CIHM
Microfiche
Series
(Monographs)

ICMH
Collection de
microfiches
(monographies)

Canadian Institute for Historical Microreproductions / Institut canadien de microreproductions historiques

Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming are checked below.

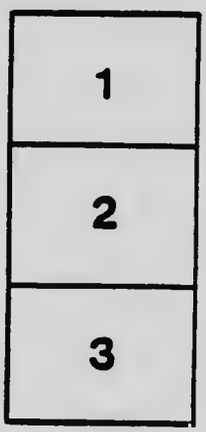
- [x] Coloured covers / Couverture de couleur
- [ ] Covers damaged / Couverture endommagée
- [ ] Covers restored and/or laminated / Couverture restaurée et/ou pelliculée
- [ ] Cover title missing / Le titre de couverture manque
- [ ] Coloured maps / Cartes géographiques en couleur
- [ ] Coloured ink (i.e. other than blue or black) / Encre de couleur (i.e. autre que bleue ou noire)
- [ ] Coloured plates and/or illustrations / Planches et/ou illustrations en couleur
- [ ] Bound with other material / Relié avec d'autres documents
- [ ] Only edition available / Seule édition disponible
- [ ] Tight binding may cause shadows or distortion along interior margin / La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure.
- [ ] Blank leaves added during restorations may appear within the text. Whenever possible, these have been omitted from filming / Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.
- [ ] Additional comments / Commentaires supplémentaires:

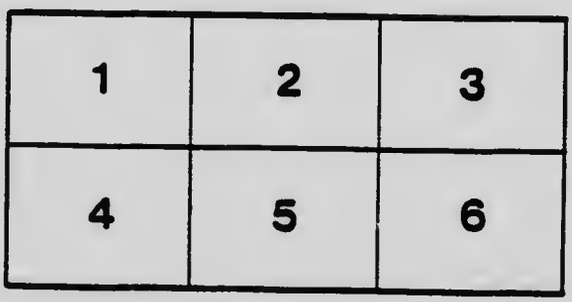
L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- [ ] Coloured pages / Pages de couleur
- [ ] Pages damaged / Pages endommagées
- [ ] Pages restored and/or laminated / Pages restaurées et/ou pelliculées
- [x] Pages discoloured, stained or foxed / Pages décolorées, tachetées ou piquées
- [ ] Pages detached / Pages détachées
- [x] Showthrough / Transparence
- [ ] Quality of print varies / Qualité inégale de l'impression
- [ ] Includes supplementary material / Comprend du matériel supplémentaire
- [ ] Pages wholly or partially obscured by errata slips, tissues, etc., have been refilmed to ensure the best possible image / Les pages totalement ou partiellement obscurcies par un feuillet d'errata, une pelure, etc., ont été filmées à nouveau de façon à obtenir la meilleure image possible.
- [ ] Opposing pages with varying colouration or discolourations are filmed twice to ensure the best possible image / Les pages s'opposant ayant des colorations variables ou des décolorations sont filmées deux fois afin d'obtenir la meilleure image possible.

This item is filmed at the reduction ratio checked below / Ce document est filmé au taux de réduction indiqué ci-dessous.

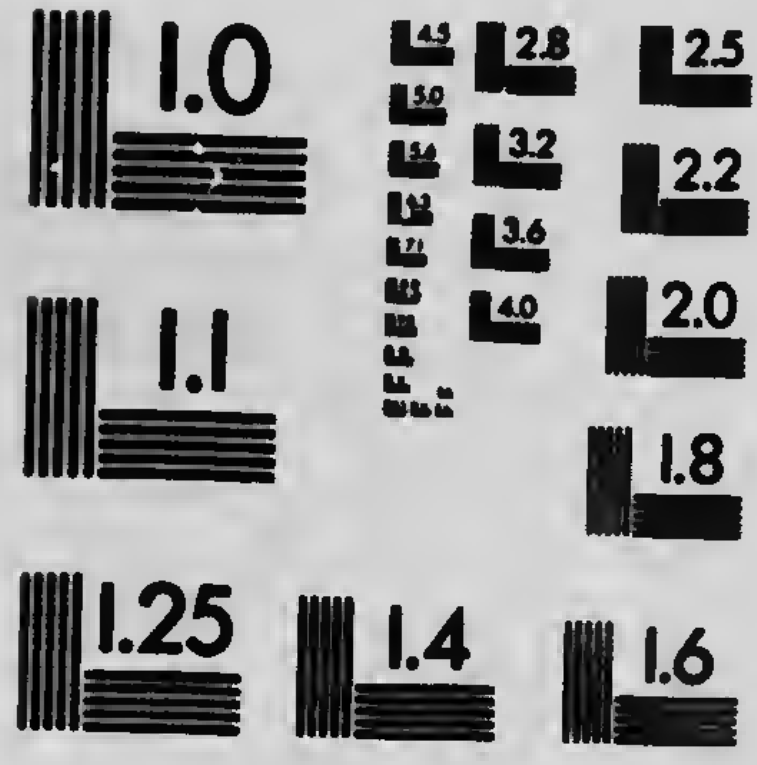
10x	12x	14x	16x	18x	20x	22x	24x	26x	28x	30x	32x
								/			





MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

1653 East Main Street
Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
(716) 288 - 5989 - Fax

REPORT OF

THE BUREAU OF MINES

1906

VOL. XV. PART II

THOS. W. GIBSON, Director

4th copy

Clay and the Clay Industry of Ontario

BY

M. B. BAKER

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO:
Printed and Published by L. K. CAMERON, Printer to the King's Most Excellent Majesty
1906

REPORT OF

THE BUREAU OF MINES

1906

VOL. XV. PART II

THOS. W. GIBSON, Director

Clay and the Clay Industry of Ontario

BY

M. B. BAKER

PRINTED BY OR[illegible]E LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO:
Printed and Published by L. K. CAMERON, Printer to the King's Most Excellent Majesty
1906

WARWICK BRO'S & RUTTER, Limited, Printers
TORONTO

CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS.—*Continued.*

PREFACE.

The more stable but more prosaic mineral industries of a country are apt to be somewhat neglected for those which appeal more strongly to men's imagination or cupidity. The clay working industry, which next to agriculture can be called the most ancient of industries, has up to the present been almost ignored by scientific workers, although during late years in Germany, the United States and in other countries, it has been receiving more attention. Several of the States of the American union, and other countries now have departments devoted to the study of clay and its products. In Ontario the clay industry has grown rapidly during recent years. Brick, which is cheaper than stone, is being used in modern cities in place of wood for fire protection purposes. As years go on the clay industry must become proportionately more important. It is well, therefore, at this time, for Ontario to have a systematic report such as that of Mr. Baker on "Clay and the Clay Industry."

In Part I. of bis report Mr. Baker gives, in 41 pages, an account of the character, origin and modes of occurrence of clay, written in such a way as to be understood, it is believed, by persons who have had little technical training. His age classification of claya will doubtless be found very useful by manufacturers, as well as possessing an educational value from the side of culture. Every worker'a interests will be widened and his mental attainments broadened by his understanding something of the origin and relationships of the materials with which he is dealing. There is nothing in Mr. Baker's report treating of the relationships of the various shales and clays—Erie, Red Top, Leda and Saugeen—with which every clay worker in the Province has something to do, that cannot be understood by almost any one who can read English. Manufacturing difficulties will thus be avoided, and a scientific knowledge will be gained which cannot be estimated in mere dollars and cents.

Tho 15 pages of Part II. are devoted to the Manufacture of Clay Products. Methods of manufacture are described, and practical hints are given for overcoming difficulties which are met with almost daily in manufacturing.

In Part III., pages 56-112, typical shale and clay working plants are described under the heading of counties, which follow one another in alphabetical order This part of the report will be of local interest. The clay worker who desires to gain a knowledge of the modes of occurrence of his material will have descriptions of similar occurrences in his own county with which to compare it.

Pages 112-120 deal briefly with various industries in which clay is used as part of tho raw materials.

Tbe seventy-one illustrations in the report have been carefully selected to illustrate typical occurrences of clay and shale, to throw light on the modes of occurrence of these materials, and to represent various machines and plants used in the clay industry in the Province.

Mr. Baker's labors in connection with the industry have not only been of value in tbe preparation of this report, but he has done work, which has been highly commended by clay workers in various parts of the Province, in giving practical advice in his visits to many plants.

