan. This would seem to indicate that the central mass of the embankment is rock, overlain by hardpan, and that on this the clay is laid down. In many places the clay is covered by 10 to 20 feet of fine stratified sand.

The following is an analysis of the blue clay near Rondout which is used for the manufacture of cement:

Silica	57.8
Peroxide of iron and alumina	22.6
Lime	4.85
Magnesia	2.07
Water and alkalies	12.68
	100.00

East Kingston, Ulster Co. There are eight brick manufacturing firms at this locality, viz.: Streeter & Hendrix, D. S. Manchester, Brigham Bros., C. A. Schultz, A. S. Staples, R. Maine & Co., Terry Bros. and W. Hutton. They all obtain their clay from the terrace escarpment which extends from Glasco to Rondout. (For thickness of clay see table.) At Street & Hendrix's yard the clay lies some 300 yards from the river. They obtain their tempering sand from Wilbur. Manchester's bank is similar. At Brigham Bros.' yard the clay is yellow, being weathered clear through to its base. It has a thickness of 10 feet and rests on an uneven ridge of shale. On account of its toughness it is worked by undermining, as is the case with other yards along here where clay is being dug. C. A. Schultz has an exposure of clay 80 feet thick, overlaid in spots by sand that can be used for tempering. Next on the south is A. S. Staples' yard. The bank has been

excavated to a lower level than the preceding one. The clay is underlain by hardpan. R. Maine & Co. have five acres of clay land. The terrace here is quite narrow. At Terry Bros'. yard the clay, which is mostly blue, has been excavated sufficiently to expose the limestone against which the terrace lies. At Hutton's yard the blue clay is exposed from eight feet above mean tide, to 110 feet above it; overlying this is 10 feet of yellow clay and then 15 feet of sand. It will be seen from the limits quoted above and in the table, that the thickness of the clay between Glasco and Rondout varies considerably, amounting to 120 feet in places, while in others it is not over 15 or 20 feet. This is due to the great irregularity of the underlying rock surface.

Smith's Dock, Ulster Co. The only yard here is that of Theo. Brousseau. He has about 90 acres of clay land. The clay, which is mined with plow and scrapers, is obtained from the terrace east of the yard. It is mostly blue and covered by a few feet of loam. The yard lies some 700 feet from the river and the bricks are carted down to the dock. Brousseau's property extends west to the West Shore Railroad and the farms north and south of him are underlain by clay.

Malden, Ulster Co. The clay at Cooney & Farrell's yard to the north of the village is mostly yellow, and lies 10 to 20 feet thick on the upturned edges of the Hudson River shales. This yard was started in 1891.

Glasco, Ulster Co. Washburn Bros. This firm is one of the largest producers along the river having a yearly capacity of 50,000,000. They have about 150 acres of land, a large part of it being situated along the river. Their clay is mostly blue and rises in a bank to the height of 130 feet. It has been excavated to eight feet above mean tide. The upper 10 feet is yellow sand; a thin strip of yellow clay separates it from the red. The lower third of the bank is somewhat sandy, and the best results are obtained by a mixture of the upper and lower portions of the clay. Both pallets and open yards are used for drying; the former at the yard situated on the terrace. A short distance below Washburn Bros. is F. M. Van Dusen's yard. The clay is blue 70 feet thick and is underlain by shale whose surface is glaciated. Several feet of loam overlie the clay. Tempering sand is brought from Wilbur on Rondout creek. J. Porter's yard

adjoins Van Dusen on the south. The clay lies on a ridge of shale which rises steeply from the shore to a height of 60 feet. The brick yard is at the foot of the cliff and was started in 1891. Plows and scrapers are used to mine the clay which is of a yellow color, and overlaid by three feet of loam. Carts are used for hauling the clay. About a mile below this are the yards of C. H. Littlefield, A. Rose & Co. and D. C. Overbaugh. The three are close together. A ridge of shale rises steeply from the river and behind this the clay lies. The terrace here is 150 feet high, and borings which have been made show a depth of as much as 60 feet (see table). The clay is quite dry, and mostly yellow. It is worked by picks and undermining. Carts haul it to the edge of the cliff, where it is sent down shutes to the tempering pits. The drying is done on pallets at Rose's yard.

Arlington, Dutchess Co. Flagler & Allen. The clay deposit which is yellow is situated a half mile east of Poughkeepsie and has an extent of about 40 acres of clay, it averages from six to eight feet in depth. This is easily worked, there being only a stripping of six inches of sod. Underneath the yellow is considerable blue clay, of which the yellow is of course the weathered portion. The clay is tempered in soak pits and about 20,000 brick are made daily. The machinery is run by horse power. Repressed brick are also made. The clay burns a cherry red.

H. R. Rose's brickyard is also situated at this town and about three miles east of the Hudson river. The clay deposit, which has an extent of 60 acres, is yellow in color and eight feet thick. A blue clay is said to underlie the yellow. The bricks are molded in soft mud machines operated by horse power.

Barrytown, Dutchess Co. There are deposits of clay along the river at this locality but they are not being worked. The following is an analysis of them:

Silica	59.81
Peroxide of iron and alumina	22.00
Lime	4.35
Magnesia	2.29
Moisture	.37
Combined water and organic matter	7.89
Alkalies, not determined	.....
	96.71

Catskill, Greene Co. Alexander McLean's yard is situated on Water St. east of the wagon bridge. He has 12 acres of clay land. The clay is mostly blue with yellow and red on top, and is about 90 feet thick.

A partial analysis of the blue clay is as follows:

Silica	50.60
Alumina	21.00
Peroxide of iron	7.35
Lime	3.75
Magnesia	.96

The upper portion of the clay bank is a tough material and has to be worked with a pick. A gray black sand of the same structure and appearance as that at Coeymans underlies the clay. At this locality it contains too much lime, however, to use it for tempering. Mr. McLean has to bring his tempering sand from Jones' Point at the cost of 40 cents a cubic yard. The manufacture of drain tile, hollow brick and sewer pipe has been attempted with this clay, but was given up it is said for financial reasons. Ferier & Golden's yard is situated on the opposite side of the street from McLean's, and their clay bank is practically a continuation of his. Their tempering sand is carted from near the West Shore Railroad station, a distance of about three quarters of a mile. The bricks are burnt with wood, though petroleum was used for a while successfully, it is claimed. The bricks are run down to the dock on cars. Lying along the creek north of the bridge is the Derbyshire Brick Co.'s yard. Most of the drying is done under sheds. The clay is both blue and yellow and is dug in a rather steep face causing it to slide often. The blue has been excavated to 38 feet from tide level, and its upper limit is 82 feet above tide; over this is 12 feet of yellow clay and three feet of loam. The tempering sand is obtained about half a mile from the works As at the preceding yard the bricks are loaded on cars at the kiln and run down to the dock.

Hudson, Columbia Co. There are three yards at this town. J. Fitzgerald's Sons' yard is situated in a reëntrant curve of the shore, and about 300 yards east of it is the yard of Arkison Bros. The former is no longer in operation. Both these firms obtain their clay from different faces of the same hill. The clay, which

is fairly dry, is mined with plows and scrapers. It is blue and yellow, from 70 to 80 feet thick, overlaid by two feet of loam, and underlain by grayish black sand.

W. E. Bartlett's brick yard is also situated along the shore, about one quarter mile north of Hudson. The clay is similar to that farther down at Fitzgerald's. Scrubby pines cover the surface at this locality. The bank is worked in benches. Ring pits are used for tempering.

Stuyvesant, Columbia Co. Walsh Bros. have two yards situated along the river midway between Stuyvesant and Coxsackie. All the clay thus far mined is yellow in color, very tough and unstratified. It is worked by picks and carted down to the yards. The bank which is 30 feet in height is located on the hillside some 500 feet east of the yard. It is probably underlain by the sand and gravel which crops out in the terrace escarpment behind the yard, and which is used for tempering.

Coxsackie, Greene Co. There is only one yard here, that of F. W. Noble. It is situated at an elevation of 100 feet above the river, and about a quarter mile north of the village. The clay bank adjoins the yard and is 35 feet high. Both blue and yellow clay are used. Shale underlies it. The clay is quite dry and is broken up by undermining. Soak pits are used for tempering. There is an exposure of blue clay in the terrace escarpment south of Coxsackie.

Athens, Greene Co. Of the three yards at this locality, situated about half a mile north of the village and adjoining each other, only two are running. The most southern one is that of William Ryder, situated 80 feet above tide level and about 500 feet from the river. Mr. Ryder owns 12 acres of clay land. The clay which has not been excavated below the level of the yard runs up to 125 feet above mean tide, and is both blue and yellow with about six feet of loam covering. A well was sunk 18 feet below the level of the yard, without reaching bottom. The clay is mined by plows and scrapers. The upper six feet of loam are mixed with the clay. The bricks when taken from the kilns are sent on cars down to the shore, where they are loaded on barges for shipment to New York City. Adjoining this yard on the north is that of Mr. Porter, not being worked. A few hundred feet north of this, on the south side of Murder Creek, is the yard

of I. R. Porter. Although the yard is situated near the shore the water is not deep enough for the brick barges, and the bricks have to be carted some 200 yards to the dock. The clay bank adjoins the yard and is mined by plows and scrapers. Horse-power machines are used.

Coeymans Landing, Albany Co. There are two brick yards at this town; they lie north of the town along the river shore and adjoin each other. The one nearest town belongs to Sutton & Suderly, and is worked by them and four other parties. Their clay is obtained from the bank west of the yard. It is both blue and yellow, chiefly the former, with streaks of fine sand.

The following partial analysis has been made of Sutton & Suderly's clay:

Silica	51.10
Alumina	17.65
Peroxide of iron	6.47
Lime	7.45
Magnesia	.87

Being of a soft nature the clay is dug with shovels at any convenient point at the base of the bank, which is 120 feet in height. A charge of dynamite is usually exploded in the bank in the spring, thus bringing down a large mass of clay to a level with the yard. The clay does not have to be hauled more than 150 feet to the machines. A drive-pipe well sunk near the owners' barn on top of the terrace (140 feet above mean tide) some 300 feet back from the river, showed 70 feet of clay and 60 feet of sand. The sand underlying the clay is of a grayish black color, consisting chiefly of grains of quartz and shale, the latter predominating.* Grains of garnet and feldspar, and large pebbles of quartz are scattered through it. The sand after being screened is used for tempering. The upper limit of the underlying sand varies, at the north end of the property rising to within a few feet of the terrace level, while some 300 feet south of this the clay has been excavated to 15 feet above mean tide without striking sand.

Adjoining Sutton & Suderly on the north is the brick works of Corwin & Cullough, sublet by them to T. Finnegan and Delaney

* This underlying material is much faulted owing to the pressure of the clay above it.

& Lavender. The clay, which is obtained just west of the yard has been excavated to seven feet above mean tide and bottom not yet reached. It contains several veins of fine sand. Both yellow and blue clay are present. At the south end of the yard the escarpment of the terrace is drift containing small bowlders. The tempering sand is obtained from this bank.

There are outcrops of clay on the land of Mr. Bronk, to the north of Corwin & Cullough's yard; also on the Lawson property to east of the white iron bridge crossing Coeymans Creek. This latter locality lies some 800 feet from the river, and would be somewhat more expensive to work. Again, on Main st., just south of the residence of Miss Wolf, there is an exposure of clay on the hillside some 400 feet from the river.

Albany, Albany Co. There are several yards situated on the outskirts of the city. The clay banks, which are all of the same nature, belong to the Hudson River estuary formation, being stratified and blue or gray in color with the upper portions weathered yellow or red. M. H. Bender's yard is on Delaware avenue near Dove St. He manufactures common pressed brick and drain tile. The upper loamy clay can only be used for common brick; the lower blue and some of the yellow are used for the other products. Auger machines are used for better grade brick and the tile, and the latter are made in several sizes. Scove kilns are used for burning the brick and down-draft kilns for the tile. These latter kilns hold 60,000 small size tiles or 35,000 assorted size. It takes three wheelers and two setters two and a half days to fill the kiln and burning occupies four days. The tiles after molding are first dried on shelves under a closed shed.

Adjoining Bender's yard are those of J. Babcock, E. Smith, J. C. Moore and D. H. Stanwix. They make common brick chiefly, and their clay banks are the same as Bender's. They are all open yards.

T. McCarthy's yard is situated on First Avenue. The clay bank is about 15 feet thick and covers an area of about 10 acres. It is chiefly blue. The stripping is a light soil and sand underlies the clay. The bricks are manufactured by the soft mud process.

Alfred Hunter's yard is situated on Van Woert street near Pearl. The clay is blue with yellow on top. About 40 feet of clay is at present exposed. There are only a few inches of soil to be stripped. The bottom has not yet been reached. Ring pits and soft mud machines are used and the bricks are dried in the sun. Burning is done in scove kilns. Albany and vicinity consume most of the product.

The brick yard of M. Roberts is on Swan street between Ten-Broeck and Colonie. The clay is blue in color and about 25 feet thick. It is overlain by a loose soil; the bottom has not yet been reached. Soft mud machines operated by steam power are used; the bricks are dried on open yards and burned in scove kilns. Albany consumes the product.

Greenbush, Rensselaer Co. Mrs. T. Rigney's yard is at East Greenbush on the east side of the Boston and Albany railroad. The clay, which is blue and yellow, has a thickness of about 90 feet. Loam overlies the clay; the bottom has not yet been reached. The machinery is run by horse power. Greenbush and New York city are the chief markets for the product.

Troy, Rensselaer Co. Alex. Ferguson's brick yard is situated on Hoosick above First street. The clay bank is about 40 feet high and runs in an east and west direction; it is deeply incised at either end by two streams. The clay, as is common to these Hudson estuary deposits, is stratified, yellow in the upper portion and blue clay in the lower. The blue contains some quicksand. A stronger and better colored brick is made from the tough upper clay, but it shrinks considerably in burning. On the other hand the blue clay makes a smoother but not as strong brick, but one of more even shape. Underlying the clay is slate rock which has been used for building purposes.

J. B. Roberts' bank is about 20 feet in thickness. The clay, which is mostly yellow, is covered with a foot of loam and underlain by gravel. Capacity, two million.

Cohoes, Albany Co. J. E. Murray. Yard situated between Crescent and Cohoes, on west side of Erie canal. The clay is chiefly blue, the upper few feet being yellow. It rises in a bank to 50 feet height. It is underlain by rock and there is a slight covering of loam. The bricks are molded by steam power

machines, and dried in the sun. The product is sold in Cohoes and vicinity. J. E. Murray also operates the brick yard formerly belonging to N. Gardonas.

J. Baeby. The clay bank is about 40 feet high, 400 feet long and about 250 feet from the yard. Mr. Baeby has about 40 acres of clay land. The clay is yellow on top and blue beneath. It is covered by about four inches soil and underlain by gravel. One yard is operated by horse, the other by steam power.