Three or four years ago the clay workers, first of Ontario, and now of the whole Dominion, organized a society known as the "Canadian Clay Products Manufacturers," which holds an annual meeting—the last two being at Waterloo and Hamilton respectively—at which papers are read and discussions held on various topics connected with the industry. These meetings have proved very valuable, and every clay worker of the Province should join the rapidly growing membership of the society.

The statistics of the clay industry show more clearly the relative importance of clay among mineral products. In this Province the manufactures from clay have till recently represented nearly 20 per cent. of the output of our total mineral industry. In the United States clay products form nearly 10 per cent. of the very large mineral output. Moreover, it should be remembered that a high percentage of the receipts from the clay industry are expended on labor and supplies. From this point of view no mineral industry can be claimed to benefit a community or a country more than that whose raw material is clay.

W. G. M.

CLAY AND THE CLAY INDUSTRY OF ONTARIO

BY M. B. BAKER

PART II.—CLAY, AND ITS MODE OF OCCURRENCE

In dealing with clay, it would probably be as well to have a clear understanding of the substance itself, before discussing its properties and uses. Almost everyone is sufficiently acquainted with clay to recognize the substance readily, but if asked for a definition of clay it is doubtful whether many could so define it that a stranger would recognize the substance on seeing it. To define clay specifically then, we would say, "Clay is an earthy material which when moistened becomes plastic, and can then be moulded or fashioned into any desirable shape; which shape is preserved intact upon drying. Furthermore, if heated to redness, or slightly above it, the substance fuses, and on cooling assumes a rock-like consistency." From this definition we see that clay has several essential qualities, and cannot well be confused with any other substance.

The above is a rather popular definition, and one easily understood by almost everyone. To define clay chemically, *i. e.*, taking note of its actual composition, we would say that clay is a hydrated silicate of aluminium, with the following formula, Al_2O_3, $3SiO_2$, $2H_2O$. It is a substance resulting from the decomposition of rocks containing silicates of aluminium, with alkalies, etc. Chief among these is the mineral feldspar, which is a silicate of aluminum with the alkalies, potassium or sodium or calcium, having in general the following chemical formula: K_2O, Al_2O_3, $6SiO_2$, Rain-water and percolating solutions in general, on meeting this mineral, dissolve the alkalies and carry them away in solution, leaving behind the silicate of aluminium, which has become hydrated during the change. This part being insoluble is left as a residue, and is a pure kaolin or "residual" clay. We can readily see that pure kaolin, or residual clay, is not very apt to be left undisturbed, but is almost sure to be transported mechanically by moving water, and finds a resting place in some hollow, e. g., a valley or lake. This is the normal method for the collection of clays.

We have seen above that clay is not usually left in the place at which it formed, but is transported or collected into beds by water. Sometimes, however, clays form in place and remain there; they are then properly called residual clays. When we remember that the weathering commences at the surface, and works gradually downward, we see that the surface has been suffering alteration for a longer period of time than the deeper portions, and so we expect to find, starting at the surface, first a layer of completely formed clay; below this a layer composed of a mixture of clay and partially decomposed rock fragments; below this again is a layer of comparatively fresh rock, which passes finally into the undecomposed rock proper.

The character of the clay will naturally vary with the character of the rock from which it is formed. If the parent rock be largely feldspar, with the composition as given above, the resulting kaolin should be white, or nearly so. If the parent rock contain free silica or quartz, then the resulting clay will contain considerable sand, and will be what is known as a "lean" clay; the pure clay being known as a "fat" or "strong" clay. If, again, the parent rock contains considerable iron, the resulting clay will contain iron, and will be a light yellow to brownish, or even a rich red, color, according to the percentage of iron present. All possible combinations of these may arise. Another point worth considering is the presence of lime in a clay. If the original rock contains limestone, or calcite, considerable of it will be left as grains, mixed with the clay, *i.e.*, particles of completely decomposed mineral, represented by

the clay, will be mixed with particles of undecomposed mineral, represented by the grains of limestone. The reason, then, why our clays are so variable in composition is apparent. It is because all varieties of chemical, as well as mechanical, impurities are present.

The Origin of Shale

We have seen that the most of our clay is a mechanical accumulation of little particles in the bottom of a drainage channel, or a lake. In time these accumulations become so thick, or other mechanical accumulations are piled on top of them by the same collecting process, until the lower-lying clay becomes pressed into a solid rock-like series of bands. This process continues until these sediments finally become compacted into a perfect rock, and this rock is known as shale. Shale differs from ordinary clay in this one respect only, that it has become pressed into a solid mass by natural agencies. If the shale be blasted and pulverized, it will be found to be in every way like the parent clay from which it was formed, and it can be used for all the purposes to which the clay could he put. Occasionally, however, associated with the pressure there has heen considerahle heat, so that the clay not only becomes pressed but also more or less baked or indurated. The resulting rock will now be a slate instead of a shale, and if pulverized will be found to have lost the properties of a clay, namely, plasticity, easy fusibility, etc.

Fig. 1. Rock surface striated by a glacier.

In Ontario, in fact in Canada, we find few, if any, beds of residual clay. At a time, prohably fifteen thousand years ago, a period of intense cold prevailed over the northern part of Canada, accompanied by immense snow-fall. This great accumulation of snow in the northern parts of the Dominion, soon pressed the lower parts into ice, and a series of ice-flows, or glaciers, passed southward over the country, extending roughly to ahout the 43rd parallel in the United States of America. Evidences of this are to be seen on all sides in our collections of sand, gravel, and boulder clay, which is a mixture of clay, sand and gravel, with many large smooth, round boulders of all sizes. A further evidence is to be seen in the smooth, polishd surfaces of our hare rocks. Needless to say, these immense ice-sheets scoured off and carried away

not only all the collections of clay, which had formed previously from the decomposed rocks, and were lying over the surface of the country, but ground off and carried away probably thousands of feet from the surface of the rocks themselves. For this reason, it is almost useless to look for residual clays in Ontario. The only places where such could be found would be in some decomposed vein, crevice, or other place which had been locally protected from the grinding action of the glaciers.

The only examples of uniform clay to he found in the Province, at least of economic importance, are our shale beds, the method of whose formation has been explained above. Shales of three distinct ages are worked in Ontario. All the pressed brick, decorative brick, terra-cotta, roofing tile and sewer pipe, made in the Province, are manufactured from ground shales. The shales used are the Hudson River shales about Toronto, Don, etc.; the Medina shales about Hamilton, Beamsville, Milton and Brampton; and the Devonian shales at Thedford.

Boulder and Lacustrine Clays

Of our ordinary clays, that most commonly distributed is the boulder clay, which, as we have seen, is of glacial age. Being a mechanical collection, simply scraped together by the glaciers, we must expect great variations in its composition. For

Fig. 2. Sclater's quarry, St. Mary's, Perth County. For lime burning only. Ten feet of clay and gravel overlying limestone.

example, we find it in one place quite clean, at another, and but shortly removed from the first, it is very sandy, or gravelly, or even filled with large, round boulders, but almost always containing such a large percentage of clayey material that the whole deposit is called a clay. In many places it is so free from sand, pebbles, or other mechanical

impurities that it presents a fat, clean clay, and it is in these places that it is used for the manufacture of brick and tile. The surprise is, that so much of the clay should be found so free from impurities. The series of analyses given below made from Erie clay, taken from all parts of the Province, show what a remarkable uniformity there is in this accumulation as a whole. (See table on page 14.)

This remarkable sameness in the clays of the Province would seem to indicate the presence of immense quantities of water, associated with the ice, because in most cases where sand or gravel is found with the clay, it is well sorted into distinct beds, and where large deposits of clay are found, many of which are from 70 to 120 feet thick, they are remarkably clean, only occasional stones being found scattered through them, which would appear to have dropped from pieces of floating ice, in melting.

There is still a third class of clay found in Ontario, namely, lacustrine clays, or clay, collected locally into hollows or lakes. These accumulations have taken place since glacial times. Such clays will naturally be re-sorted glacial clay in most cases, with possibly here and there a slight accumulation of clay formed from the decomposition of exposed rock surfaces. These clays will not be widespread, nor of great thickness, as the time since the glacial period is, from a geological standpoint, not a long one.

We have now shown that the clays of Ontario are of three great classes, according to their method of accumulation. Keeping this in mind, we may classify our Ontario clays as follows. In this classification, the shales as well as the clays are taken into consideration, as the shales are simply the clays of earlier times, pressed into a hardened or rock-like form, and as we have seen above, they require only to be blasted and pulverized to be in every respect true clays, and capable of being used extensively in the manufacture of clay products. The classification as given below is in descending order.