Lansingburgh, Rensselaer Co. T. F. Morissey has a horse-power yard situated along the Old Turnpike near the railroad. The clay bank is 75 feet high, there being about six acres of clay land. The upper third of the bank is red, the lower two thirds blue. About 30 feet of sand underlie the clay.

Crescent, Saratoga Co. Newton Bros. have a bank of clay 30 feet thick, the upper six feet being gray, the rest blue. There is a stripping of two to four feet of sand, which can be used for tempering. The blue and yellow clay, together with a certain portion of sand, are tempered in the pug mill. The bricks are molded on a Martin soft mud machine and dried on pallets for about five days. Burning is done in scove kilns and the product is loaded onto the Erie canal boats at the yard.

Mechanicsville Brick Co., Saratoga Co. The brick yard is situated on the Champlain Canal in the town of Half Moon, about a mile south of Mechanicsville. The clay bank is 50 feet high. The upper 10 feet are yellow and under this is blue clay; the latter is underlain by sand. The bank adjoins the yard and is worked in benches; the clay is hauled in carts to the ring pits. Soft mud machines are used, the brick are dried on pallets and burned in clamps.

Saratoga, C. L. Williams. The yard is situated about one mile from the town, 600 feet from the Delaware and Hudson Railroad. Mr Williams has about 50 acres of clay land, the clay running six feet thick. It is blue, with the upper portion of it weathered to yellow. There is a stripping of about one foot of loam. The clay is put through a crusher first; it is then pugged and molded. The bricks are dried on pallets, the racks having a capacity of 260,000. Wood is used for burning, being obtained from a lot of 200 acres near the yard. The product is chiefly used locally.

The other brick yard at Saratoga is owned by Mr. D. Davidson. It is situated at the outskirts of the town, just west of Judge Hilton's yard. The clay bank, which is about 28 feet thick, is about 150 feet from the yard; it is stratified, the layers being from one to eight inches thick and separated by thin laminæ of sand. The clay is of a light brown color, being underlain by calciferous limestone and overlain by a foot of soil. Mr. Davidson has 22 acres of clay land. Tempering is done in ring pits and the clay is molded in a soft mud machine. Drying is done in an open yard, and burning in scove kilns. The fuel used is hard wood.

Hoosick Falls, Rensselaer Co. John Dolin's clay bank is about 40 feet high and has an extent of six acres. It is used for making building brick. The product is consumed in the vicinity.

Middle Granville, Washington Co. J. H. Pepper is the only manufacturer at this locality. His clay bank is 45 feet high, and 2000 feet long. The clay is blue, and scattered through it are some streaks of sand. A bed of gray sand 20 feet in thickness underlies the clay and is in turn underlain by slate.

Plattsburg, Clinton Co. There are several yards here. That of J. Ouimet lies at the north end of the town. It is an open yard and the bricks are made by hand power. The clay which is hard and tough is of a yellowish brown and red color and is mined with plows.

Charles Vaughn's yard is similar to the preceding, and is at the south end of the town. The clay is 20 feet thick.

Gilliland and Day's yard is situated on Indian Bay, six miles south of Plattsburg. The bricks are also molded by hand power.

All these yards sell most of their brick at Plattsburg.

The following is an analysis of the clay at J. Ouimet's brick yard:

Silica	65.14
Alumina	13.38
Peroxide of iron	7.65
Lime	2.18
Magnesia	2.36
Alkalies	8.51
	99.22

Gouverneur, St Lawrence Co. The brick yard of G. R. Thompson is situated east of village and on the eastern bank of the Osgewatchie river. The clay bank rises to a height of 10 feet above the river and the section exposed is:

Sand	4 feet
Gray clay	8 "
Blue "	6 "
	18 "

A Martin soft mud brick machine is used and the bricks are dried under sheds. The product finds a ready sale on the local market.

A pallet yard has recently been started at this locality.

Carthage, Jefferson Co. Wrape & Peck. The brick yard and clay pit are situated in the Black River Valley near the town of Carthage. The clay deposit which is several hundred acres in extent and about five feet thick is of a gray color with streaks of brown. The bricks are molded in wet mud machines and put in steam dryers. Local market consumes most of the product.

Potsdam. D. W. Finnimore's brick yard is situated a few rods outside of the village limits. The clay is of a blue color and six to eight feet deep. It is overlain by one to two feet of dark sandy soil and underlain by gravel. The yard is equipped with a Quaker soft mud machine, and a Kells & Son's dry press machine. The product is used locally.

Watertown, Jefferson Co. At the north end of the town on Main street are the works of the Watertown Pressed Brick Co. They have about 20 acres of clay, red in color, horizontally stratified and averaging about 20 feet in thickness. It is underlain by Trenton limestone. The tempering sand has to be carted nearly three miles. Analysis of the clay shows:

Silica	64.39
Alumina	4.40
Peroxide of iron	5.00
Lime	3.60
Magnesia	1.31
Alkalies	4.66
Water and organic matter	6.64
	100.00

The clay is rather tough. It is loaded on cars which are drawn by cable some 75 feet, up into the machine shed where it is dumped into a disintegrator. It next goes to the pug mill for tempering, and is molded in a Martin machine. Drying is done on pallets and burning in scove kilns, the latter occupying about seven days. The consumption is chiefly local.

Ogdensburg, St Lawrence Co. Paige Bros.' yard is on Cedar cor. Canton st. at southwest end of town. The clay is of a deep blue color, the upper 10 feet being somewhat sandy. It has been bored to a depth of 60 feet in places, but this depth is not constant, and in spots the underlying limestone rises to within a few feet of the surface. The sand for tempering has to be brought two miles. The following is an analysis of the clay:

Silica	49.20
Alumina	17.47
Peroxide of iron	6.23
Lime	7.86
Magnesia	4.87
Alkalies	9.82
	95.45

Only common brick are made. Soft mud machines are used. Drying is done in the sun and burning in scove kilns. The bricks have been largely used in the consumption of the asylum buildings at Ogdensburg.

Madrid, St Lawrence co. Three miles north of the depot is the brick yard of Robert Watson. The clay is of a blue color and about 20 feet thick. The section is

Yellow sand	3 feet
Blue clay	20 "

The bottom has not yet been struck. Horse power is used for operating the machinery. The clay has to be tempered with sand. Drying is done on pallets or in the sun. Burning takes about one week. The consumption is local.

Raymondville, St Lawrence Co. Coats Bros.' works are at Raymondville, about seven miles north of Norwood. The clay

bank lies on the east side of the Racket River. It is about 25 feet in thickness and there is a covering of 12 feet of fine sand. The clay is rather tough and requires an admixture about one-third sand for making brick. An abundance of unworked clay is still in sight.

St Johnsville, Montgomery Co. J. S. Smith is the only brick manufacturer in this town. The clay bank is 60 feet high, and the following is the section involved:

Loam	1 foot
Fine sand	7 feet
Dark building sand	3 "
Gray clay	1 foot
Quicksand	4 feet
Hardpan	1 foot
Blue clay	75 feet
Total thickness	92 feet

Only common brick are manufactured.

Fonda, Montgomery Co. W. Davenport's brick yard is about one mile west of the village on the north side of the N. Y. C. R. R. The clay bank lies to the north of the yard, is 12 feet high, and yellow in color. The brick are molded in soft mud machines operated by horse power, dried on open yards and burnt in scove kilns. The product is sold in Montgomery county. Drain tile are also manufactured.

Dolgeville, Herkimer Co. A. C. Kyser has a bed of clay about 50 acres in extent, and 30 feet thick. He manufactures ordinary building brick, which are consumed by the local market.

The clay is tempered in a pug mill with the addition of a certain amount of sand, and passes thence to a Quaker soft mud machine. Drying is done on an open yard, and the bricks are burned in a scove kiln. This latter operation takes five to eight days.

South Trenton, Oneida Co. H. L. Garrett has manufactured brick at this locality for 45 years. His clay bed is several acres in extent and about four feet thick. The clay is blue below and yellow and red in the upper portion of the bed, due to weathering. It is slightly stratified. Underlying the clay is slate.

Amsterdam, Montgomery Co. H. C. Grimes' brick yard is located on Florida Ave. The clay deposit underlies a tract of about 20 acres, and the section is as follows:

Soil	1–3 feet
Yellow clay	6 "
Blue clay	...

Common bricks are manufactured.

The clay is first passed through a Cotts disintegrator and is then molded on a soft mud machine. Drying is done on pallets. This yard has been in operation for 16 years.

Gloversville, Fulton Co. H. McDuffie's brick yard is situated on the outskirts of the town. The clay, which is of a dark brown color, is in a bed two and a half feet thick. It is underlain by hardpan and overlain by a thin soil. The bricks are made by the soft mud process, being molded in horse-power machines.

W. A. Stoutner. His clay bank is about three feet thick, underlain by hardpan and overlain by a few inches of soil. The clay is reddish brown and burns to a red color. The brick are made on a Peekskill hand-power machine. The brickmaking season at Gloversville runs from about the middle of May to the end of September.

Ilion, Herkimer Co. S. E. Coe. Brick yard situated along the Erie Canal, with the West Shore Railroad crossing the property. Mr. Coe has about 10 acres of clay land, the clay running in depth from eight to 15 feet. It is of three different colors, black, gray and blue. The latter makes the stronger brick. No stripping to be done except a few feet of black soil.

Rome, N. Y., Oneida Co. W. Armstrong's yard is located on the edge of the town and along the Rome and Clinton branch of the New York, Ontario and Western Railroad. The clay deposit is about 25 acres in extent and the clay is of a dark gray color and seven to 10 feet deep. The bricks are molded in soft mud machines.

W. W. Parry. Yard located near the town; the clay is obtained from the flats bordering the Mohawk river, and the bed of it is from six to nine feet deep. It is underlain by gravel, which rises to near the surface in many places. A light loam covers the clay. For making brick the clay is mixed from top to bottom.

Both soft and stiff mud machines are used and burning is done in scove kilns.

Deerfield, Oneida Co. G. F. Weaver's Sons' yard is located on the Mohawk river about one quarter mile from the New York Central Railroad depot. Their clay deposit is about 40 acres in extent, and has been worked to a depth of 10 feet.

South Bay. C. Stephens has a brick and tile works at this town. The clay deposit is from 20 to 25 feet deep and underlies a tract of 800 acres bordering on Oneida Lake. Underlying the clay is a fine and closely cemented blue gravel. The Elmira, Cortland and Northern Railroad passes through the property. Chiefly drain tile are manufactured. These works were established in the spring of 1891.

Canastota, Madison Co. M. Ballou has a brick yard at this locality.

Syracuse, Onondaga Co. At the northeast end of the town is an extensive deposit of clay, underlying the low lands at the end of Onondaga Lake. It is worked by several brick manufacturers. The yards are mostly on Seventh North St. The first is that of T. Nolan, a horse-power yard; adjoining him is the yard of Preston Bros., also a horse-power yard. Next comes F. H. Kennedy, at whose yard the bricks are molded by hand. C. H. Merrick have a steam-power yard on S. Salina, and farther out on the Cicero plankroad are the brick works of J. Brophy.

The clay is stratified, red above and blue below. In the center of the flat land it runs seven to 10 feet deep, while at the edges it thins out to two feet. It is underlain by sand and gravel.

New York Paving Brick Co. This company has its works at Geddes near Syracuse and obtains its clay from a point called Three Rivers on the Syracuse and Oswego Railroad. The clay deposit is said to be 35 feet thick, and horizontally stratified. It is blue with the upper portions weathered to red. The brick factory is situated along the Erie Canal and the clay is brought by boat and stored in heaps, which in winter are covered to prevent freezing. Two Penfield soft mud machines with pug mills attached are used for molding. Drying is done in tunnels heated by coal fires. The green brick are nine inches long, but when burnt shrink to seven and one half inches. Both rectangular and cylindrical down-draft kilns are used. In addi-

tion to paving, a square tile, for linings, seven by seven inches and two inches thick is being manufactured. These, it is claimed, were placed for seven weeks in the acid vats at the Solvay works and were unaffected. The following tests were made on these bricks at the Watertown, Mass., arsenal:

	Cracked at	Crushed at
	Pounds.	*Pounds per sq. in.*
No. 1	91,000	29,060
No. 2	93,400	28,530
No. 3	119,000	20,060
No. 4	167,000	23,500

The bricks are said to absorb on 1.49 per cent. moisture, which is very little.

Warners, Onondaga Co. The Onondaga Vitrified Pressed Brick Co This yard uses both shale and clay. The works are situated about half a mile east of Warners along the West Shore track.

Analyses of the shale have been made and are given below:

COMPOSITION.	Calcareous layer in shale bank	A green brick. Being a mixture of the different shales.	Red Shale.	Blue Shale.	Clay.
Silica	25.40	54.25	52.30	57.79	45.35
Alumina	9.46	16.89	18.85	16.15	12.19
Peroxide of iron	2.24	5.81	6.55	5.20	4.41
Lime	22.81	4.34	3.36	2.73	10.99
Magnesia	10.39	5.21	4.49	4.67	6.38
Carbonic acid	20.96	4.30	3.04	3.42	7.24
Potash	.95	2.95	4.65	4.11	3.26
Soda	.....	.83	1.35	1.22	1.14
Water and organ matter	7.60	5.01	5.30	4.50	8.90
Oxide of manganese	.....	.....	Trace.	Trace	.....
Total	99.81	99.59	99.88	99.79	99.86

Analyst, Dr H. Froehling, Richmond, Va.
The samples were all dried at 212° F.

It may be of interest in this connection to give the composition of some other clays found at Warners, and which are used in the manufacture of cement. The following are only partial analyse

Silica	45.12	43.19	46.00	41.78	41.70	44.00
Oxide of iron and alumina	13.79	14.62	25.02	16.09	18.24	17.33
Lime	12.91	12.36	7.13	12.40	12.71	11.74
Magnesia.....	7.21	7.05	3.67	5.83	6.02	6.83

These last analyses would indicate a rather fusible clay. The clay used by the Onondaga Co. is dug in the field adjoining the works. It is a pinkish color, stratified and runs about 15 feet in depth. The shale used belongs to the Salina formation and is obtained from the hillside about 1000 feet from the yard. It is of various shades of red, green and some gray, and disintegrates very rapidly. The whole mass is traversed by numerous seams so that a small blast brings down a large portion of the bank in small fragments. Tracks are laid from the brick yard up to the working face, the base of which is 35 feet higher than the yard. The loaded cars are run down to the dry pans by gravity and hauled back when emptied by a horse. Carts are used to haul the clay. Dry pans grind the shale and about one quarter clay and three quarters shale are mixed in a wet pan. A man shovels the mixture onto an endless belt which carries it to the molding machine. The yard is fitted with both a plunger and auger stiff mud machine, the former being side cut, the latter end cut. The green bricks are placed on cars and run into the drying tunnels. These are of brick, heated by coal fires, the heat passing through flues under the tunnel. Round kilns are used for the burning which takes about five days. The kilns have a capacity of about 60,000. Soft coal is used for burning.

The company manufactures paving brick, hollow brick and terra cotta lumber for fire proofing.

Baldwinsville, Onondaga Co. Seneca River Brick Co. The works are four miles west of Baldwinsville on the south bank of the Seneca River. Their clay bed is six acres in extent. It is

blue clay weathered to red in the upper portion and the blue is stratified. Gravel underlies the clay. The red clay is chiefly used as it burns a better colored brick than the blue. The dry press process is used and the bricks are burnt in kilns of the Flood type. These are both up and down draft. They are 18 by 54 feet and have 20 inch walls, which are lined with fire brick from the doors up. There are four fireplaces on each of the long sides and between these is a series of smaller ones connected with a set of flues opening into the lower part of the kiln to give an up draft. Wood fires are started in these smaller fireplaces for water smoking. The larger openings connecting with individual pockets on the inner wall of the kiln lead the fire into the upper portions first whence it passes downward through the kiln and off through a large flue at the bottom. Water smoking takes 10 days and burning eight days. The whole time for burning, water smoking and cooling taking about three weeks. The molded bricks are set directly in the kiln on coming from the machine.

Oswego Falls. W. D. Edgarton. The brick yard is situated on the Syracuse and Oswego railroad, 11 miles from Oswego. The clay varies from three to five feet in thickness and is yellow. It is underlain by gravel. A few inches soil has to be stripped. The lower portions of the clay make the better brick. Soft mud machines are used and both common and repressed brick are made.

Weedsport, Cayuga Co. There is a brick yard at this locality belonging to Mrs. C. S. Gilette, but it is not in operation.

Auburn, Cayuga Co. John Harvey's brick yard is situated on the outskirts of the town.

Owasco, Cayuga Co. A. Lester has a brick and tile yard near the village. It is described under the head of drain tile.

Seneca Falls, Seneca Co. There is only one brick yard at this locality, that of F. Siegfried. His clay bed is about 12 feet thick, the upper seven feet being used for brick and the lower five feet for tile. Gravel underlies the clay and there is a covering of a few inches of soil. The machinery is run by horse power and the product is sold locally.

Geneva, Cayuga Co. Five firms manufacture brick in this locality. They are W. G. Dove, C. Bennett, Goodwin & Delamater, Mrs. Baldwin, The Torrey Park Land Co. The last-mentioned company began operations in the spring of 1892; their brick yard is some distance from the town.

Lyons, Wayne Co. The clay bed of F. Borck is about eight feet deep. The upper portion of the deposit is yellow, the rest is blue. Quicksand underlies the latter. Soft mud machines are used to mold the brick.

Canandaigua, Ontario Co. Burke & Mead's * works are about three quarters of a mile southwest of the station; their property adjoins the N. Y. C. R. R. track. The clay deposit, which covers several acres, is basin-shaped and has a known depth of at least 20 feet. It is of a blue color, weathered to red above, and on top of it is about a foot of peat. The clay after being dug in the fall is stored under shed until spring when it is molded by dry press machine. The brick are set directly in the kiln. Water smoking is done with wood and subsequent firing with oil. The blue clay burns buff and the other clay a red, so that by mixing the two a speckled brick is obtained. This firm has not been in operation very long.

The clay is quite siliceous, as the following analysis shows, and is similar in composition to the red terra cotta clay at Glens Falls. The composition is as follows:

Silica	62.23
Alumina	16.01
Peroxide of iron	6 96
Lime	1.24
Magnesia	2.21
Alkalies	5.08
	93.73

Rochester, Monroe Co. The Rochester Brick and Tile Manufacturing Co. is located on Monroe St. at the eastern end of the city. Adjoining this is the German Brick and Tile Co. The

* Since this report was written the firm name has been changed to "Empire Pressed Brick Co."

clay is reddish in color, four to five feet thick and underlain by hardpan. Lime pebbles occur in the lower portions. Molding sand is obtained from a neighboring esker.

The following is an analysis of this clay:

Silica	50.55
Alumina	15.46
Peroxide of iron	4.38
Lime	10.95
Magnesia	3.35
Alkalies	6.30
	90.99

Maplewood, Monroe Co. Robert Gay's yard lies along the N. Y. C. R. R. His clay is very similar to the preceding, but somewhat lighter colored. It is underlain by quicksand. This clay is used at Rochester to mix with Jersey fire clay in the manufacture of sewer pipe.

Clarkson, Monroe Co. M. Parker's brick plant is on northern side of the ridge road, at Clarkson, one mile north of Brockport. The clay is a shallow loamy deposit, and is owned by J. Sigler. The yard is an open one and both brick and drain tile are made. The molding sand is obtained from near the depot at Brockport. Product consumed locally.

Albion, Orleans Co. There is a small yard about a mile north of the town but nothing is known concerning it.

Lockport. The Lockport Brick Co.'s yard is at the northeast end of the town. The upper portion of the clay is being used. It is red in color, due to weathering. The clay is molded as taken from bank, the bricks are dried on pallets and burnt in scove kilns. Product used locally.

La Salle, Niagara Co. Tompkins & Smith run a small yard at this locality. Clay is very similar to that at Tonawanda. It is underlain by hardpan. Rolls are used to crush the lime pebbles in the clay before molding it. The product is marketed in the vicinity.

Tonawanda, Niagara Co. To the southeast of the town is the brick plant of Martin Riesterer. The clay is of a red color pass-

ing downward into blue and has a thickness of about five feet. Only common brick are manufactured, and the consumption is chiefly local. The burning is done with coal.

Lancaster, Erie Co. There are two yards here, the Buffalo Star Brick Co., near the Erie depot, and the Lancaster Brick Co. about two miles farther out. In the former's bank the clay is of a blue color below and weathered to red on top. Limestone pebbles are common in the clay, and for the purpose of separating them, the clay is stored in sheds to dry during the winter and passed through a barrel sieve before being used the following spring and summer. Plows are used to mine the clay, and coke and coal are used to burn the brick in stationary kilns with one fire per arch.

The bank of the Lancaster Brick Co. is similar to the one just mentioned showing:

8 feet red clay
1–2 feet blue clay
4 feet gray "
Rock

Limestone pebbles are also present and the clay after drying is screened. The bricks are burned in stationary kilns, coke being used for the water smoking and coal for the subsequent firing.

Buffalo, Erie Co. At East Buffalo is an extensive series of flats underlain by red clay which varies in depth from six to 20 feet. The following firms situated chiefly on Clinton St. use the clay for making brick: Chas. Berrick & Sons, Brush Bros., H. Dietschler & Son, F. Haake, L. Kirkover, Schusler & Co., G. W. Schmidt. Their combined production in 1892 was 65,000,000 brick. The clay is said to rest on the underlying rock.

The following is an analysis of it:

Silica	57.36
Alumina	16.20
Peroxide of iron	4.55
Lime	5.34
Magnesia	3.90
Alkalies	6.98
	94.33

Pebbles of limestone are scattered through it in places, and at a few spots several feet of yellow sand, suitable for molding or tempering, covers the clay. Below the limit of weathering the clay is blue and does not give as nice a colored brick as the red. The addition of tempering sand is not considered necessary. Soak pits and soft mud machines are used. All the yards dry their brick on pallets and burn them in stationary kilns, using coal fuel. One fire is made to burn one, two or three arches, according to the construction of the kiln. The burning takes nine days. Buffalo and its vicinity consume a large portion of the product.

Situated at the north end of Buffalo are the works of the Adams Brick & Terra Cotta Co. They have but recently commenced operations, and their chief product is brick and drain tile. The clay deposit is of the same general character as that of East Buffalo, having two to six feet of red clay on top, and below this blue, to a depth of 25 to 40 feet. Much of the blue can be used for coarser grades of pottery. A soft mud machine is used for common bricks, and a plunger stiff mud machine for tile and front brick.

They also have a dry press machine for making front brick. A. Steadman disintegrator is used in connection with this latter. The common brick are dried on pallets, the front brick in chambers. Burning is done in down-draft kilns and scove kilns. The latter are 40 by 15 feet, a smaller size than is customary. Five to six days is required for burning. This is a comparatively short period, and is partly due to size of kiln and partly to earthing. Parting sand from the iron foundry is used for molding.

Jewettville, Erie Co. Brush & Smith have recently started a brick yard at this locality. It is situated along the B. R. & P. R. R. track, about a quarter mile northwest of the station. The material used is Hamilton shale. It is of a grayish color and is easily worked. An opening has been made next to the yard and at the same level. A black, gritty shale crops out farther up on the hill, but this has not yet been used. The shale is loaded on cars and run into the machine shed, where it is

crushed in a dry pan and then molded in a dry clay machine; drying is done in tunnels and burning in stationary up-draft.

Spring Brook, Erie Co. There are extensive deposits of clay and shale at Spring Brook, on the land of E. B. Northrup, but they are not being worked.

Evans, Erie Co. Wm. Bolton has a horse-power yard here. The clay is a local deposit, chiefly blue in color, and the lower portions are stratified. It is underlain by sand and hardpan. The yard is run in accordance with the local demand for brick.

Dunkirk, Chautauqua Co. Wm. Hilton's yard is situated in the valley, about one mile west of the town. The clay deposit is about 20 feet thick, and is underlain by rock. The upper six feet are yellow and below this is blue. Stones are found scattered through the clay and have to be separated. The yellow clay gives a better colored brick, while the blue clay shrinks more, but is said to give a harder product. The blue clay obtained from the main clay bank has to be tempered with sand; it has not been much used up to the present, however. Rolls are used to crush the stones and the clay is tempered in a pug mill. Mr. Hilton uses a soft mud machine of his own manufacture. The brick are dried on pallets, and the burning, which takes eight to 11 days, is done in scove kilns. Coke is used for watersmoking and coal for subsequent firing. Most of the brick are used in the vicinity.

Jamestown, Chautauqua Co. Two yards are in operation four miles east of this locality. Those of C. A. Morley and M. J. Mecusker & Son. They are about four miles east of Jamestown. The two yards adjoin each other, and the deposit of clay worked by them is of considerable size. In addition to brick, Mecusker & Son make drain tile and hollow brick. The clay deposit is basin-shaped. A boring near the water works showed:

Yellow sand	4	feet
Quicksand	6	inches
Yellow clay	5	feet
Blue clay	70	"
Hard pan	?	

Randolph, Cattaraugus Co. J. Turner owns a brick clay deposit at this town, but has ceased working it.

Hornellsville, Steuben Co. The Hornellsville Brick & Tile Co. has its works at the north end of the town and have only been running one season. They use a Devonian shale for making brick, and have turned their attention thus far to paving brick. The shale is mined about a mile from the works. It contains several thin layers of sandstone which can not be used. The process as followed here consists of grinding the shale in a dry pan, molding in stiff mud side cut machine and then repressing. Drying takes about 24 hours, and is done in chambers heated by a hot blast. Burning is done in down-draft cupola kilns and takes seven to 10 days. The paving brick are in extensive use in Elmira.

An analysis of this clay made by C. Richardson in the office of the engineering commissioners, at Washington, showed:

Silica	64.45
Alumina	17.77
Peroxide of iron	7.04
Lime	.58
Magnesia	1.85
Potash	2.52
Soda	1.95
Insol. in acid	88.74

W. H. Signor owns the other yard at Hornellsville. His clay bank is owned by M. Adsit. It is a shallow deposit, not over seven feet thick and underlain by quicksand, this latter allowing the inflow of water from the neighboring stream. The bricks are molded by an auger machine, dried in the sun and burnt in scove kilns, the burning occupying about seven days.

Alfred, Steuben Co. Rock Cut Clay Co. This is another yard using a shale, which is in the same geological horizon as that at Hornellsville. The works are on the Erie R. R. a few hundred yards south of the station. They have but recently commenced operations. A dry clay brick is being made. A peculiarity in the dry clay process as practised here, is that the clay is molded a trifle damp, it being thought that this will preserve the corners

of the brick better. To dampen the ground clay it is discharged from the hopper into a long box of square cross section in which a worm screw revolves. The axis of the screw is hollow and has nipples which project into the tube three fourths inch so that if any of the steam which is injected to dampen the clay condenses it will not escape into the clay. The shale used is mined near the yard and hauled in carts to the dry pan.

Big Flats, Chemung Co. Near the village is an extensive bed of clay owned by J. R. Lowe. It underlies an area of about 50 acres. Excavations have been carried to a depth of 15 feet without reaching the bottom of the deposit. The clay is of a bluish gray color. Mr. Lowe manufactures drain tile only and most of these are for private use.

Horseheads, Chemung Co. R. G. Eisenhardt has a clay deposit 100 acres in extent, and having an average thickness of about 20 feet. There is a covering of about 10 inches of soil. Underlying the clay is sand and gravel. Both the yard and clay bed are situated on a high terrace.

Breesport, Chemung Co. About one and a half miles south of the town are the yards of the Empire State Brick Co., Locy Bros. and P. M. C. Townsend. The bank from which they obtain their clay lies along the eastern side of the valley. It is about one half mile long and has a height of 50 feet. It is chiefly of a bluish color and is stratified in places.

We give herewith the analysis of the clay:

Silica	52.48
Alumina	16.78
Peroxide of iron	6.79
Lime	6.63
Magnesia	3.59
Alkalies	7.16
	93.43

At Locy's yard where borings show the clay to be 30 feet thick, a red clay also occurs. Yellow sand overlies the clay at several points and can be used for molding. The yards of Locy Bros. and Townsend are open ones. At the Empire State Co.'s yard tunnel driers are used, the clay being mixed in a wet pan and

then discharged through an opening in the floor of the latter on to an endless belt which carries it up to the molding machine. The brick are burnt in scove kilns.

Spencer, Tioga Co. W. H. Bostwick's yard is about one mile south of the village. The clay which is dug in a field adjoining the works, is a tough reddish material four to six feet thick. It is underlain by sand and gravel. The bricks are dried on pallets and burned in stationary up-draft kilns.

Newfield, Tompkins Co. F. C. Campbell's brick yard is about one mile north of the station along the Lehigh Valley Railroad. Adjoining the yard is the clay bank which rises to a height of about 50 feet. The clay is of a bluish color, the upper portions containing more sand.