Age Classification of Ontario Clays

WESTERN ONTARIO.	EASTERN ONTARIO.
Post-glacial—Lacustrine.	Post-Glacial—Lacustrine.
Glacial .... Saugeen. / Upper Erie or Red Top. / Erie. / Boulder.	Glacial. Saugeen clay. / Upper Leda or Sadicava saud. / Leda. / Boulder.
Pre-Glacial Residual. / Underlying rocks including Hudson River, Medina, and Devonian shales.	Pre-Glacial. Residual. / Underlying rocks comprising chiefly limestones and igneous rocks, but no shales.

The above classification is based upon the time of the accumulation. Amongst the pre-glacial, we notice residual clays. These have been discussed above with the possibility of their occurrence in Ontario, and nothing further need be said here concerning them.

Composition of Ontario Shales

As to the shales of pre-glacial times, they play an important part in Ontario, for the manufacture of all the better classes of clay products. As mentioned already, the three shales used in Ontario are the Hudson River, Medina, and Devonian. The Hudson River shale is a red-burning shale with certain bands more highly calcareous, which burn to cream or buff-colored goods. These shales are worked exten-

sively about Toronto and the Don, and at Toronto Junction, in the manufacture of vitrified paving brick by the Ontario Paving Brick Company. The Medina shales are very abundant about Hamilton, Milton, and up the Credit Valley. They are a rich red color, so much so, that the surface of the ground, where these shales occur, is quite red or painty from the leaching of the iron from the shales. Needless to say, this Medina shale burns to a rich red color, although there are many bands of a blueish-gray shale in the Medina, which, if blasted and worked by themselves, yield an excellent buff-colored product. These shales are used in the manufacture of pressed brick,

Fig. 3. Shale bank, Milton Pressed Brick Co., Milton. Note lighter band of shale about half way down section, which burns to buff brick; also over-burden of boulder clay.

terra-cotta, etc., at Beamsville, Milton, Brampton and other places in the Credit Valley, and are also used at Hamilton, Swansea and Mimico in the manufacture of glazed sewer pipe.

The Devonian shale is worked at only one place at present in the Province, namely, at Thedford, Ontario. Here the shale is of a deep blue color, resembling very closely ordinary blue Erie clay. It is exposed on the surface by the removal of the overlying sandy Erie clay from 8 to 12 feet in thickness. The surface of the shale on exposure to the air, soon slakes sufficiently to be dug, and is used then like an ordinary clay

in the manufacture of brick and tile by the stiff-mud process. Scattered through this shale, and occurring abundantly in the overlying clay, are many fossils of Devonian age, including among others the following: Zaphrentis prolifica, Cystiphyllum, Heliophyllum, Crinoidea, Spirifera mucronata, Favosites, and many other typical Devonian fossils. The following are analyses of these various shales:—

ANALYSES OF WESTERN ONTARIO SHALES.

No. sample.	Silicia. per cent.	Alumina. per cent.	Ferric Oxide. per cent.	Lime. per cent.	Magnesia. per cent.	Soda. per cent.	Potash. per cent.	Sulphur trioxide. per cent.	Loss by heat. per cent.
9	54.96	19.15	6.68	4.02	2.71	.52	3.47	.63	8.48
15	66.82	11.68	6.58	.62	.90	.38	2.58	.59	8.85
18	59.84	17.78	6.20	2.48	3.11	1.25	2.73	.27	6.10
19	56.52	15.21	5.82	6.86	2.82	.56	3.59	.20	8.79
20	56.46	18.19	7.43	2.56	2.93	.63	3.54	.15	8.52
21	47.98	13.10	4.82	12.53	3.25	.78	3.39	.13	14.50
22	58.20	17.73	5.91	6.00	3.24	.46	3.40	.14	9.58
23	65.04	16.14	6.37	.80	2.17	.64	3.21	.12	5.98
24	55.90	18.46	6.60	3.82	2.65	.58	3.55	.31	8.74
36	50.40	15.21	4.11	10.13	4.60	1.95	2.59	.27	11.00
70	59.54	17.20	5.43	6.72	2.42	.50	1.60	.17	7.44
71	57.86	20.00	6.83	2.92	3.25	1.70	2.70	.....	5.74
72	43.38	10.96	4.56	18.00	3.33	1.30	2.12	.....	16.52
73	57.12	18.52	7.28	3.92	3.32	.40	3.06	.....	8.40
74	63.60	16.49	5.27	.99	2.40	1.04	1.30	.....	8.71

9.—Red burning Devonian shale which is allowed to slake on the surface, when it is dug and worked into brick and tile by the stiff-mud process, by Mr. Elliot, of Thedford, Ont.

15.—A shale probably of Hamilton age, occurring in Lambton county, and underlying Erie blue clay, No. 14, at Alvinston. The shale occurs in the bed of the river. It has never been worked, but would yield splendid red products.

18, 20.—Red-burning Medina shales, worked for brick by the Port Credit Brick Company, at Port Credit.

19.—Red-burning Medina shale worked for red pressed brick by the Brampton Pressed Brick Company, of Brampton.

21.—A bluish-gray shale, interbanded with the Medina shales and made into buff-colored pressed brick by the Milton Pressed Brick Company.

22.—Red-burning Medina shale, from the same deposit.

23.—Red-burning Medina shale, manufactured into glazed sewer pipe by the Toronto and Hamilton Sewer Pipe Company, of Hamilton. The shale is blasted and shipped by Grand Trunk from Waterdown, Ont.

24.—Red-burning Medina shale, which is allowed to slake and is then dug and used for the manufacture of red pressed brick, by George Crain, of Beamsville, Ont.

96.—Another sample of the Devonian shales from Thedford, Ont. This sample taken a little lower in the bank than No. 9 above, would probably burn buff-colored products.

70.—A red-burning shale-like clay blasted out and worked by Wagstaff, Webb, Logan and Price, Greenwood Ave., Toronto.

71.—Red-burning Hudson River shale used for manufacture of red pressed brick by the Don Valley Brick Company, Toronto.

72.—Buff-burning clay, with Hudson River formation, worked by the Don Valley Brick Company, Toronto.

73.—Red-burning Hudson River shale, used by the Toronto Fire Brick Company, Mimico, for manufacture of red pressed brick.

74.—Red-burning Hudson River shale, used by the Ontario Paving Brick Company at Toronto Junction, for the manufacture if vitrified paving brick.

We have now had a description of the pre-glacial clays and shales of Western Ontario. In Eastern Ontario all that was said regarding residual clays would apply equally well, but there are none of the shales mentioned above in this part of the Province, the underlying rocks being, for the most part, stratified limestones and sandstones of Cambrian and Ordovician age, together with igneous rocks of pre-Cambrian age. None of these are suitable for the manufacture of clay products.

Fig. 4. Bank of Medina shale worked by Toronto Pressed Brick Company, Milton. Note overburden of boulder clay.

The Province has been divided into these two parts, the Eastern and the Western, because there is a distinct difference between the clays found in these two sections. If a line be drawn roughly from the town of Prescott, on the St. Lawrence River, in a northwesterly direction through Perth, Ottawa, Arnprior, and on northerly, it will be found to divide the Province roughly into its two areas. In these two areas the clays, though contemporaneous in age, are distinctly different in composition and other characteristics. We shall discuss the western area first.

The Clays of Western Ontario.

Immediately overlying bed rock, it will be noted in the table above, that we have boulder clay, followed by Erie; Upper Erie, or what is called in this report, for reasons which will appear later, "Red-Top" clay; and all these are followed by Saugeen clay. All of these clays are glacial in origin. This term is not used to indicate that they were collected by the glacier, but rather that the accumulation took place at some time during the glacial period, some of the clays being formed directly by the glacier and collected by it, *e. g.*, the typical boulder clay; others from material ground up by the glacier, but collected in the presence of great quantities of water with masses of ice floating in it, *e. g.*, the cleaner parts of the Erie clay, where we have only scattered pebbles dropped into the clay by the melting of floating ice. Again, we have accumulations of clay practically free from stones or gravel, *i. e.*, beds of interstratified clay and sand, repeated many times, showing no doubt the flood and ebb of the water in the retreating or melting stages of the glacial period. Each of these will be discussed more fully.

The Boulder Clay

By boulder clay is meant those mixed accumulations of sand, gravel, clay, and mixed boulders, the whole mass containing a sufficient amount of clay or clay-like powdered rock, as to justify its being called a clay. These boulders, whether large or small, even to the fine gravel, represent the scoured, rounded fragments of rock carried by the glacier, and smoothed and polished by its action. The pebbles or boulders represent pieces of rock of every description. Many of them are fragments of limestone, from the adjacent limestone areas of the Province, but many others are pieces of igneous rock carried for unknown distances from the northern part of the country. In many cases the boulders, gravel, or coarse sand is considerably sorted and collected into patches or bands into the clay. Needless to say, this typical boulder clay is practically useless for the manufacture of clay products.