An analysis of this clay showed

Silica	51.30
Alumina	12.21
Peroxide of iron	3.32
Lime	11.63
Magnesia	4.73
Alkalies	4.33
Organic matter	1.50
	89.02

Notwithstanding the high percentage of lime which gives the brick its cream color, a very strong product is produced. Covering the clay is several feet of yellowish stratified sand. Lime pebbles occur in the clay and a special apparatus is used to extract them. It consists of a large shallow circular pan in which a number of small wheels revolve on a shaft. The bottom of the pan is perforated. The clay is thus ground and passes through the bottom of the pan, while the stones are not crushed. The bricks are molded on stiff mud machines and repressed on a hand-power machine. Chamber dryers are used and burning done in down-draft kilns or scove kilns. The clay burns to a whitish brick; further burning at a higher heat gives a hard yellow brick, which is smaller, but sold for paving purposes. The following is a report of tests made on these brick in the laboratory at Cornell University: "All the bricks were tested on edge, as used for pur-

pose of paving. The sides were dressed to parallel planes on an emery wheel, so as to get uniform bearing over every part. Single layers of thick paper were placed between the brick and the machine.

	No. 1.	No. 2.	No. 3.	No. 4.
Wt. of brk. in lbs.....	4.86	5.14	5.1	5.00
Dimensions	$7\frac{3}{4}\times3\frac{5}{8}\times2\frac{3}{16}$	$8\times3\frac{7}{8}\times2\frac{5}{16}$	$8\times4\times2\frac{2}{19}$	$7\frac{3}{4}\times3\frac{3}{4}\times2\frac{5}{16}$
Cubical contents.....	61.35 cu. in.	70.7	74.	67.20
Area strained.....	16.95 sq. in.	18.5	18.5	17.92
Height of column.....	$3\frac{5}{8}$	$3\frac{7}{8}$	4.	$3\frac{3}{4}$
Total stress				
First crack.....	208000	84000	56000	48000
Splinters fly.....	250000	....	133000	108000
Crushed	254000	172000	180000	141200
Stress per square inch				
First crack.....	12230	4580	3508	2600
Splinters fly.....	14800	.....	8362	6000
Crushed	14990	9300	10909	7880
Color of brick.....	Lt. cream Homogen. columnar.	Lt. cream Black vitrified.	Lt. cream Homogeneous.	Lt. cream Homogeneous.
Fracture				
Position of 1st fracture	One corner	Central ..	Central ..	At one end.
Direction of fracture ..	Vertical..	Diagonal.	Vertical..	Vertical.
Kind of brick	Repressed	Common.	Common .	Common T. of soil.
Sp. gr.....	2.18	2.01	1.91	2.07
Wt. per cu. ft.....	136.9	125.6	118.8	129.0

The repressed brick shows great strength; more than sandstone and four fifths that of granite. The best results of pressed brick usually show 6000 to 10,000 pounds per square inch.

Homer, Cortland Co. The brick yard at this locality belongs to Horace Hall of Cortlandt. His clay bed underlies the flat lands near the village of Homer, and is from three to five feet thick. Quicksand underlies the clay and overlying it is a dark soil two to six inches thick. The clay is of a bluish color.

Binghamton, Broome Co. There are two yards at this town, viz.: Wells & Brigham and the Ogden Brick Co. Their clay beds are similar, both being shallow deposits six to eight feet thick,

underlain by sand and gravel. The former of the two is a pallet yard, the other uses a tunnel dryer. Their product is consumed locally.

Brookfield, Madison Co. The Brookfield Brick Co. is the only firm manufacturing brick at this locality.

Oneonta, Otsego Co. Two firms are manufacturing brick at this locality, J. Denton & Son, and Crandall & Marble. The works of this latter firm is situated on the Albany and Susquehanna Railroad near the village of Oneonta. Two kinds of clay are used; one of them from a bank five to 20 feet in thickness, the other from a surface deposit three to five feet in depth. This latter bed is underlain by sand. The product is consumed by the local market.

Goshen, Orange Co. P. Hayne has a clay deposit 55 feet deep, underlain by black gravel. There is a slight stripping of sod. Both drain tile and brick are made from the clay.

Florida, Orange Co. W. H. Vernon's brick yard and clay deposit are situated in the valley near the town. The clay bed is 10 feet thick, blue in color and tough. The upper three feet are weathered to a red clay and make a better brick. The blue is of sufficient purity for making pottery. Underneath the clay is sand and hardpan.

Oakland Valley, Sullivan Co. Mr. O. B. Wheeler of Middletown, N. Y., has an extensive clay deposit here. There are about 125 acres of clay land lying between the Navesink River and the West Shore Railroad. The clay is found not only in the valley but is also exposed in numerous cuttings on the hillside. At the former spot a depth of 46 feet has been proven by boring and at the latter 17 feet. In many places the clay crops out; at others it is covered by one to three feet of loam. An analysis of the clay made by Prof. Draper of the New York City University shows:

Silica	37.50
Peroxide of iron and alumina	54.00
Magnesia and lime	3.50
Moisture	5.00
	100.00

It will be seen from the above that the clay runs high in iron, which would apparently make it fusible; however it is found to stand a high heat, according to a report made on it by Dr. N. L. Britton, of Columbia college. About one eighth sand had to be added to the clay for brick or tile ware. The sand, which is of a bright yellow color, is in banks along the Navesink River near the clay beds. This clay is also said to be available for paint. Oakland Valley is about 12 miles from Port Jervis.

New Paltz, Ulster Co. New Paltz Brick Co. Their brick yard is located on the outskirts of the town and near the Wallkill Valley Railroad, with which it is connected by a switch. The clay deposit is yellow, red and blue in color, and varies in depth from 15 to 50 feet. It underlies a tract of six acres. The separation of the clay in four to eight inch layers facilitates the digging of it. There is a thin stratum of overlying sand which has to be first stripped. Soft mud machines operated by horse power are used for molding.

Warwick, Orange Co. Although there are no brick yards in this vicinity, still extensive deposits of clay are undoubtedly present. A sample of clay from the Drowned Lands, lying along the Wallkill River in Orange Co., was analyzed in the laboratory of the N. J. Geol. Surv. with the following results:

Silicic acid in combination	28.9
Quartz	22.9
Silicic acid free	1.2
Titanic acid	0.5
Oxide of alumina	23.1
Peroxide of iron	7.2
Lime	0.7
Magnesia	2.6
Potash	4.1
Water	9.7
	100.9

The clay is said to exist in large quantity, forming a thick layer at this point in the alluvial district of the Drowned Lands, and underlying much of the black muck surface of this district.

The specimen sent was thoroughly air dried and was slate gray in color, and showed a little fine gritty sand. It contains too much oxide of iron and potash for any refractory or fine materials. Washing out the fine sand might enable it to be used in some styles of paper facing. It is most interesting as the basis of a valuable, enduring and fertile soil, and if properly drained it would be unsurpassed for tillage or pasturage; and as such it furnishes another argument for the drainage of this tract of drowned lands.

Brick yards

East Williston, Queens Co. W. & J. Post have two yards at this locality. Their clay pit is in a field some 500 feet west of the yard on the land of H. M. Willis. The clay has been excavated to a depth of about 15 feet. It is chiefly a bluish clay and can be easily dug. The clay is extremely siliceous as the following analysis shows, but the percentage of lime, magnesia and iron is low:

Silica	69.73
Alumina	16.42
Peroxide of iron	2.58
Lime	1.66
Magnesia	0.69
Alkalies	6.27
	97.35

Carts are used to haul it to the yard. Pumps have to be used to keep out the water which comes up through the underlying sand. The clay is tempered without the addition of sand in ring pits run by horse power. The bricks are dried either on the open yard or on pallets and burnt in scove kilns with wood. They are shipped on the L. I. R. R., which passes by the yard.

Oyster Bay, Queens Co. An extensive deposit of clay is being worked on Center Island, in Oyster Bay, by Dunn, Dolan & Co. They manufacture common brick. The bank adjoins the yard, and the clay, which is in thin layers, separated by fine laminæ of sand, is of a bluish color in the lower portions of the deposit and

brownish above. The brown clay is more sandy, and there are six or eight feet of it. Over the brown is a less gritty and tougher clay, which runs nearly to the surface. The total height of the bank is about 25 feet, but the front is broken up into several wide benches. Springs issue from several sandy spots in the blue clay. In making the brick the different grades of clay are mixed together, and a certain proportion of sand, and also some coal dust added. Ring pits are used for tempering. The brick are dried on an open yard and burned in scove kilns. They settle eight to ten inches in burning.

West Neck, Suffolk Co. The clay at this locality rises in a bank to a height of over 100 feet. There are three yards but only two of them are active. Both are along the east shore of Cold Spring Harbor. The most southern one belongs to Dr. Jones. The clay in this bank is of a red and brown color, there being about 25 feet of the latter at the bottom and above it is the red which is of a more sandy nature. There is an upper covering of 15 or 20 feet of yellow gravel and sand, which after screening is used for tempering. This latter is done in ring pits. All the machinery is run by horse power. The bricks are dried on an open yard and burnt in scove kilns. The product is loaded on schooners and sent to New England and New York City. The lower brown clay has been used for coarser grades of pottery, and its composition is given below:

Silica	61.01
Alumina	19.23
Peroxide of iron	5.43
Lime	0.96
Magnesia	1.88
Alkalies	4.60
	93.11

Adjoining Jones' yard is that of Crossman Brothers. It is leased by Wm. Hammond. The clay in his bank is similar to that of Jones'. The yard is also an open one, steam power being used for running the machines and the tempering is done in rectangular pits.

Fresh Pond, Suffolk Co. This locality is about four miles east of Northport on the north shore of the island. There are two yards, about a mile apart. The most eastern one belongs to G. Longbottom. It is situated some 500 feet from the shore and about 50 feet above Long Island Sound. The clay bank is about 200 feet west of the yard and at the same level. A section in the summer of 1892 showed

Sand and gravel	4 feet
Red sandy clay	8 "
Red clay	6 "

The overlying sand and gravel is stratified and dips east. It is screened for tempering. Carts are used for hauling the clay to the machines. Molding sand is obtained from Hackensack. The clay and sand are shoveled directly into a vertical pug mill, from which they pass to the molding machine. Coal dust is also added in tempering. The product is loaded on cars. run down to schooners at the dock and shipped to Connecticut. Adjoining Longbottom's yard is the inactive plant of Provost.

About a mile west of Longbottom's and situated along the shore is the yard of R. Sammis. His land extends 2000 feet along the shore and the whole of that distance the clay crops out from underneath the sands and gravels. The lower portion of the clay is a bluish red, the upper, red in color and somewhat more gritty. The clay is rather tough but not so dry as Longbottom's. The carting is done along the shore, and the overlying sands which are highly stained with iron are used for tempering. A cutting has been made in the cliff just east of the yard for tempering sand. The bricks are burnt with wood.

Greenport, Suffolk Co. The works of the Long Island Brick Co. are some two miles west of Greenport on the shore of Pike's cove, opposite Shelter Island. Their clay is a glacial deposit of red color, rather tough and contains numerous stones. Mr. Sage, the owner, claims a depth of 64 feet for the deposit in places. Several openings have been made in it, one of them 24 feet deep. It is said to thin out to the east of the yard, where it is found to be underlain by hardpan. It is undermined, the working face being about eight feet high and

the clay is hauled to the machines in carts. It is tempered in soak pits, with the addition of one third its volume of sand. Hematite is also added in order to produce a good color in burning. The bricks are dried on pallets or on open yards. They are burnt in scove kilns, loaded on schooners and shipped largely to Connecticut. Many also go to points on Long Island.

Southold, Suffolk Co. Two miles east of the village is C. L. Sanford's yard. The clay is similar to Sage's. Mr. Sanford has about 29 acres of clay. It is worked chiefly by undermining, the working face being about 10 feet in height. In places gravel is scattered through it, but in others it is very free from stones. Borings have shown a depth of 65 feet of clay. The clay and coal dust are put into rectangular soak pits and from these are shoveled into the machine, the tempering sand not being added until then. The drying is done on pallets, whose total capacity is 154,000. Most of the product goes to Connecticut by schooner.

Below is given an analysis of the clay:

Silica	59.05
Alumina	22.11
Peroxide of iron	6.54
Lime	2.19
Magnesia	2.64
Alkalies	6.22
	98.75

Fisher Island, Suffolk Co. The extensive deposit of clay at this locality is worked by the Fisher Island Brick Manufacturing Co., whose plant has a capacity of about 15,000,000. The yards are situated on the north shore of the island between Clay Point and Hawk's Neck Point. About 1500 feet from the shore is the bank of clay, which is of a reddish color and thinly stratified, the layers of clay being separated by very thin ones of sand. In most places, however, the mass has been disturbed by glacial movements. There is a stripping of 20 or 30 feet of a whitish sand, the finer portions of which can be used for tempering. Their present working face is 30 feet above tide at its base, and the clay, it is claimed, has a depth of 40 feet at

least below this, as shown by borings. A sample from the upper half of the bank showed the following composition:

Silica	53.77
Alumina	20.49
Peroxide of iron	9.23
Magnesia	4.22
Lime	2.04
Alkalies	9 60
	99.35

The clay, which is said to improve with the depth, is worked by undermining. It is then loaded on carts and hauled about 200 feet to a platform, underneath which cars are run to receive the clay and sand. These cars in trains of three or four are drawn to the yard by four horses, the grade being slightly descending. Tempering is done in large rectangular soak pits, and open yards are used for drying the brick, or it is done on pallets. A small quantity of hematite is added to molding sand. The bricks are burnt in scove kilns with wood. Most of the product goes to Connecticut and Rhode Island.

West Deer Park, Suffolk co. About a quarter of a mile north of the station are the works of the Wyandance Brick and Terra Cotta Co. In appearance their clay bank is unique, for there is hardly another in this State which exhibits such a variety of colors. Two openings have been made for getting the clay. The main one shows a face about 12 feet high chiefly of black clay, the lower portion of this latter having thin layers of a grayish sand. Over the black is several feet of red and yellow clay. The other opening lies to the south of the first one, the clay being mottled, and shows various shades of red and yellow. Scattered through it are lenticular streaks of red and yellow sand. This second pit has a face about 20 feet high. In some places the stripping is 20 feet of sand and gravel, while in others it is not over three feet. A track is laid from clay shed to face of bank, the clay is loaded on cars and drawn by horses to the foot of an incline, up which it is drawn by cable into the clay shed and dumped.

A loam obtained near the yard is added to the clay to temper it and also to help in producing a brick of good red color. Hematite is also added to the clay while it is being pugged. The clay and loam are fed between a pair of rolls to crush any stones that may be present, and from these it passes to an inclined pug mill, where the water and hematite are added. The wet mixture goes through a second pair of rolls of smaller opening than the first, and is then carried by endless belt to the molding machine. A soft mud machine is used for molding the common brick, and for the front brick and hollow brick an auger machine is used. The molding sand is dried on brick floors 60 feet long, under which there is a series of flues, the heat being obtained from a coal fire at one end. Steam heated tunnels are used to dry the bricks. This takes about 36 hours. Exhaust fans are used to draw off the air. The burning, which takes seven to eight days, is done in Wingard and similar types of kilns, hard and soft coal being the fuel used Hollow brick are placed round the sides of the kiln, and front brick in a rectangular mass in the center. The black clay alone burns to a white brick. The product is shipped to points on the Long Island Railroad.