The Erie Clay

The Erie clay represents local deposits of the boulder clay, which are often so free from stones and gravel, and so largely made up of clay, that it can be used in the manufacture of clay products. At no place in the Province has this clay been found absolutely free from stones, but it is in many places sufficiently clear to them to be used in the manufacture of brick, tile, etc., the few pebbles which it does contain being removed by one of the processes mentioned in part two of this report.

The Erie clay is widespread in Ontario. In Geology of Canada, 1863, we find a note on the Erie clay, as follows: "The Erie clay, with few interruptions, runs along the north shore of Lake Erie from Long Point westward to the Detroit River, and appears to underlie the [illegible] country between this part of the lake and the main body of Lake Huron. It is again found at Owen Sound, and occurs along the Nottawasaga River, and along the shores of Lake Ontario, and as far east as Brockville." Even at that time the Erie clay had been sufficiently studied to show that it was of great extent in Ontario; but during the writer's examination of the clay deposits of the Province, he has found that the Erie clay is much more extensively distributed than was formerly believed. The Erie clay was found in every county west of the line mentioned above as extending from Prescott to Ottawa, showing that the whole of Western Ontario is covered by a mantle of Erie clay which varies in depth from 1 foot to 130 feet, and in many places is no doubt thicker still.

The Erie clay then, appears to be only the cleaner localized accumulations of the boulder clay, and was probably formed in the presence of much more water than was ashy-gray color when dry. It is highly calcareous, as will be seen by the group of the typical boulder clay. The Erie clay is of a deep blue color when wet, and of an analyses given on page 14, so much so that it effervesces freely when moistened with an acid of any kind. Some specimens, especially from the more westerly parts of the Province, contain as much as 30 per cent. of carbonate of lime. They are in reality an impure blue marl rather than a clay. Most of the Erie clays which are used

Fig. 5. Boulder clay at Thedford, resting on Devonian shale in place. (Hat and box are on one bed of shale). R. Elliott's yard.

in the manufacture of brick, do not exceed 18 per cent. carbonate of lime, but even this is sufficient to counteract the effects of as much as 6 per cent. of ferric oxide and cause the brick to burn to a white or buff color. All the white brick, white tile, hollow block, etc., made in Ontario, are from the Erie clay. It is usually found in deep banks of a stiff, tough nature, and is commonly known as "blue clay."

Almost everyone is familiar with this clay. It is not often seen on the surface, but in railroad cuttings, in the banks of rivers, and in almost every well, this stiff blue clay, or hard-pan, is readily recognized. When properly worked by the stiff-mud process, and even by the soft-mud process, it yields a good class of brick, but, as is

well known, most of our white brick do not retain their bright cream color for many years. This clay has been recently tried in the dry state in the manufacture of dry-press buff brick, by Mr. Keller, of the Stratford Brick, Tile & Lumber Company, and samples seen rec ntly by the writer were of excellent quality. Should this process be developed, Ontario would hold an enviable position as a brick producer.

One of the best exposures of Erie clay to be found in the Province, is at Goderich, in the banks of the Maitland River. During the past summer the Canadian Pacific Railway Company in constructing the Guelph-to-Goderich branch of their railway,

Fig. 6. Section of Erie blue clay overlaid by sand and gravel; exposed in cutting C. P. railway, Goderich.

built their line along the cliff of the Maitland, making a long sweep from the general level of the country down to the level of Lake Huron, in order to reach the docks. In so doing they used steam shovels to construct a bench on which to place their line, and in the west bank of the Maitland river, exposed a section of Erie clay, fully 120 feet in depth. The uniformity of this great bank of clay is astonishing. With the exception of a few feet at the top and a few feet at the bottom, which are more or less mixed with layers of sand and gravel, and even with boulders, the remainder of the bank is practically pure, stiff, blue Erie clay, with only a few small stones scattered here and there as if dropped from floating ice.

Splendid exposures of the Erie clay, reaching depths of 50 to 100 feet, are also seen in the banks of the Thames near Chatham, on the shores of Lake Erie, at Port

Dover, Port Stanley, and Port Talbot, in the cuts about the Don at Brantford, at Owen Sound, at Walkerton, and elsewhere, and the blue clay may be seen from 10 to 30 feet thick at almost any place.

It is often interstratified with bands of gray quicksand, which are frequently at such convenient distances apart, that the clay can be worked as a series of benches, the sand making a splendid floor to which to break.

Fig. 7. Bank of Erie blue clay 120 feet deep, in west bank Maitland river, Goderich.

Fig. 8. Close view of Erie clay bank, showing jointings and some laminations at base.

The Erie clay often shows vertical jointing, and in many places distinct lamination with small bands of gray quicksand, or even with thin streaks of gravel. There is no series of characteristics, which will apply everywhere to the Erie clay, and this fact has led so many clay-users to claim that their particular clay is different from all others. Any real differences depend upon the percentage of impurities such as sand, quicksand, gravel, etc. There are only two or three characteristics which are

constant; namely the blue color of the clay, its highly calcareous nature, and the presence in it of a greater or smaller proportion of stones, rounded and scratched owing to their glacial origin. In addition it always burns to white or buff-colored goods.

If we look at the analyses below, we will be impressed with the uniformity of composition of this Erie clay, and when we think of the method in which it has been accumulated, our surprise is that there is any similarity at all. All the variations claimed by different brick-makers are really small local differences, caused usually by variable proportions of sand in the clay. The presence of sand in a clay will modify the ease of working in almost every way, that is, it will make a difference in the digging, a difference in the amount of water required for tempering, a difference in the ease of pugging, a difference in the facility with which the clay passes through the machine, a difference in the rate and result of drying the brick, a difference in the rate and result of burning the brick, and a difference in the color, porosity, and strength of the brick itself. Consequently, even although we find considerable differences in the manipulation and ease of working in the various yards, the clay is nevertheless only the Erie blue clay, in one or other of its phases.

ANALYSES OF ERIE CLAY.

No. sample.	Silica. per cent.	Alumina. per cent.	Ferric oxide. per cent.	Lime. per cent.	Magnesia. per cent.	Soda. per cent.	Potash. per cent.	Sulphur trioxide. per cent.	Loss by heat. per cent.
3.....	40.16	13.76	5.88	15.74	3.78	.70	3.09	.17	17.48
3.....	45.46	9.78	3.08	15.00	5.08	.78	1.38	.12	17.37
5.....	44.30	11.21	4.05	16.10	3.81	.88	2.09	.38	17.76
6.....	38.40	8.82	3.94	17.32	5.88	.88	1.35	.15	21.46
8.....	37.72	10.72	3.81	16.90	7.05	.87	3.19	.18	21.76
11.....	38.94	12.10	4.88	17.56	4.17	.90	2.08	.52	18.62
12.....	50.20	12.06	5.14	11.46	2.68	1.35	3.12	.58	13.06
13.....	41.40	12.54	4.88	15.08	4.20	1.00	2.38	.08	17.65
14.....	39.92	12.06	4.67	18.56	3.72	.76	2.43	.38	18.32
17.....	40.14	15.04	4.56	14.80	4.97	.81	1.66	.06	18.51
25.....	37.50	10 81	3.80	22.56	3.61	1.11	2.34	.12	18.00
27.....	34.46	9.11	3.71	28.32	4.08	.80	1.76	.19	22.80
30.....	51.92	13.74	5.08	10.06	3.78	1.67	3.06	.19	11.84
31.....	51.90	8.80	3.70	13.68	3.82	1.64	2.27	.14	13.68
37.....	45.89	14.10	5.56	10.00	3.00	3.22	1.68	.18	13.94
38.....	51.06	15.58	4.78	10.00	4.47	3.42	2.08	.87	9.76
39.....	47.50	13.68	4.44	15.56	.80	2.22	1.80	.15	12.94
40.....	52.17	14.20	4.20	9.19	4.14	1.91	2.18	.18	10.08
41.....	68.22	14.06	5.21	11.06	.61	1.01	2.44	.80	11.67
42.....	46.35	15.10	6.18	11.32	4.18	1.35	2.70	.20	10.28

2. Erie, blue clay, underlying No. 1, for whose analysis see table on page 17. This blue clay is worked at Stratford for white brick and tile, and has recently been used by the Stratford Brick, Tile & Lumber Co., in the manufacture of buff-colored dry pressed brick. It yields a first-class sharp-edged brick.