The light color of the brick made from the black clay is due to the absence of iron, and the black color of the clay is caused by the organic matter. The following is an analysis of it:

Silica	59.83
Alumina	24.45
Oxide of iron	trace.
Lime	0.23
Magnesia	0.59
Alkalies	8.75
Organic matter	4.28
	98.13

Farmingdale, Suffolk Co.— There is only one yard in operation at this town, that of M. Meyers. The inactive one belongs to Stewart. Meyers' yard lies about one mile north of the village, along the southern edge of the moraine, on a branch track of the railroad. The clay pit is some 300 feet from the yard, and several feet lower in level. The clay is chiefly a reddish yellow

and very plastic, but tough in places. The lower portions are quite free from sand. Mr. Meyers claims a thickness of at least 25 feet of clay in addition to the 10 feet exposed. At the entrance to the pit the clay is seen to be underlain by a bluish white micaceous sand, which is cross bedded and dips under the clay at a very steep angle. Hauling the clay is done in carts, and tempering in ring pits with the addition of sand and coal dust. Soft mud machines are used, and the drying is done on palettes. The pallet racks have sectional roofs which are hinged and can be lifted by a lever for the purpose of admitting more sunlight. The bricks are burnt with wood in clamps, and the product is shipped to various points on Long Island.

Below is given an analysis of the lower clay:

Silica	62.39
Alumina	23.60
Oxide of iron	3.39
Lime	0.10
Magnesia	0.10
Alkalies	5.89
	96.07

The low percentage of lime and magnesia would make this clay available for a higher grade of clay product, such as terra-cotta or pottery, but the high percentage of alkalies is somewhat objectionable.

Staten Island has two yards where common brick are manufactured. One of them belongs to McCabe Bros. at Green Ridge. Their deposit is a stony glacial clay of a red color, and lies to the northwest of the yard. Small boulders are scattered sparingly through it, and the upper portion is somewhat loamy. Borings have penetrated the clay to a depth of 25 feet and stratification appears with the depth. No sand or coal are added to the clay in tempering. It is first passed through rolls two feet in diameter, the one making 60 the other 600 revolutions a minute, and having an opening of half an inch. This partially breaks up the stones. The crushed material falls on a belt and is carried up to a pug mill where the water is added before it passes to the machine. Drying the bricks is done either in the sun or in tunnels. In the latter the bricks shrink more. The

tunnels are heated by coal fires. Wood is used for burning, and the kiln settles about four inches. The products go to New York city and the vicinity.

Wood & Keenan's yard is situated on the shore of Arthur's Kill, opposite Carteret. It is an open yard of greater capacity than its output. The clay is of the same character as McCabe's. It is tough and has to be worked with picks, and the pit is about 10 feet deep. Ring pits are used for tempering and the bricks are burnt with wood. New York city and Newark are the chief markets.

The New York Anderson Pressed Brick Co. has its works at Kreischerville adjoining Kreischer's fire brick factory. Various styles of ornamental and pressed brick are made. The company declined to give any information concerning its works. Their clay is obtained from a pit near Green Ridge. It is of a black and gray color. The pit is worked in benches, the clay being hoisted in buckets and loaded on cars which are run down to the works.

Drain-tile

A clay that is capable of making good building brick will usually make a good drain-tile. That is to say, a plastic clay and one that will burn to a tough product. Contrary to bricks tile may be somewhat porous in their character. It is of importance that the clay should be thoroughly tempered before molding. This latter is in most instances done with some form of stiff mud machine, the clay being forced out through a die of desired pattern, and the cylinder of clay as it issues from the machine is cut up into desired lengths. Drying is sometimes done on pallets such as are used for common brick, or it may be performed under enclosed sheds. The drain-tile should be thoroughly dry before being set in the kiln. Burning is done in ordinary scove kilns, clamps or down draft kilns. The smaller tile are set in the lower portions of the kiln and around the sides, while the larger ones are set in the center. Very often when several sizes are burned at the same time they are nested, the smaller ones being set within the larger.

The styles of drain-tile made are as follows :

Horseshoe-tile, having cross section shape of a horseshoe.

Sole-tile, cylindrical with a flat base.

Pipe tile, plain cylinder.

Flange-tile, like preceding but with flange at one end.

It is considered by many that the best form of tile is the sole-tile with an egg shaped section having the smallest diameter across the bottom thereby keeping the water collected in the smallest possible space and securing a good current to carry off the sediment. The horseshoe-tile is objected to as it is liable to break from the lateral pressure of the soil. In Westchester county glazed sewer pipe are generally used for draining the soil, but it is doubtful if there is any special advantage in their use to warrant the use of this more expensive material. In sizes the tiles range from two to 12 inches in diameter and one to two feet in length. They are laid at varying distances below the surface according to depth the ground is to be drained. A drain is said to draw water from the soil on either side for a distance of from 30 to 100 feet, according to depth of drain and character of soil.

The following firms in this State are making drain tile:

Albany, Albany Co. The New York State Drain-tile Works are large producers. The drain-tile are made in numerous sizes. Hudson river clay is used. Front brick are manufactured.

Chittenango, Madison Co. Central N. Y. Drain Tile and Brick Co. Only tile manufactured at present. The plant is located about one mile from the N. Y. C. R. R. and three-quarters of a mile from the W. S. R. R., and a few rods south of the Erie canal. The clay bed lies at the foot of the hill. There is no stripping, and sand underlies the clay. The tiles are made with horse power machinery, dried under sheds and burned in down draft kilns.

Allen's Hill, Ontario Co. B. G. Abbey's are the only works here. Few brick have been manufactured for several years, as drain-tile are the chief production. After stripping a few inches of soil the clay is mixed from top to bottom of the bank for use. The bank is 20 to 25 feet in height, and the clay is blue in color, becoming reddish gray near the surface. A small amount of coal dust is added to the clay. The tiles are made in various sizes.

East Bethany, Genesee Co. B. F. Peck manufactures brick and drain-tile. The clay deposit worked is a portion of a strip one to

two miles in width and extending east and west across Genesee Co., a few miles north of its southern boundary. The clay is usually covered with a thin layer of clayey loam. Mr. Peck has about 50 acres of clay of sufficient quality for making bricks and tile. It averages about four feet in thickness. The upper portion when dry is nearly white, but becomes blue with the depth, and below four feet is very much so. It is also tough, coming up in hard flakes of a stony nature. Below this it passes into the shale, hard enough to resist the pick but crumbling on exposure This last mentioned rock is said to contain calcareous layers, varying in thickness from one to six inches. About 250,000 feet of drain-tile are annually made for local use. The clay burns to a nice red in the drain-tile, deepening to brown when burned harder. The machinery is run by steam power.

Owasco, Cayuga Co. A. Lester's clay bank and brick yard are located in the north end of Owasco village on the bank of Owasco Creek. The clay deposit has an area of about nine acres and is from 10 to 15 feet in thickness. Gravel overlies the clay in places. Soak pits are used for tempering, and a Penfield plunger machine for molding. The tiles are dried in an open shed and burnt in scove kilns. Drain-tile is the chief production but a few bricks are made. The color of the product is white.

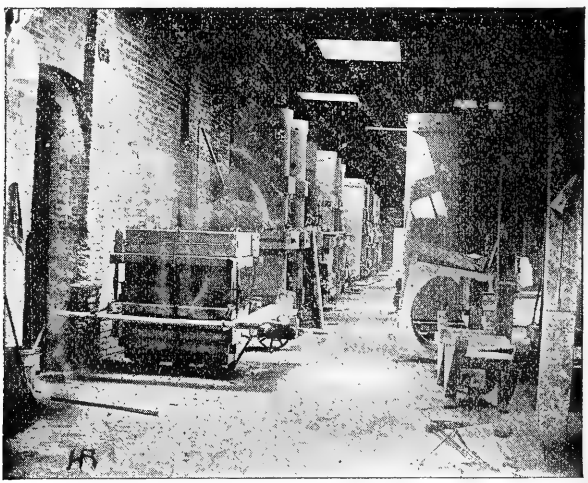
Other manufacturers of drain-tile and whose works have been already mentioned in the detailed account of brick yards, are:

M. H. Bender, Albany
William Davenport, Fonda
C. Stephens, South Bay
Rochester Brick and Tile Manufacturing Co., Rochester
A. Mosell, Lockport
Adams Brick and Terra Cotta Co , Buffalo
James Sigler, Clarkson
J. E. Mecusker & Son, Jamestown
B. G. Abbey, Allen's Hill
J. B. Lowe, Big Flats
P. Hayne, Goshen

Fire Brick.

A fireclay to be refractory should not contain over four per cent. of impurities. Fireclays may or may not be plastic. The latter are represented by the flint clays, but these do not occur

in New York. Fireclays vary in color, being black, gray, red, green, blue or white. Many are soft and can be dug with pick and shovel while others are shale like in their nature and have to be blasted. Fireware must be able to withstand great and sudden changes of temperature. It should resist intense heat without shrinkage or fusion, and it should also resist corrosion of substances in a state of fusion. Coarsegrained ware resists temperature while finegrained ware can best withstand corrosion. If the fireclay is to be used for saggers it must make a product which will not crack when subjected to repeated alternations of heat and cold. The porosity of a fire brick is often caused by



Molding-room of Gas-retort Works.

coarse sand and may be remedied by the addition while preparing of ground burnt clay, or "cement clay" as it is called. Ground quartz may be added if the material contains an excess of alumina. Weathering the clay is of the utmost importance and is often carried on for several months. It breaks up the clay and tends to lessen shrinkage in burning. The clay is next tempered as a further step toward the production of a homogeneous brick. It is first passed between rollers to break it up and is further cut up in a ring pit together with sand. The material is next soaked in a pit with water. Several grades of clay are usually mixed in certain proportions in this pit, the amounts

added being the secret of the manufacturer. After soaking for a few hours the material is transferred to a pug mill for further tempering. The clay is now ready for molding. This is done by hand in wooden molds.

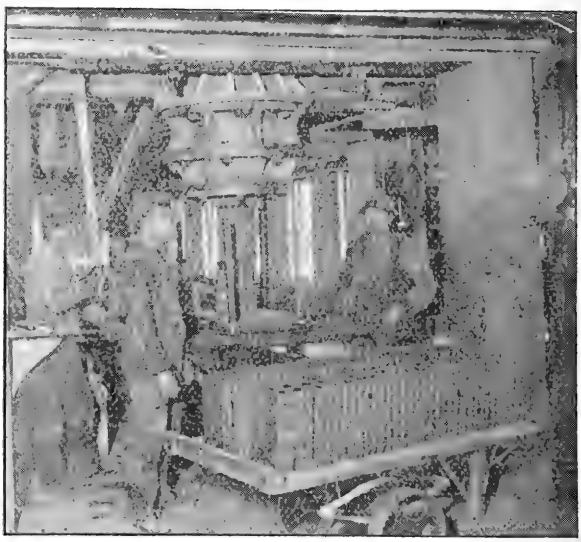
The chief object is to bring the mass of tempered clay into a convenient and approximately rectangular form before repressing it. Very little pressure is exerted in this handmolding. The bricks thus molded are spread out on a drying floor of brick, heated by flues passing underneath it. These brick are next repressed and further dried in tunnels before setting them in the kiln. The kilns are circular, having a height of 15 feet, and a diameter of 20 to 30 feet. Burning takes five to six days. The kiln has two openings, and while the burned brick are being taken out of one door the green brick are being carried in through the other one and set up for burning. The gas retorts are made by hand in sectional molds and burnt in the same kiln with the brick.

Although there are several fire brick factories in the state all of them with one exception obtain their clay from New Jersey. The New Jersey fire clays which are of Cretaceous age extend in a belt across New Jersey and over onto Staten Island, and it is at this latter locality that the refractory clays of New York state occur. The fire brick factory of William Kreischer's Sons is located on the southwestern shore of Staten Island at Kreischerville. They manufacture fire brick, cupola brick and gas retorts. Most of the clay used is obtained from Staten Island, and the rest from New Jersey. Four openings have been made in the vicinity of Kreischerville. The deepest one is opposite Kilmeyer's Hotel. The clay in this pit is used for fire brick. It is tough, of a whitish color and mottled with yellow. Its thickness is not very great and there is 15 or 20 feet of stripping. Southwest of this opening is another pit, but in this the clay is of a more sandy nature and is overlain by about four feet of sand. The clay is bluish in color and is chiefly used for mortar. A third opening has been made near the shore and is known as the "Wier Bank." The material obtained from it is a stoneware clay. In this pit the clay as at present exposed is about 10 feet thick, and is overlain by horizontally stratified fine sand.

Sewer Pipes

Sewer pipes are made from a clay that will vitrify. There are several works in this state which import their clay from New Jersey. The two works described below use native clay.

Angola. John Lyth & Sons. The works are situated along the Lake Shore R. R. some few hundred feet southwest of the station. The material used is a Hamilton shale, of a gray color and containing streaks of bituminous matter. It is mined about 200 feet east of the factory, and a small blast serves to loosen a large quantity of it. Cars drawn by horses convey the shale to



Press for sewer pipe, tile and hollow brick

the dry pans where it is ground to a fine powder and is then further ground with the addition of water in a wet pan. The tempered material is then carried in a bucket ladder to the upper floor of the building where it is fed into the sewer pipe press. This consists of two vertical cylinders separated by iron frames. The upper cylinder contains the steam piston and is about 30 inches in diameter. The lower one is the clay cylinder. The area of the steam cylinder is usually several times greater than the area of the clay cylinder. The clay piston is a continuation of the steam one, and within the clay cylinder at its lower end is the bell which regulates the internal size of the pipe. Sockets

are made by means of a core attached to the end of the die, the bending of the pipe being caused by the core forcing the clay out through the die faster on one side than the other. Underneath the end of the cylinder is a counterpoised table which receives the pipe as it issues. When a sufficient length of pipe has issued the press is stopped and the pipe cut off at the mouth of the die. It is then removed from the table, which, relieved from the weight, ascends to receive another length of pipe. Y joints are made by hand, a hole being cut in the side of one piece of pipe and the end of another trimmed to fit over it, the joint being closed by means of wet clay.