3.—Sandy Erie clay, worked by F. Entricken for the manufacture of white brick and tile at the Little Lakes, three miles east of Stratford.

5.—Stiff Erie blue clay, worked by Bechtel Bros., of Waterloo, for the manufacture of wire-cut brick and tile.

6.—Sample of Erie blue clay taken from C.P.R. cut at Goderich. This clay here reaches a depth of 120 feet, and rests directly on glaciated limestone.

8.—Erie blue clay as found in the Crediton yards, and worked into white brick and tile. It is overlaid by a thin band of Red-Top clay, No. 7. (See table on page 17.) But this clay has never been recognised or worked.

11.—Erie blue clay, worked by James Irwin at Norwich.

12.—Sandy Erie blue clay, worked in two yards situated side by side at Orwell. Used chiefly in the manufacture of tile.

13.—Stiff Erie blue clay, manufactured into white brick and tile by the stiff-mud process, by H. Janes of Delaware.

14.—Stiff Erie blue clay about 70 feet deep overlying shale No. 15, (see table on page 8,) and manufactured into white wire-cut brick and tile at Alvinston.

17.—A mixture of yellowish brown Erie and typical blue Erie clay, as used by Bell Bros., at Paisley.

25.—Stiff Erie blue clay, yielding excellent white tile, and worked for brick and tile by the Beaverton Brick and Tile Company, at Beaverton.

27.—Erie blue clay, very highly calcareous, yielding a very white brick and tile, and used for the same at Picton.

30, 31.—Two samples of Erie blue clay, which are found underlying red top clay, No. 29, (see table on page 17,) and used for the manufacture of white brick, by Wiser & Son, Prescott.

37.—Sample of Erie blue clay as found on St. Joseph's island, yielding a buff-colored brick.

38, 42.—Samples of sandy, yellowish brown, upper Erie clay, as found underlying Red Top clay No. 48, (see table on page 17.) Used in the manufacture of white brick and tile by the soft-mud process, and he Kells machine respectively, by Thomas Henderson of Renfrew.

39.—Sandy Erie blue clay, overlaid by Red Top clay No. 57, (see table on page 17), and manufactured into white brick by the soft-mud process, by Curtis Bros., Peterborough.

40.—Blue clay, very sandy, and not very calcareous. Burns to buff-colored products, and worked by the Imperial Land Co., of Sturgeon Falls. A thin layer over Saugeen clay; therefore a lacrustine clay.

41.—Stiff blue Erie clay, not strongly calcareous, and found above sample No. 27, at Sullivan's yard, Picton. Note the difference in the percentage of lime, between this clay and No. 27 above, taken from the same bank, but No. 41, being at a higher horizon than No. 27, has lost considerable of its lime contents by the leaching action of percolating solutions.

The Upper Erie or Red-top Clay

The upper Erie, or what the writer has named the Red-Top clay, found in Ontario, is not a seperate formation. It represents simply a weathered zone on the top of the Erie clay. It has been given a distinct name, the Red-top, because it is an extremely important formation in Ontario. It was formerly thought that all the red brick, tile, etc., made in Ontario, were from the Saugeen clay, or from the shales as explained above. But this is not the case. Nine-tenths of the red brick made in the Province, are simply the product of the upper weathered band of the Erie blue clay. This weathering usually extends from one to three feet below the surface, rarely deeper than this.

The weathering extends to a very uneven line, in some places reaching 3 feet, while in others not over a foot. The deepest spots were along cracks or joints, or following roots of weeds, shrubs or trees. An idea of the irregularity of this weathering may be gathered from fig. 9. Here we see how irregular is the contact between this Red-top clay and the underlying Erie clay. This fact leads to a great deal of trouble for those brick makers using the Red-top clay, as they are constantly digging too deeply, thereby including some of the underlying blue clay, which causes the resulting brick to be spotted by inclusions of the white-burning clay.

From the analyses given below, it will be noticed that the lime is reduced from roughly 16 per cent. in the case of the Erie clays, to about 2 to 4 per cent. in the Red-top, while the percentage of iron remains about the same. The percentage of magnesia is also reduced, and the loss on ignition is also lessened from roughly 18 per cent. to about 5 per cent. All these are the result of the weathering of the original Erie clay.

We mentioned above that the Erie clay was highly calcareous, that is, it contains abundance of calcium carbonate. In burning this Erie clay, the calcium carbonate is broken up by heat, and carbon dioxide gas is given off, which accounts for the large percentage of loss by ignition. It is a well-known fact that calcinm carbonate is soluble in acids, however weak. Ordinary rain water existing as clonds, or when further

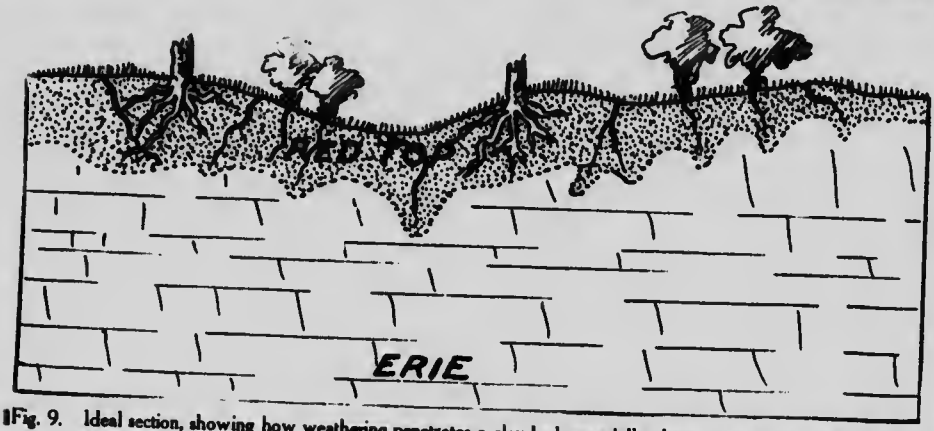


Fig. 9. Ideal section, showing how weathering penetrates a clay bed, especially along roots and cracks in the clay. This process has produced the Red-top clay from Erie blue clay.

condensed and falling as rain through the air, and further still by coming in contact with decomposing vegetation on the earth's surface, becomes more or less charged with carbon dioxide gas. The rain water thns becomes, in reality, a dilute solution of carbonic acid, and on meeting the Erie blue clay dissolves much of the calcium carbonate.

Fig. 10. Section of Erie clay bed, with Red-top clay above as the darker weathered top of the Erie, which in the cut is lighter colored.

carrying it away in solution. Thus we have the resulting weathered Red-top clay, much reduced in lime and magnesia and with a corresponding diminution in the amount of loss on ignition.

Iron oxides are almost insoluble in these dilute solutions, therefore the percentage of ferric oxide is left practically, unchanged. The result is, the iron which was present

in the blue clay is still present in the Red-top clay, and being no longer counteracted by the high percentage of lime, it is able to burn to the ferric state, thereby coloring the brick red.

In every place where the Erie blue clay is found in the Province, and exposed on the surface, a band of the Red-top clay of some thickness was found as the first mantle varying from a few inches to 3 or 4 feet, according to the ease with which the percolating solutions could attack the clay. And in every case upon digging through the Red-top clay, the underlying Erie clay was found. So invariable is this, that in almost every brickyard in the Province, both red and white goods are manufactured from the same clay bank, the red clay being dug off the top, from one to three spades deep, and worked by itself into red brick, tile, etc., after which the underlying Erie clay is dug, and worked by itself into white products.

In all other respects the Red-top clay corresponds to the Erie clay, *i.e.*, it is distributed throughout the Province, is in many places so stony as to be properly a boulder clay, while in many others it is like the Erie, almost free from stones. As already mentioned, the upper portions as well as the base of the Erie clay are usually a little more sandy, gravelly, and stony than the more central parts. We therefore find considerable of this Red-top clay quite stony, and a great deal of it is leaner, *i.e.*, more sandy, than the underlying stiff blue Erie clay. The following analyses of the Red-top clay will show how uniform it is throughout the Province, corresponding in this feature with the uniformity of the Erie clay.

ANALYSES OF RED TOP CLAY.

No. sample.	Silica. per cent.	Alumina. per cent.	Ferric Oxide. per cent.	Lime. per cent.	Magnesia. per cent.	Soda. per cent.	Potash. per cent.	Sulphur trioxide. per cent.	Loss by heat. per cent.
1	69.12	14.03	4.81	1.94	1.10	1.53	2.05	.10	4.80
4	67.10	15.30	4.80	1.63	1.59	.91	2.30	.16	5.44
7	63.56	16.91	6.24	1.91	2.42	.70	3.15	.28	5.64
10	65.06	14.15	4.67	2.36	2.18	1.48	2.66	.32	6 76
29	61.08	17.28	6.20	2.54	2.35	1.80	3.50	.16	5.19
43	59.48	17.48	7.38	2.60	3.32	1.74	2.96	.30	3.82
44	66.14	14.80	5.50	1.76	1.80	1.33	2.19	.25	6.56
45	63.28	17.20	6.26	2.82	1.60	1.85	3.14	.16	4.30
46	58.97	18.10	7.30	2.84	2.50	2.12	2.40	.14	5.90
47	57.88	18.64	7.20	2.86	1.95	1.46	3.22	.18	6.64
48	54.38	19.18	7.30	4.60	3.70	1.42	3.62	.12	5.60
49	55.34	19.80	7.62	2.18	2.39	1.93	3.74	.13	7.12
50	59.96	19.58	5.86	2 62	2.30	2.48	2.57	.23	5.00
51	61.78	16.03	6.16	3.37	2.28	1.95	2.38	.31	5.50
52	57.16	20.45	6.28	3.12	2.72	1.40	2.76	.17	5.00
53	56.18	19.40	6.69	2.88	1.94	1.32	3.76	.17	8.80
54	58.00	17.04	6.16	2.84	3.43	1.42	3.72	.13	5.52
55	57.18	16.38	7.36	2.76	3.91	2.34	3.21	.09	5.96
57	64.44	15.26	5.96	3.65	1.78	2.52	3.20	.21	2.92

1.—Clay from 1 to 3 feet deep overlying No. 2. (See table on page 14.) Worked for red brick at Stratford, Ont.

4.—Red-top clay, one and a half to three feet thick, dug at Stratford and shipped by Grand Trunk railway to Durham, for the manufacture of Portland Cement.

7.—Red-top clay, 6 inches to 2 feet in thickness, overlying Erie clay No. 8. (See table on page 14.) Will yield an excellent red brick if worked by itself. Sample taken from Mr. Kuhn's yard at Crediton.

10.—Red-top clay worked in the several yards making red brick at Conestogo.

29.—Red-top clay about 3 feet thick overlying No. 30 and 31 Erie blue clay (see table on page 14), at Prescott, Ont.

43, 44.—Samples of Red-top clay worked in Mouldy Bros. yard at Kingston.

45, 46.—Samples of Red-top clay, the first containing loam and worked for red brick in F. Lingham's yard, Belleville.

47, 51.—Samples of Red-top clay, the second containing loam, from Mr. Lawrence's yard, Tweed.

48, 49.—Red-top clay one to three feet thick, overlying Erie clays Nos. 38 and 42. (see table on page 14), and worked in Thomas Henderson's yard, Renfrew.

50.—Red-top clay, 3 feet thick, taken from Watson's yard, Orillia.

52, 53, 54.—Three samples of Red-top clay. The first a strong chisel clay, the last two ordinary brick clays, taken from Mr. Rollin's yard, Madoc.

55.—Sample of Red-top clay taken from a cut on the Bay of Quinte railway extension at Bridgewater.

57.—Red-top clay about 2 feet thick, overlying Erie blue clay, No. 39, (see table on page 14), and worked for red brick by Curtis Bros., Peterborough.

The Saugeen Clay

The latest of the glacial clays, or that named in our classification Saugeen, is a distinct and separate clay, readily distinguishable from the Erie and the Red-top.

Fig. 11. Saugeen clay along railway near the shore of Lake Temiskaming, between Haileybury and New Liskeard, Ont.

It is found in every case overlying the Erie clay, unconformably, and is usually separated from it by a layer of sand or gravel. In Geology of Canada, 1863, page 896, we find the following note: "Two divisions have already been indicated in the stratified clays of western Ontario, the lower of which was partially worn away before the deposition of the upper division, so that this rests unconformably upon it, adapting itself to the irregularities of the denuded surface. The latter is sometimes associated with beds of sand or gravel, a layer of which belonging to the upper division sometimes marks the contact with the underlying deposit."

"The upper division of these deposits which is largely developed and well-exposed along the Saugeen river, may be called the Saugeen clay. With the exception of a yellow band sometimes found at the top, it consists of thinly bedded brown calcareous clay, containing but few boulders or pebbles. The layers of clay seldom exceeding an inch in thickness are separated by thin partings of a drab or olive color. This

division is sometimes underlaid by beds of sand which separate it from the Erie clay; and in certain parts of its distribution it is also interstratified with sands and gravels."

From the above reference we see that this clay was known, and very accurately described nearly half a century ago. It is as mentioned above, a series of interstratified bands of a rich, reddish brown clay, with bands of gray or greenish gray sand, or shell marl. In some places the bands are only slightly calcareous, as at Walkerton, while at others the gray bands are almost entirely calcium carbonate, as for instance along the line of the Temiskaming and Northern Ontario railway, between Haileybury and New Liskeard.

Regarding this clay, W. G. Miller in the Report of the Bureau of Mines, 1905, Part II, page 26, says, "The soil is essentially a well-banded clay * * * * ort rops of solid rock in many cases representing hill tops which project through the clays, are seen. The clay does not constitute a continuous mantle, but there are large areas of tillable land, which have been rapidly settled. North of the height of land, a large agricultural area estimated at 16,000,000 acres, and known as the great Clay

Fig. 12. Finely laminated Saugeen clay, New Liskeard. Note the great number of bands of clay and sand.

Belt, exists, in which exposures of solid rock are few in number, and the clay on both sides of the height of land is pretty uniform in character. The percentage of lime and magnesia are rather high. This is owing to the alternate bands containing considerable marl. The clay effervesces strongly in acid." Analyses of this clay are given below, Nos. 59 and 65, page 26.

If a line be drawn roughly from lake Huron eastward through Walkerton, Hepworth, Paisley, Bracebridge, Pembroke, Ottawa, and Casselman, to the St. Lawrence river, it will be found to form roughly the southern boundary of the Saugeen clay area. The clay as described above is composed of a great number of alternate bands of "fat" clay, with bands of more or less calcareous sand. Each band of clay or sand is seldom over three-quarters of an inch in thickness, but the series is repeated so many times, that banks of Saugeen clay are seen varying from 8 to 20 feet in thickness, the whole presenting a very unique appearance. All the Saugeen clay seen in the Province lies north of the line mentioned above, and the farther north we go the more abundant

is this clay. In age the writer has placed it as dating from the close of the glacial period, for it appears to have been formed from the flow and ebb about the edge of the retreating or melting glacier, and each two bands, *i.e.*, a band of clay with a band of sand, together represent the accumulation for one season. During the summer or warmer months, the increased flow of water carried the clay farther out, and the sand would be deposited closer to the ice margin. In the winter or colder months, when the flow of water was lessened, a layer of clay would be deposited over the sand, and this was repeated year after year, for many years, as shown by the great number of bands in this accumulation. This process would be gradually carried back in a northerly direction as the ice-front slowly retreated, and in this way we find the deposits thicker and more widespread as we go north. The few stones found in this clay—and they are extremely scarce—would be caused by small pieces of floating ice, dropping imprisoned stones, upon melting.

Fig. 13. Saugeen clay. This illustration represents a closer view of a part of the clay bank shown in Fig. 11. The alternate lighter-colored layers are more or less marly.

Composition of the Saugeen Clay

We have mentioned above that the Saugeen clay varies considerably in its composition, more especially in its calcium content. In some places the gray bands which occur with the brown rich bands of clay, are shell marl, *i. e.*, calcium carbonate. In the railway cutting of the T. & N. O. railway between the towns of Haileyhury and Liskeard the clay beds are shown in figures 9 and 10; the gray bands are shell marl. In other places the gray hands are sand, for example, at Pembroke, Walkerton and Casselman. In others, again, the gray bands are a sandy clay, for example, at North Bay, New Liskeard, Sturgeon Falls and Sault Ste. Marie. These localities are cited because they are places where the clay is being worked; but local differences of sand contents are often seen in the same yard; for example, at Mr. Evans' yard at Sudbury and at Mr. Elliott's yard at Sault St. Marie. Here a decided difference in the character

of the clay is seen in fifty yards of the clay bank, so much so that it was necessary to change the plant because in the one place the clay was so strong that it could not be worked, the drying being very difficult. A change of only fifty yards to a much leaner part of the deposit yielded a clay which worked admirably in every part of tho process.