After the pipes are molded they are set on the drying floors until thoroughly dry. Burning is done in circular down draft kilns, such as those described in the manufacture of brick. It takes five to eight days. The glaze to sewer pipe is made by adding salt to the fires toward the end of the burning and when the fires are hottest. The salt is thrown into the fireplace and by the heat is broken up into hydrochloric acid and oxide of sodium, and this latter fluxes with the silica in the pipe forming a vitreous coating known as the "salt-glaze." When sewer pipes are made of pipe clay, they are often coated with "Albany Slip," a calcareous clay obtained in the Hudson River Valley. The material composing this fuses at a lower temperature than the fire clay and gives the desired glaze. The composition of this material published in Vol. VII of Ohio Geol. Surv. 1893 is:

Silica	60.59
Alumina	12.46
Oxide of iron	5.79
Lime	6.84
Magnesia	3.28
Alkalies	4.39
Water	5.82
	99.17

Another analysis given in the Clay-worker of December, 1894:

Silica	58.47
Alumina	16.90
Lime	6.19
Magnesia	Tr.

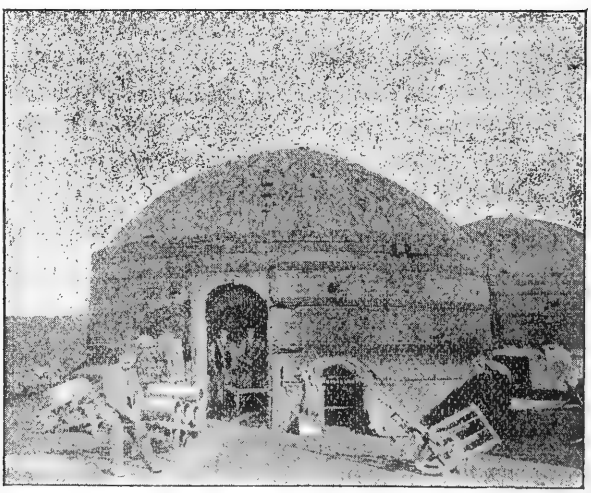
Oxide of iron	3.72
Alkalies	8.85
Water	7.49
	101.62

We give here an analysis of the shale at Lyth's yards:

Silica	65.15
Alumina	15.29
Oxide of iron	6.16
Lime	3.50
Magnesia	1.57
Alkalies	5.71
	97.38

J. Lyth & Son also manufacture hollow brick and terra cotta lumber.

Rochester. Otis & Gorsline use a mixture of New Jersey fire clay and a quarternary clay obtained from Chili near Roches-



Circular down-draft kiln for tiles, etc.

ter. The method of manufacture followed by them is very similar to that at Angola. Rectangular kilns are however used for burning, which takes about one week.

Sewer pipe are also manufactured at Albany and Troy but from New Jersey clays.

Flower Pots

There is a deposit of mottled blue clay on Long Island between Southold and Greenport, which is used for manufacturing flower pots at the latter place. The clay at Oakland Valley on the land of O. B. Wheeler has also been used for this purpose. (*See* detailed account of brick yards.)

Hollow Brick and Terra Cotta Lumber

A clay that will make a good building brick or drain-tile can generally be used for the manufacture of hollow brick. The same sort of machine is used in their manufacture as is used for drain-tile, a different shape of die being of course needed. The brick are made in various sizes and of rectangular cross section. They are manufactured by the following firms:

Wyandance Brick and Terra Cotta Co., Wyandance, Long Island,

J. E. Mecusker & Son, Jamestown,

Adams Brick and Terra Cotta Co., Buffalo,

Onondaga Vitrified Brick Co., Warners,

John Lyth & Sons, Angola.

Terra cotta lumber differs from the above in having about fifty per cent. sawdust added to the clay This is burned out in the kiln giving a porous product. It is used for partitions and nails can be driven into it. Only two firms in New York are making it, viz. The Onondaga Vitrified Co. and John Lyth & Sons.

Stoneware — Clay

Deposits of clay suitable for the manufacture of stoneware are found on Staten Island and Long Island. Those of S. I. are located at Kreischerville. The L. I. ones are found at Elm Point on Great Neck, Glen Cove and Little Neck near Northport. They are shipped to Poughkeepsie, Rochester, Utica and Ellenville in N. Y.; also at New Haven, Stamford, Norwalk and Hartford, Conn.; Newark, N. J.; and Pittston, Pa.

The Long Island clay is usually mixed with the Jersey clay in proportion of one to three. These latter clays, if used alone for the manufacture of stoneware, are apt to crack in burning, due to the unequal shrinkage and warping, while the Long Island

clays, being of a more sandy nature, prevent this. The clays of Long Island when used alone for the manufacture of stoneware give a creamy colored product, if burnt medium hard, but if burnt hard they produce a ware of a light blue or drab color. The sandy nature of the Long Island clays makes it difficult to turn them on the potter's wheel.

Elm Point. About one and a half miles northwest of Great Neck on Elm Point is a deposit of dark gray clay, worked by G. W. Mahan. The clay is overlain by about 20 feet of yellow gravel and drift. Lignite occurs abundantly in the clay, and nodules of pyrite are occasionally found. Several pits have been sunk in the clay, one of them 30 feet deep and 10 feet in diameter. Much of the clay is used by the New York Architectural Terra Cotta Co., at Ravenswood, Long Island, and some is also shipped to Boston where it is used for the manufacture of clay pipes.

Glen Cove. Carpenter Bros. have a bed of stoneware clay, fire sand and kaolin on the east side of Hempstead Harbor. The clay is of a white and pink color, the layers being four inches to one foot thick and interstratified with layers of quartz pebbles. Nearer the shore this dips under a bed of the clay free from pebbles. Associated with the clay is a deposit of kaolin and fire sand. The clay burns a cream color. The quartz pebbles which contain small cracks crumble easily and seem to have been subjected to the action of some alkaline solution.* When ground they can be used for the finest grades of pottery and stoneware. The fire sand and kaolin are screened and sold according to grade.

This clay is used chiefly for the manufacture of stoneware, it being shipped to various cities in Connecticut and New York states. It is also used by Perkins and Pit of Stamford, Conn., for the manufacture of stove linings. In this latter case about 15 per cent. of it is mixed with New Jersey clay. Under ordinary fire this clay burns to a light color, but with a hard fire it is said to blacken. The fire sand found associated with this clay bears a most excellent reputation as regards its refractory qualities.

* F. J. H. Merrill. Geology of Long Island, Ann. N. Y. Acad. Sci., 1884.

Northport. The Northport Clay and Fire-sand Co. has an extensive series of pits on Little Neck near Northport. Both fire sand and clay are obtained. The clay bank has a height of about 40 feet and the clay is of a bluish black and yellowish white color. The darker clay is the lower, and contains much carbonaceous matter. The deposit is stratified, the layers of clay being separated by thin sheets of a rather coarse sand. It is shipped chiefly to New England.

The following are analyses of New York stoneware clays and Kaolin:

	Elm Point.	Glen Cove.	Little Neck.	Kreischerville.	Kaolin Kreischerville.
Silica	62.06	70.45	62.66	64.26	82.51
Alumina	18.09	21.74	18.09	24.76	11.57
Oxide of iron	5.40	1.72	0.97	0.83	0.63
Lime	1.05	0.24	0.79	0.73	0.29
Magnesia	Trace.	0.30	.....	Trace.	0.78
Alkalies	6.11	5.00	2.23	2.35	2.66
	92.71	99.45	84.74	92.93	98.44

The following are analyses of Long Island stoneware clays made by C. H. Joüet (School of Mines Quart. Jan. 1895).

	White clay from Northport	Black clay from Northport.	White clay from Sea Cliff.
Silica	68.34	58.84	62.35
Alumina	19.89	23.40	23.14
Ferrous oxide	.90	1.18	1.12
Lime	.35	.....	.....
Magnesia	tr.	.....	.....
Carbonic acid	.....	.....	.....
Sulphuric acid	.....	1.03	1.09
Potash	3.55	5.04	3.17
Soda	.84	.34	1.76
Combined water	6.03	9.20	6.77
	99.90	99.03	99.40

Stoneware

The following description of the manufacture of stoneware and earthenware is quoted from vol. V of the Geological survey of Ohio.

"Stoneware is the product of an unmixed, natural clay, burnt at high enough heat to oblige the impurities to combine with the dry silica and thus cause an incipient vitrification or fretting without loss of shape. It should be impermeable to water without any glazing on it, but it frequently fails in this point. The color is bluish gray due to combined iron."

"Earthenware is a product of very similar clays burnt a little to vitrify the body or combine the iron. It is of a yellow or red color from the free iron and is porous unless glazed."

The successive steps in the manufacture of stoneware are

1. Wetting the clay.
2. Grinding.
3. Wedging.
4. Turning.
5. Drying.
6. Slipping.
7. Burning.
8. Sorting the product.

The wetting or soaking of the clay is usually done at small works where the grinding machines are operated by horse power. Several kinds of grinders are used for the clay, the simplest one being the pug mill. A machine often used at many potteries consists "of a square frame pivoted on an upright beam which runs through the point of crossing of the diagonals. On the projecting ends of this frame are fastened cart wheels which work in a circular trough beneath. The whole frame revolves by the motion of a large cog wheel above, which receives its power from the horse or engine. The machine is slowed up by weighting the corners of the frame. The wheels in their revolutions manage to cut the clay to pieces quite effectually." This machine has a capacity for grinding from 1,200 to 1,500 pounds

at a charge, taking two hours for the operation. Such a charge makes from 180 to 190 gallons of ware. The ground clay is rolled into masses and "wet blanketed" to keep until used. At some factories steam tracer mills are used for doing the grinding. They can grind about 1,200 pounds in 60 to 100 minutes, but eliminate blebs or substances in the clay and particles of foreign matter. The balls of clay are successively divided by a wire into two parts, these halves being each time struck together in such a manner that the two pieces unite different faces. The clay is next turned to the required shape. Crocks and fruit jars are the simplest kinds of product made and after that come jugs, milk-pans and churns. At small works the ware is often laid on flat boards in the sun to dry. At the larger works drying is usually done in closets or rooms heated by a series of steam pipes.

The dry ware now has to be slipped, that is to say, it is covered with a wash consisting of a very fine ground clay suspended in water. By this means the ware becomes covered with a film of clay. These slip clays vitrify easily to a black glaze which covers the ware. The slip commonly used is obtained from the Hudson river clays at Albany and a partial analysis of it is as follows:

Sesquioxide of iron	1.43
Potash	3.17
Soda	.74
	5.34

There are also present large percentages of carbonates of lime and magnesia, which add to the fusibility of the clay. For other analyses see sewerpipe.

A difficulty experienced in the use of slip glazes is the tendency to blister. By many potters this is considered to be due to hasty burning, and it is thought by them that it may be overcome by heating the ware at a low red heat for several hours before raising the temperature. After this a rapid raising of the heat is harmless. The kilns in which the ware is burned vary consider-

ably in shape and size. At small works they are often small square structures. "The fireholes are left above ground and communicate through the various arches and masonry which separate the floor of the chamber above. This floor is full of holes, through which the fire passes and the gases escape through vents in the roof which is arched." Such a chamber is usually about eight feet in diameter and seven feet high. Firing is commenced at night and proceeds slowly at first. By morning the ware is fairly dry and the heat is then continued from 20 to 30 hours, according to conditions. The slip is usually applied only on the inside of stonewares, the outside being glazed with salt.

"The salt is thrown in the fire when heat is highest, the vapors are seized by the clay and the soda silicate forms over the surface of the ware. The heat required to do this is the culminating of the point of burning." Either coal or wood fuel is used. Many of the larger works use down-draft rectangular kilns for burning their wares. At Akron, Ohio, these are 32 by 16 feet and 12 feet high. The fireplaces are at each end and are six in number. The ware is set through lateral doors. Burning requires about 70 hours. It is considered that the cooling of a kiln should occupy as much time as the burning.

A common trouble, in addition to blistering of the slip, is the pitting of the ware in spots, due to iron. "It is a peculiarity of stoneware clay that while it needs iron to give it color by far the largest part of the iron present is collected in grains and has no favorable effect on the color. These grains, if the heat is high enough to vitrify them, pimple on the surface or break out in rough spots, which are black and ill-looking from the silicate of iron formed. If the heat is too low to vitrify the clay, the slow change in its volume by heat causes a scale to separate from the ware, causing a light colored cavity with the piece of the oxide of iron at the bottom."

"Failure of the ware to glaze is also considered due to irregular burning, but another cause is thought to act at times."

In many of the clays there is sulphate of lime present in the form of fine crystals of a whitish color. When exposed to the

vapors of salt at a high heat these change to a chloride of lime, leaving the soda as a sulphate, which will either not displace the silica through combination or will not do it at a temperature which the ware will stand without losing shape, and therefore no glaze is produced.

"Stoneware should exhibit on fracture a blue uniform tint of a somewhat vitrified appearance. This varies very often, however, with the clay."

Terra Cotta

There are four companies in New York who are engaged in the manufacture of this product, viz.: the Celadon Terra Cotta Co., the Corning Brick Co., the New York Anderson Brick Co., the Glens Falls Terra Cotta Co., and the New York Architectural Terra Cotta Co. The first-mentioned company is gradually giving up the manufacture of terra cotta and turning its entire attention to roofing-tile.

The Corning Brick Co. makes its terra cotta from a Hamilton shale. The New York Anderson Brick Co. makes its ware from the Cretaceous stoneware clays of Staten Island; among the largest Terra Cotta works in the state are those of the Glens Falls Terra Cotta Co.; the clay used by them is a portion of the Hudson estuary deposit, it being of a bluish gray color with the upper portions weathered to red. We give herewith a partial analysis of their two clays.

Bluish-gray.		Red.
48.35	Silica	57.46
11.33	Alumina	21.15
4.02	Oxide of Iron	5.52
15.38	Lime	3.65
3.17	Magnesia	1.50
1.18	Organic Matter	.....
6.05	Alkalies	4.72
89.48		94.00

The high percentage of lime in the bluish-gray clay enables them, by the use of it alone, to produce a light-colored ware,

while a mixture of the two clays gives a speckled product, and the red clay alone, a red product.

New York Architectural Terra Cotta Company. The works of this company are situated at Ravenswood, Long Island city. They use clays from both Long Island and New Jersey for the manufacture of terra cotta. The Long Island clay is obtained from Great Neck, L. I. It produces a ware of light yellow color. Coal was formerly used for burning the ware, but oil is now used instead. It is found that 160 gallons of oil is equal to one ton of coal. The advantage of oil is a saving of labor and time, and it is also more convenient and cleaner to use.

The Manufacture of Terra Cotta

In order to produce a good quality of terra cotta, a clay should not whitewash; it should not shrink over one inch per ft. in burning, and should do so evenly; the shrinkage can be regulated by the addition of "grog," (pulverized brick, or sand). Clays which are too sandy can be washed; this is done by dumping them into a circular trough filled with water, in which there revolve paddles fastened to a vertical axis in the center of the trough; from the trough, launders run to settling vats.