In places where the clay is marly, it is unsuitable for brick-making. The marl burns to lime and this affects the color of the brick, making them a light pink color. It also causes the brick to break up badly on exposure to heat. Where the gray bands are sand we have a combination which is most desirable. The brown clay of itself would be too strong to work, bnt the addition of the sand already mixed in the clay renders the whole so mild that it works admirably, and a deep Sangeen clay bank where the clay is interbanded with sand forms the best possible deposit for the manufactur. of red stock brick. Such clay tempers easily, shifts easily, dries readily, and burns witn little shrinkage, while the sand does not affect the color.

Where the gray bands, with the brown clay, are themselves a gray sandy clay, the percentage of sand is not quite sufficient to make the whole workable, such a deposit being so strong that it can only be mixed with great difficulty. Moreover, such strong clay is very difficnlt to shift and still more difficult to dry. This is a difficulty which many brick-makers in northern Ontario are experiencing. In drying tbe brick, they find that if exposed to direct sunlight or to wind the brick crack. This is becanse the clay is so strong that, having been wet in the making of the brick and now exposed to the air, it really slakes; or, in some cases, the outside of the brick dries so much more rapidly than the inside, on account of the density of the strong stiff clay, that a shell is formed aronnd the outside, so that when the inside of the brick finally dries and therefore shrinks it cracks this shell, or onter part of the brick. Two things would help this clay; first, it should be dug into heaps and allowed to slake thoroughly before making the brick; second, in tempering the clay it should be mixed with about 25 per cent. of clean sand. The character of the sand does not matter much so long as it is clean, that is free from organic impnrities and limestone.

The Saugeen clay belongs to the later glacial period. It rests unconformably on the Erie clay with a layer of sand forming the contact. There are a few exceptions to this rule, however. As we work northward from the sonthern boundary of the Saugeen clay belt, which was described above, we find that the Erie clay becomes shallower in depth until we reach North Bay on the C. P. R. main line, when in general we find that the Erie clay is almost entirely wanting, and the Saugeen clay rests immediately on top of the galciated surface of the rocks. In fact, the rocks form

Fig. 14.—Igneous rocks overlaid by clay and sand, and later cut by the Spanish River.

the greater part of the area with local collections of sand, or gravel, or Saugeen clay in the hollows. At North Bay tbe clay associated with red sand is found in a hollow extending from North Bay to Widdifield on the T. & N. O. railway. Passing northward we find no more clay to speak of till we reach tbe town of Haileybury. From here north the clay becomes more and more abundant and also quite strong in most places. Soon the Temiskaming outlier of great Clay Belt of New Ontario is reached, composed of Saugeen clay, and is estimated to cover roughly one million acres. For the most part this clay is strong, but it naturally has its sandy places or milder spots, as any other like area would have. Moreover in some cases in this northern part we find the

Saugeen clay again lying unconformably upon the Erie blue clay, as in the more southerly parts of the Province.

As we work westward from North Bay, clay is not at all abundant till we reach the vicinity of Massey on the Sault branch of the C. P. R. or Kenora on the main line. From Massey to Sault Ste. Marie clay becomes more and more abundant, until at the Sault itself good Saugeen clay is plentifully present. It is used here in the manufacture of stock brick, wire-cut brick and dried pressed brick. We notice, too, as we work westward from Massey that the clay becomes a rich red color, due to the high percentage of iron oxide which it contains. This iron has no doubt been received from the iron-bearing rocks in the northern part of this area.

A very interesting area of Saugeen clay is found between Webbwood and Massey on the Spanish river. The old glaciated igneous rocks are found on all sides as a bed or cradle in which was deposited a series of Saugeen clay and sand, and this was later cut by the Spanish river.

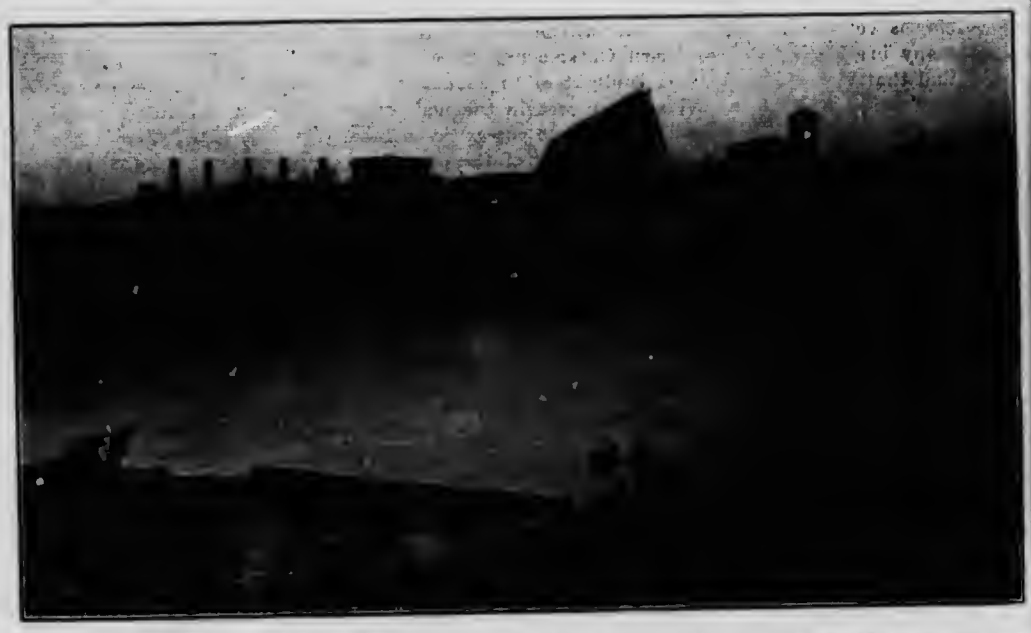


Fig. 15.—Large pulp mills of the Spanish River Pulp and Paper Company; also workmen's houses of red brick made from Saugeen clay, Espanola.

Starting at the surface we have a thickness of sand varying from 2 feet to 20 feet or more. This rests on a mild Saugeen clay, i. *e.*, the thin bands of dark clay are inter-laminated with bands of about equal thickness of sand. This mixture renders the whole about 50 per cent. or more of sand, making a very mild mixture. This mild clay is about 8 feet to 12 feet in thickness, and passes gradually into a very strong clay almost free from sand. This series extends as low as the level of the Spanish river, when sand and quick-sand are usually found at about water level.

A Bank at Webbwood

At Espanola on the Spanish river above Webbwood we find one of the best sections to be seen in this series. Here the Spanish River Pulp and Paper Company have erected an immense pulp mill and have built the plant and the workmen's houses of red brick, made from this Saugeen clay.

On the opposite bank of the Spanish river from the pulp mills, we find a section of clay and sand about 35 feet deep. It occurs in a hollow between two ridges of rock as shown in the accompanying cut. The first 5 feet from the water's edge is composed of sand and quick-sand, with a few glaciated boulders mixed through it. Above this we pass into strong Saugeen clay. It is inter-laminated with sand, hut the sand partings are very thin, so that the whole series of 10 feet or more is very strong clay. Towards the upper part of this strong helt the sand layers hecome thicker and thicker, until a belt is reached in which the percentage of sand is about right for a first-class mix for hrick-making. This belt is about 10 to 12 feet thick, and is ready to work into red hrick as it lies. The underlying strong clay mentioned ahove would require sand before it could be worked, as it is so strong that it could not be dried or hurned as it is. There is ahundance of sand on all sides to render this clay the proper temper.

Fig. 16.—Saugeen clay overlaid by sand. Note junction about half-way up the series. Exposed in banks of Spanish River at Espanola.

Above the mild clay the sand gets thicker and thicker, while the layers of clay get thinner till we pass into a series of 6 to 10 feet of very fine sandy clay or almost pure sand with only very thin partings of clay. Three analyses are given helow of this series.

Sample.	Silica. per cent.	Alumina. per cent	Ferric Oxide. per cent.	Lime. per cent.	Magnesia. per cent.	Soda. per cent.	Potash. per cent.	Loss. per cent.
No. 1.....	69.62	13.07	2.99	4.42	1.96	2.98	2.19	3.32
No. 2.....	59.50	15.30	5.26	6.15	3.11	2 82	2.50	6.16
No. 3.....	61.40	17.08	6.34	2.66	3.35	1.94	2.74	4.52

No. 1.—Is the sand or sandy clay forming the upper 6 to 8 feet of the section.
No. 2.—The mild, workable clay forming the middie beit of the section.
No. 3.—The strong clay forming the lower part of the section.