The motion of the paddles drives the water with the suspended particles of clay into the launder, down which it flows to the vats, while the coarse sand remains behind in the trough; after the clay has settled in the vats, the water is drawn off; this is the method followed at Glens Falls. Before molding the clay, it should be thoroughly pugged, or, in other words, mixed, and after this the mass should be piled up and allowed to "cure," that is to say, it settles by its own weight, becoming denser while the excess of water evaporates.

The clay is next molded either by machine or by hand; the former method is used for plain forms, while the latter is used for ornamental styles of terra cotta.

Hand molding is of course slower, more difficult, and requires more care; plaster molds are used, and the clay is forced into all the corners with the hand or fingers.

The form is then allowed to remain in the mold until it has dried and shrunk sufficiently to drop out of it, or to permit the mold

being lifted off entire or in sections. The surface of the molded piece is then trimmed and smoothed, and it is put in the drying room until sufficiently dry to burn. Burning is done in down-draft kilns, and takes seven to nine days. The kiln has to be fired very cautiously at first to prevent the ware from cracking; and the heat within it is regulated by means of dampers on the roof and sides.

Large lumps of clay are placed just inside the doors of the kiln to serve as testers. When the burning is nearly done, one of these is withdrawn from time to time and allowed to cool, and from its appearance is determined whether the contents of the kiln are burnt enough; the kiln must be cooled very slowly in order to prevent the ware from cracking; when cool, the terra cotta is taken out and is ready for market.

The following are analyses of New York clays used for making terra cotta:

	Alfred Center.	Glens Falls blue.	Glens Falls red.	Elm Point.
Silica	53.20	48.35	57.46	62.06
Alumina	23.25	11.38	21.15	18.09
Iron peroxide	10.90	4.02	5.52	5.40
Lime	1.01	15.38	3.65	1.05
Magnesia	.62	3.17	1.50	Trace.
Alkalies	2.69	6.05	4.72	6.11
Sulphuric acid	.41	.....	.....	.....
Titanic acid	.91	.....	.....	.....
Water (comb)	6.39	.....	.....	.....
Manganese oxide	.52	.....	.....	.....
Total	99.90	88.30	94.00	92.71

Roofing-tile

Alfred Centre is the only locality in New York at which roofing-tile are being manufactured. The Celadon Terra-Cotta Co. has been in operation for several years, and another factory has recently commenced operations. The material used is a mixture of local bluish gray clay and a Devonian shale. These two are thoroughly ground in dry pans, from which they are carried to

hoppers on the floor above. They are then fed to a pug mill which mixes the clay and shale, and the pugged material is fed directly to a stiff-mud machine. As the bar of plastic mixture issues from the machine it is cut up into slabs which go to the molding room. The Celadon Terra-Cotta Co. has six hand-power machines with a daily capacity of 1,500 each. As the slab of clay comes up from the stiff-mud machine it is taken by the workman who with a wooden tool pound a broad shallow groove in one surface, and then passes it to a second workman who puts it in the machine where it is pressed into shape between two steel dies, which are heated by steam. The repressed tile is taken from the machine by a lifter having two flat steel prongs and laid on a plaster frame held in readiness by a third workman. The latter hands it to another who trims the edges of the green tile with a knife. The tile and plaster frame are set on the racks in the drying room until placed in seggars for burning. Burning requires seven days, and is done in cupola kilns. The company also has a steam power tile pressing machine which has a daily capacity of 15,000. Tests of these tile were made at Columbia college and they showed a crushing resistance of 40,000 lbs. per square inch. The tiles are made of many patterns, and each style required a plaster frame to fit its shape, while drying.

Appendix

Since the foregoing report was written in the latter part of 1892, there have been a few changes in the clay industry of New York that deserve mention.

In the manufacture of common brick, which constitutes the chief branch of the industry in this State, there has been little change; some of the manufacturers are substituting coal for wood as a fuel for kilns, and a few have given up open air drying and are using artificial means, in addition to those already doing so.

There were published in the Engineering News for Dec. 13, 1894, an exhaustive series tests of building and paving brick, many of the samples tested being from New York State.

The use of shale is steadily increasing. A paving brick plant with a daily capacity of 180,000 has recently been erected at Catskill, N. Y. The shale used is brought from Cairo, ten miles distant.

Experiments have also been made with the Niagara shale from Medina, N. Y. Sample lots were made into brick and then tested in the crushing machine, and gave very good results.

In the manufacture of fire brick the method of hand-molding and repressing are no longer used, but the bricks are molded in a soft mud machine. The time of manufacture is considerably lessened thereby as is also the selling price.

These are the principal changes which have occurred. There has been a favorable advance in all branches of the industry in this State.

TABLE OF SECTIONS OF CLAY DEPOSITS

LOCALITY	Owner	Thickness of clay, ft.	Color	Underlying material	Overlying material
Albany	T. McCarthy	15	Blue	Sand	Soil.
	A. Hunter	40	Blue and yellow		Soil.
	M. Roberts	25	Blue		Loose soil.
Greenbush	Mrs. T. Rigney	90	Blue and yellow		Loam.
Troy	A. Ferguson	40	Blue and yellow	Slate	Loam.
	J. B. Roberts	20	Yellow	Gravel	1 foot loam.
Cohoes	J. E. Murray	50	Blue	Slate	Loam.
	J. Baeby	40	Yellow and blue	Gravel	Soil.
Lansingburg	T. F. Morrissey	75	Red ⅓, blue ⅔	30 ft. sand	
Crescent	Newton Bros	30	Gray and blue		2–4 ft. sand.
Mechanicsville	Mechanicsville Brick Co	50	Yellow 10 ft., blue 40 ft.	Sand	3 feet soil.
Saratoga	C. L. Williams	6	Blue	Sand	1 foot soil.
Middle Granville	J. H. Pepper	45	Blue	20 ft. gray soil, slate	
Hoosick Falls	J. Dolin	40			
Plattsburg	J. Ouimet	20	Yellowish brown		1 foot soil.
Gouverneur	G. R. Thompson	14	Gray 8 ft., blue 6 ft		Sand, 4 feet.
Carthage	Wrape & Peck	5	Gray		
Watertown	Watertown Brick Co	20	Red	Trenton limestone	Soil.
Ogdensburg	Paige Bros	60	Blue	Limestone	Soil.
Madrid	R. Watson	20	Blue		Sand 3 feet.
Raymondville	Coats Bros	25	Blue		Fire sand 12 feet.
Breesport	Empire State Brick Co	50	Blue		Soil.
Spencer	W. H. Bostwick	6	Red	Sand and gravel	Soil.
Newfield	T. C. Campbell	40	Blue		Sand 4 feet.
Homer	H. Hall	5	Blue	Quicksand	Soil.
Binghamton	Wells & Brigham	6	Blue	Sand and gravel	Soil.
Goshen	P. Hayne	55		Black gravel	Soil.
Florida	W. H. Vernon	10	Red and blue	Sand and hardpan	
Oakland Valley	O. B. Wheeler	46	Blue		
New Paltz	New Paltz Brick Co	40	Red and blue		Sand few feet.
Chittenango	Central N. Y. Drain-Tile Co		Red	Sand	Soil.
Allen's Hill	B. G. Abbey		Blue		Soil.
Owasco	A. Lester	10–15			Gravel.
South Trenton	H. L. Garrett	4	Yellow, red, blue	Slate	
Amsterdam	H. C. Grimes	6+	Yellow and blue		Soil 1–3 feet.
Gloversville	H. McDuffie	2½	Dark brown	Hardpan	Soil.
	W. A. Stoutner	3	Red brown	Hardpan	Soil.
Ilion	S. E. Coe	8–15	Black, gray and blue		Few feet soil.
Rome	W. Armstrong	7–10	Dark gray		
	W. W. Parry	6–9		Gravel	Loam.

South Bay	C. Stephens	25		Cemented blue gravel	
Syracuse	Preston Bros	10	Red and blue	Sand and gravel	Soil.
Warners	Onondaga Vitrified Brick Co	15	Red	Shale	Soil.
Oswego Falls	W. D. Edgerton	5	Yellow	Gravel	Soil.
Baldwinsville	Seneca River Brick Co.		Red and blue	Gravel	Soil.
Seneca Falls	F. Siegfried	12		Gravel	Soil.
Lyons	F. Burck	8	Yellow and blue	Quicksand	
Canandaigua	Burke & Mead	20	Red and blue	Sand	1 foot peat.
Rochester	Rochester Brk. Mfg. Co.	5	Red	Hardpan	
Tonawanda	M. Riesterer	5	Red and blue		Soil.
Buffalo	Brush Bros.	6–20	Red		Soil.
Evans	W. Bolton	10	Blue	Sand and gravel	Soil.
Dunkirk	W. Hilton	20	Yellow and blue	Rock	
Jamestown	J. E. McCusker & Son	75	Yellow 5, blue 70	Hardpan	Yellow sand 4 feet.
Big Flats	J. R. Lowe	75	Gray and blue		

DIRECTORY OF BRICK

O. Y. = Open Yard;
T. D. = Tunnel Dryers;
D. K. = Down Draft kiln;
W. C = Wire-cut machine;
F. = Front brick;
P. Y. = Pallet Yard;
S. K. = Scove Kiln;
S. M. = Soft mud machine;
H. P. = Horse power;

SUFFOLK

Post-office	MANUFACTURER	Product	Market
Fisher's Island	Fisher's Island Brick Co.	C	N. Eng.
Greenport	L. I. Brick Co	"	Conn. & S. I
Southold	C. L. Sanford	"	"
Fresh Pond	G. Longbottom	"	"
	R. Sammis.	"	"
Wyandance	Wyandance Brick and Terra Cotta Co.	" & rep brk.	L. I.
Farmingdale	M. Myers	C	"

QUEENS

Cold Spring Harbor	Dr Oliver Jones	C	N. Y. C. & S. I
Oyster Bay	Dunn, Dolan & Co	"	"
Cold Spring	W. Hammond	"	"
East Williston	W. & J. Post	"	L. I. & N. Y. C

WESTCHESTER

Croton Landing	Anchor Brick Co.	C	N. Y. C.
	Croton Brick Co	C & F	"
	W. A Underhill Brick Co	"	"
Crugers	W. H. Fisher	C	"
	C. Carman	"	"
Montrose	Lynch & King	"	"
	O. & C. Frost	"	"
	Montrose Brick Co.	"	"
	C. Hyatt	"	"
	J. Morton	"	"
Verplank	King & Lynch	"	"
	A. Fisher.	"	"
	T. N. Avery	"	"
	B. J. McGuire	"	"
	J. Morton	C. & F.	"
	S. Travers	C	"
	McConnell & O'Brien	"	"
Peekskill	Cole & Bonner	"	"
	Oldfield Bros.	"	"
	Bonner Brick Co.	"	"

ROCKLAND

Haverstraw	H. Cristie	C	N. Y. C., few to N. J.
	J. Felter	"	N. Y. C.
	P. Lynch	"	"
	Shankey, Kelly & Renn	"	"
	Denton, Fowler & Son	"	"
	Excelsior Brick Co.	"	"
	F. Frederick	"	"
	A. Donnelly & Son	"	"
	F. McGuire & Sons	"	"
	Murray & Morrissey	"	"
	G. I. Sherwood	"	"
	G. Archer	"	"
	Snedeker Bros	"	"
	C. D. & G. Archer	"	N. Y. C., N. J. & N. Eng.
	B. J. Allison & Co	"	N. Y. C.
	Allison, Wood, Keenan & Co.	"	"
	Wood & Keenan	"	"
	Bennett, Rowan & Scott	"	"
	owler & Washburn	"	"
	Diamond Brick Co	F. & C.	"
	Kelly & Byrnes	C	"
	T. C McGuire	"	"
	M. F. & L. F. Washburn	"	"
	Carr & Smith	"	"

MANUFACTURERS.

D. T. = Drain tile;
C. Y. = Covered yard;
Cl. = Clamp;
D. M. = Dry Clay machine;
C. = Common brick;
S. P. = Sewer pipe;
T. = Terra-cotta;
R. T. = Roofing tile.

COUNTY

Machine used	System of drying	Kind of kilns	Fuel	Remarks
S. M.	O. Y.	S. K.	Wood	
"	"	"	"	
"	P.	"	"	
"	O. Y.	"	"	
"	"	"	"	
S. M. & W. C.	Steam	Wingard K.	Coal	
"	P. Y.			

COUNTY

S. M. & W. C.	O. Y.	S. K.	Wood
"	"	"	"
"	"	"	"
"	O. & P. Y.	"	"

COUNTY

S. M. & W. C.	C. Y.	Cl.	Coal
"	P. & O. Y.	S. K.	Wood
"	C. Y.	Cl.	Coal & wood
S. M.	O. Y.	S. K.	Wood
"	"	"	"
"	"	"	"
"	C. Y.	"	"
"	P. Y.	"	"
"	O. Y.	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	C. Y.	"	"
"	O. Y.	"	"
"	"	"	"
"	"	"	"
"	"	"	"

COUNTY

S. M.	O. Y.	S. K.	Wood
"	"	"	"
"	"	"	"
"	"	"	"
"	C. Y.	"	"
"	"	"	"
"	O. Y.	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	C. Y.	"	"
"	P. Y.	"	"
"	O. Y.	"	"
"	Hot air tun	"	"
"	O. Y.	"	"
"	"	"	"
"	"	"	"
"	"	"	"

ROCKLAND

Post-office	MANUFACTURER	Product	Market
Haverstraw	Morrissey & Co.	C	N. Y. C.
	P. Brophy	"	"
	Dolan, Dunn & Butler	"	"
	T. & C. Peck	"	"
	T. Malley	"	"
	P. Goldrick	"	"
	T. & G. Peck & Co.	"	N. Y. C. & N. J.
	Buckley & Carroll	"	N. Y. C.
	T. Clark	"	"
	J. Brennan	"	"
	P. Ohler	"	"
	D. Fowler Jr. & Washburn	"	"
	J. Shankey & Son	"	"
Stony Point	C. A. Marks	"	"
	Riley & Clark	"	N. Y. C. ⅔
	Riley & Rose	"	"
	Allison, Wood & Allison	"	N. Y. C.
Thiells	Felter & Mather	"	Patterson & Passaic

ORANGE

Cornwall	C. A. & A. P. Hedges	C	N. Y. C. & N. Y., O. & W.
New Windsor	J. A. Whitbeck	"	Newburgh
	E. Lang	"	N. Y. C.
	J. T. Moore	"	"
	Q. Davidson's Sons	"	"
	Moore & Lahey	"	"
	D. Carson	"	"
Goshen	P. Hayne	C. D. T	Vicinity
Florida	W. H. Vernon	C	"
Roseton	Rose & Co.	"	N. Y. C.
	J. J. Jova	"	"

DUTCHESS

Storm King	Mosher Bros.	C	N. Y. C.
Dutchess Junct	T. Timoney	"	"
	L. Van Buren	"	"
	Covert Bros	"	"
	Aldridge Bros. & Co	"	"
	Barnacue & Dow	"	"
	Carman & Denton	"	"
	W. D. Budd	"	N. Y. C. & Ct.
Fishkill	Denning Pt. Brick Co	"	N. Y. C.
	Harris & Gidley	"	"
	W. H. Aldridge	"	"
	J. P. Sherman	"	"
	O'Brien, McConnel & Vahey	"	"
	Brockway Brick Co	"	"
	Lahey Bros	"	"
	Dinan & Butler	"	"
Low Point	J. V. Meade	"	"
	C. E. Griggs & Co	"	"
Arlington	Flagler & Allen	"	Local
Amenia	Amenia Brick Co.	"	Harlem R. R.

COLUMBIA

Hudson	J. Fitzgerald's Sons	C	N. Y. C.
	Arkison Bros.	"	"
	W. E. Bartlett	"	"

RENSSELAER

Stockport	Walsh Bros.	C	N. Y. C.
Stuyvesant	E. Brousseau	"	"
Greenbush	Mrs. T. Rigney	"	Albany & N. Y. C.
Troy	A. Ferguson	"	Vicinity
Lansingburg	T. Morissey	"	
Hoosick Falls	J. Dolin	"	

ULSTER

Port Ewen	S. D. Coykendall	C	N. Y. C.
	J. Kline	"	"
East Kingston	W. Hutton	"	N. Y. C. & local
	Terry Bros	"	"

COUNTY — *(Continued)*

Machine used	System of drying	Kind of kilns	Fuel	Remarks
S. M	O. Y	S. K	Wood	
"	"	"	"	
"	"	"	"	
"	P. Y	"	"	
"	O. Y	Cl	"	
"	"	"	"	
"	"	"	"	
"	"	"	"	
"	"	"	"	
"	"	"	"	
"	"	"	"	
"	"	"	"	
"	"	"	"	
"	"	"	"	
"	"	"	"	
"	"	"	"	
"	C. Y	S. K	"	
"	O. Y	"	"	
"	"	"	"	

COUNTY

S. M	O. Y	S. K	Wood	
"	"	"	"	
"	"	"	"	
"	"	"	"	
"	C. Y	"	"	
"	O. Y	"	"	
"	C. Y	"	"	
S. M. & W. C	O. Y	"	"	2½
"	"	"	"	1
S. M	"	"	"	
"	"	"	"	

COUNTY

S. M	O. Y	S. K	Wood	
"	"	"	"	1500 ft.
"	"	"	"	40 A. land
"	"	"	"	450 ft. front
"	"	"	"	250 " "
"	"	"	"	800 " "
"	"	"	"	700 " "
"	"	"	"	
"	"	"	"	26 A. land
"	"	"	"	18 A.
"	"	"	"	300 ft. front
"	"	"	"	" "
"	"	"	"	500 " "
"	P. Y	"	"	1200 " "
"	O. Y	"	"	650 " "
"	P. Y	"	"	475 " "
"	O. Y	"	"	
"	"	"	"	100 A.
"	"	"	"	Horsepower
"	"	"	"	4

COUNTY

S. M	O. Y	S. K	Wood	12 A.
"	"	"	"	
"	"	"	"	

COUNTY

S. M	O. Y	S. K	Wood	
"	"	"	"	2½ A.
"	"	"	"	H. P. 1½ A.
"	"	"	"	6 A.

COUNTY

S. M	O. Y	S. K	Oil	
"	"	"	Coal	
"	"	"	Wood	
"	"	"	"	

ULSTER

Post-office	MANUFACTURER	Product	Market
East Kingston	R. Maine & Co	C	N. Y. C
	A. S. Staples	"	"
	C. A. Schultz	"	"
	Brigham Bros	"	"
	D S Manchester	"	"
	Streeter & Hendrix	"	"
	D. C. Overbaugh	"	"
	A Rose & Co	"	"
	C H. Littlefield	"	"
Glasco	U. F. & J. T. Washburn	"	"
	T. Porter	"	"
	F. N. Van Dusen	"	"
	Washburn Bros	"	N. Y. & J. C.
Malden	Cooney & Farrell	"	N. Y. C.
Smith's Dock	T. Brousseau	"	"

GREENE

Catskill	A. McClean	C	N. Y. C.
	Ferier & Golden	"	"
	Derbyshire Brick Co.	"	"
Athens	W. Ryder	"	"
	J. R. Porter	"	"
Coxsackie	F. W. Noble	"	"

ALBANY

Coeyman's Landing	Corwin & Cullough	C	N. Y. C.
	M. J. Sutton & Co.	"	"
	J. A. Brower.	"	"
	H. Slingerland	"	"
	S. K. Brower	"	"
	Sutton & Suderly	"	"
Albany	T. McCarthy	"	Albany
	M. H Bender	C., F., D. T.	"
	J. Babcock	C	"
	E Smith	"	"
	D. H. Stanwix	"	"
	J. C. Moore	C. & F.	"
Cohoes	J. Baeby	C	V

SCHENECTADY

Crescent	Newton Bros.	C	
Niskayuna	J. E. Winne	"	Schenectady

SARATOGA

Mechanicsville	Mechanicsville Brick Co.	C	Neighboring towns...
Saratoga	C. L. Williams	"	"

WARREN

Glens Falls	Glens F. Br. & Terra Cotta Co.	C., F., T.	N. Y. State

WASHINGTON

Mid. Granville	J. H. Pepper	C	

CLINTON

Plattsburg	J. Ouimet	C	Local
	C. Vaughn	"	"
	Gilliland & Day	"	"

FULTON

Gloversville	Wm. Stoutner	C	Local

MONTGOMERY

St Johnsville	J. Smith, J. McDuffie	C	Local
Fonda			
Amsterdam			

HERKIMER

Herkimer	J. J. Mabbett		
Ilion	S. E. Coe	C	Local

COUNTY — *(Continued)*

Machine used	System of drying	Type of kiln	Fuel	Remarks
S. M.	O. Y.	S. K.	Wood	5 A. land
"	"	"	"	
"	"	"	"	A few go to N. J.
"	"	"	"	
"	"	"	"	
"	P. Y.	"	Coal	
"	"	"	Wood	
"	"	"	"	12 A. land
"	O. Y.	"	"	Staated in '91
"	"	"	"	60 A. land
"	"	"	"	Staated in '91
"	"	"	Coal	
"	O. Y. & P. Y.	"	Wood	150 A. land
"	O. Y.	"	"	Staated in '91
"	"	"	"	

COUNTY

S. M.	O. Y.	S. K.	Wood	12½ A. land
"	"	"	"	
"	O. Y. & C. Y.	"	"	
"	O. Y.	"	"	
"	"	"	"	
"	"	"	"	

COUNTY

S. M.	O. Y.	S. K.	Wood	
"	"	"	"	
"	"	"	Coal	
"	"	"	"	
"	"	"	"	
"	"	"	"	
S. M.	"	"	Wood	4 A. land
S. M. & W. C.	"	S. K., D. K.	Wood & coal	2 A. land
S. M.	"	S. K.	Wood	1½ A. land
"	"	"	"	2 A. land
"	"	"	"	1½ A. land
"	"	"	"	4 A. land
"	"	"	"	

COUNTY

S. M.	O. Y.	S. K.	Wood	
"	"	"	"	

COUNTY

S. M.	P. Y.	S. K.	Wood	
"	"	"	"	

COUNTY

S. M., D. P.	T. D.	Cl., C. K.	Coal	

COUNTY

COUNTY

S. M.	O. Y.	S. K.	Wood	
"	"	"	"	
"	"	"	"	

COUNTY

S. M.	O. Y.	S. K.	Wood	

COUNTY

"	"	"	"	

COUNTY

ONEIDA

Post-office	MANUFACTURER	Product	Market
Sangerfield		C	
South Trenton	H. L. Garrett	"	
Utica	F. Borck	"	
Rome	W. W. Parry	C., F.	

MADISON

Chittenango	Central N. Y. Drain Tile Co.	D. T	
South Bay	C. Stephens	C	

ONONDAGA

Syracuse	Onon. Vit. Brick Co	C., P	N. Y.
	N. Y. Paving Brick Co.	P	"
	F. H. Kennedy	C	Syracuse
	Preston Bros.	"	"
	T. Nolan	"	"
	C. L. Merrick	"	"
	J. Brophy	"	"
Baldwinsville	Seneca River Brick Co.	F	"
Camillus			

CAYUGA

Auburn	J. Harvey	C	
Owasco	A. Lester	"	

MONROE

Rochester	Roch. Brick & Tile Mfr. Co.	C	Local
	German Brick & Tile Mfr. Co	"	"
	Rochester Sewer Pipe Works,		
Maplewood	Robe t Gay	"	"
Clarkson	J. Sieg er	C., D. T	

NIAGARA

Lockport	A. Mosell	C	Local
Niagara Falls	R. P. Slater	"	"
La Salle	Tompkins & Smith	"	"

ERIE

Tonawanda	M. Riesterer	C	Vicinity
Buffalo	has. Berrick & Sons	"	"
	Brush Bros.	"	"
	H. Dietschler & Son	"	"
	F. Haake.	"	"
	L. Kirkover	"	"
	Schusler & Co.	"	"
	C W. Schmidt	"	"
	Adams Brk. & Ter. Cot Co.	C, F., D. T.	"
Black Rock	Black Rock Sewer Pipe Co.	Sewer pipe	
Lancaster	Lancaster Brick Co	C	Buffalo & vicinity
	Buffalo Star Brick Co	"	"
Angola	John Lyth & Sons	S. P., H. B., D. T.	N. Y. State
Evans	Wm. Bolton	C	Local
Jewettville	Brush & Smith	F. & C	

CHAUTAUQUA

Dunkirk	Wm. Hilton	F. & C	Local
Jamestown	J. E. McCusker & Son	F, C, D. T, H. B	"
	C. A. Morley	C	"

CATTARAUGUS

Randolph	J. Turner	C	Local

GENESEE

East Bethany	B. F. Peck	D. T.	Local

COUNTY

Machine used	System of drying	Type of kiln	Fuel	Remarks
S. M., W. C		S. K		

COUNTY

COUNTY

W. C	T. D	D. K	Coal
S. M	"	"	"
"	O. Y	S. K	Wood
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
D. M,		D. K	Coal

COUNTY

COUNTY

S. M	O. Y	S. K	
"	"	"	
"	"	"	

COUNTY

S. M	O. Y	S. K	
"	"	"	
"	"	"	

COUNTY

S. M	O Y	C	Coal
"	P. Y	S. K	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
"	"	"	"
S. M., D. M., W. C	1 P. Y	O. K. & S. K	"
S. M	P. Y	S. K	Wood
"	"	"	"
	Drying rooms	Cupola Kilns	Coal
"	O Y	S. K	Wood
D. M	T. D	S. K, D. K	Coal

COUNTY

S. M	B. Y	S. K	Coal
S. M., W C	P. Y	S K, D. K	Coal & wood
S. M	"	S. K	Wood

COUNTY

COUNTY

W. C

ALLEGANY

Post-office	MANUFACTURER	Product	Market
Alfred	Rock Cut Clay Co	F	
Alfred Centre	Celadon Terra Cotta Co	T. & R. T.	All over

STEUBEN

Hornellsville	Hornellsville Brick Co	P. & C	N. Y. State
	W. H. Signor	C	Local
Corning	Corning Brick Co	C. & T. C.	"

ONTARIO

Canandaigua	Burke & Meade	F	Local
Allen's Hill	B. G. Abbey	C	
Geneva	Torry Park Land Co	"	

CHEMUNG

Horseheads	R. G. Eisenhardt	C	
Breesport	Empire State Brick Co	"	Local
	P. M. C. Townsend	"	"
	Locy Bros.	"	"

TOMPKINS

Newfield	T. B. Campbell	F	Local

TIOGA

Spencer	W. H. Bostwick	C	Local

CORTLAND

Homer	Horace Hall	C	

BROOME

Binghamton	Ogden Brick Co	C	Local
	Wells & Brigham	"	"

OTSEGO

Oneonta	Crandall & Marble	C	Local
	J. Denton & Son	"	

OSWEGO

Oswego Falls	W. D. Edgarton	C. & F.	Local

JEFFERSON

Carthage	Wrape & Peck		
Watertown	Watertown Brick Co	C	Local

ST. LAWRENCE

Ogdensburg	Paige Bros	C	Local
Madrid	Robert Watson	"	"
Raymondville	Coats Bros	"	"

COUNTY

Machine used	System of drying	Kind of kiln	Fuel	Remarks
D. M.		D. K.	Coal	
Tile machine	Hot rooms	D. K.	"	

COUNTY

W. C.	Tunnel D.	D. K.	Coal	
W. C. & S. M.	O. Y.	S. K.	Wood	
S. M.	T. D.	S. K.	"	

COUNTY

D. M.		S. K. & D. K.	Oil	

COUNTY

S. M.	T. D.	S. K.	Wood	
"	O. Y.	"	"	
"	T. D.	"	"	

COUNTY

W. C.	T. D.	Cl. & S. K.	Coal	

COUNTY

S. M.	P. Y.	Cl	Coal	

COUNTY

COUNTY

S. M.	T. D.	S. K.	Wood	
"	P. Y.	"	"	

COUNTY

COUNTY

S. M.	O. Y.	S. K.	Wood	

COUNTY

S. M.	P. Y.	S. K.	Wood	

COUNTY

S. M.	O. Y.	S. K.	Wood	
"	"	"	"	
"	"	"	"	

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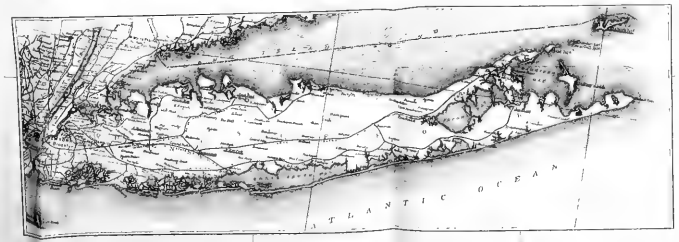
MAP
OF THE
STATE OF NEW YORK
SHOWING THE
LOCATION OF CLAY DEPOSITS
AND
MANUFACTORIES
BY
HEINRICH RIES
1893

Scale of Miles
0 5 10 15 20 25 30 35

Clay deposits only
Clay deposits and manufactories
Refractory Clays



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