The upper sand or sandy clay would do to mix with the strong clay to render it mild enough to work. This sand, however, is rather fine in grain, and coarser grained sand would be preferable. Suitable sand can be had very conveniently on all sides of this deposit, particularly on the opposite bank of the river.

With a good railway siding, plenty of fuel, and plenty of power right at hand, this bank could no doubt be worked to advantage even if the surface sand had to be removed. All these things exist there at present, as the Pulp and Paper Company have developed 11,000 horse power from the high falls adjoining this property, and there is plenty of power going to waste still.

The deposit of clay at the Pulp and Paper Company's works is the thickest one seen yet in the Province, there being fully 25 feet of clay which is already fit for working into brick, etc., or easily made so by the addition of sand.

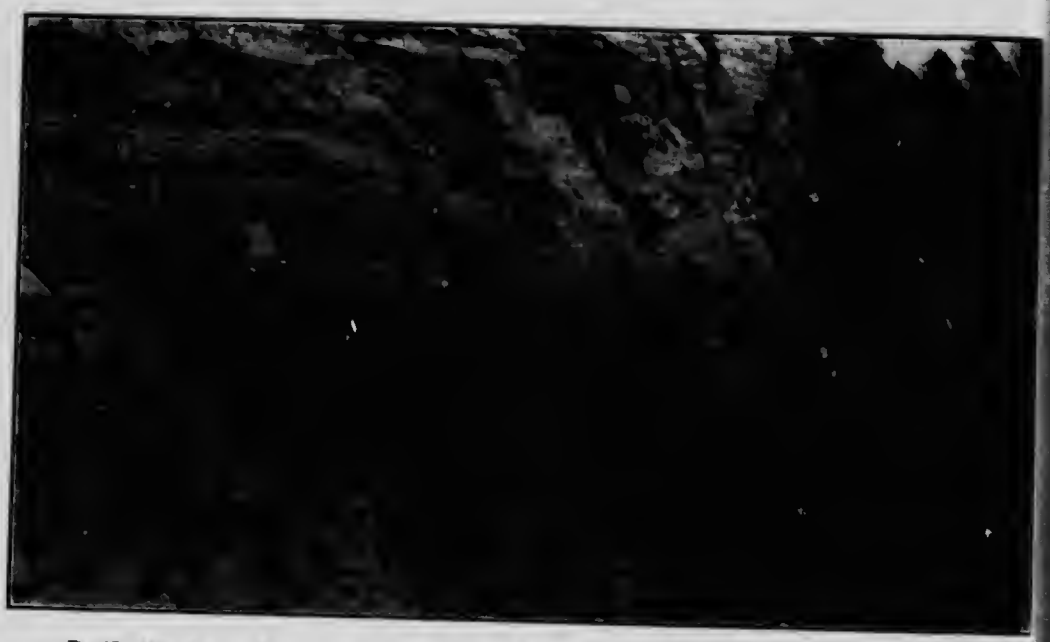


Fig. 17.—Saugeen clay in the Spanish River at Espanola; part of the bank as shown in Fig. 16 much enlarged. Note laminated character of clay.

We notice here that we have the usual layers of sand and quick-sand at the base of the Saugeen series. We note also freedom from boulders or only a few at the base of the series. The layers of clay are very thick and of sand very thin in the lower parts of the Saugeen clay, and as we work up to the surface the layers of sand get thicker and the layers of clay correspondingly thinner till they form mere partings in the sand and marly clay, as the sand did in the clay at the base of the series. These points tend to substantiate the belief that at first we had deep water, few currents and therefore more clay was laid down and little sand, also a shorter period or summer sason of melting. As the time went on the melting season got longer and the layers of sand become correspondingly thicker, till towards the close of the period the warmer climates give us much more sand, and less clay. The absence of boulders and pebbles shows freedom from floating ice.

In all parts of Ontario the Saugeen clay is remarkably free from stones and boulders, and for this reason it is an excellent clay for the manufacture of red brick

of all kinds and for the manufacture of tile or hollow blocks. Of course the location must be selected, as with every other clay. If the clay is strong a suitable supply of sand should always be sought near at hand, for it is almost impossible, as we have pointed out, to work this Saugeen clay unless it contains about 25 per cent. of sand, and if this is not already present it must be added by the workmen. If a place can be found where the clay already has sufficient sand interbanded with it to render the whole workable, no better clay could be desired than the Saugeen.

Saugeen clay with marly bands is to be avoided. The marl can always be detected by moistening a sample of the clay with a drop of any acid. If it effervesces, or bubbles, it should be avoided; but if not, it is safe.

Fig. 18.—Saugeen clay bank at Casselman. Note contact of sand and strong clay, which shows the pick marks and laminations plainly.

The Saugeen clay, as has been stated, is usually underlaid by a layer of sand or gravel. The writer's experience bears this out, for in every case where the Saugeen series and the Erie clay were found associated, a band of gray sand from 1 to 3 feet in thickness was found immediately under the Saugeen. In many cases a layer an inch to an inch and a half of sand has been converted into a flag of sandstone by a certain amount of calcium carbonate having leached down from the overlying clay, cementing the grains of sand together. At Walkerton, for example, the clay bank was drained by occasionally punching a hole through the thin cake of sandstone, into the soft sand below. The water would sink through this hole, and run away in the loose sand below, while the cake of sandstone itself afforded an excellent working floor.

The Saugeen clay with the accompanying sand worked as a whole section, forms the most homogeneous, and the best working clay in the Province, for red products. Being from 8 to 20 feet in thickness, a good supply of practically uniform quality is assured, and this is a feature entirely wanting in the Red-top clay. In the latter, the brick-maker has to skin over the whole of his clay bed, in order to get sufficient red clay for a very few years' run.

The presence of the bands of shell marl proves that the Saugeen clay in the western and northern area was laid down in fresh water. The organisms producing the marl were fresh water forms; and any of the larger shells found in these marly bands represent fresh water types, comprising among others the following,—Planorbis campanulatus, P. bicrinatus, P. parvus, Melandia acuta, M. conica, Cylas similis, etc. We will find in examining the eastern area that the organisms are marine, instead of fresh water.

Fig. 19.—Bank of Saugeen clay, Baker Bros' yard, Casselman. Here the laminated clay is overlaid by about 4 feet of sand.

ANALYSES OF SAUGEEN CLAY.

Sample No.	Silica. per cent.	Alumina. per cent.	Ferric oxide. per cent.	Lime. per cent	Magnesia. per cent.	Soda. per cent.	Potash. per cent.	Sulphur trioxide. per cent.	Loss by heat. per cent.
26	63.00	15.15	6.28	3.48	2.67	2.64	3.11	.30	3.63
34	59.34	17.68	6.74	2.94	3.36	2.13	3.07	.47	4.60
35	62.30	16.51	5.65	3.16	2.68	2.25	2.61	.40	3.60
58	61.20	16.40	6.25	3.10	3.25	1.94	2.32	.52	4.94
59	51.00	16.11	4.69	8.26	4.10	1.74	2.76	.09	9.64
56	65.08	14.83	3.17	4.18	2.57	2.76	2.24	.04	5.10
64	64.08	17.21	5.40	2.34	2.75	1.94	2.97	.05	3.90
65	58.30	15.70	5.41	5.10	3.27	2.04	2.73	.04	7.30
66	49.68	13.95	5.32	9.46	4.16	1.96	2.76	.04	1.29
67	65.42	16.06	5.44	3.20	2.31	1.90	3.06	.07	2.78
68	63.20	15.75	4.67	4.32	2.73	1.91	2.80	.04	4.35
69	64.30	15.45	5.22	3.42	2.02	2.51	2.72	.05	3.89

26. Saugeen clay about 20 feet deep worked for tile and brick by Watson & Hutchison at Bracebridge.

34. Saugeen clay about 10 feet deep worked for red brick by Merkley Bros. of Casselman.

35. Saugeen clay, very sandy. Worked from a bank about 10 feet deep by J. Thibadeau at Pembroke.

58. Saugeen clay, a continuation of the bank worked by Merkley Bros., and made into red brick by Baker Bros. of Casselman.

59. Saugeen clay in the railway cutting of the T. & N. O. railway, between Haileybury and New Liskeard. Very marly clay.

56. Saugeen clay worked by the Imperial Land Co., for red brick and tile at Sturgeon Falls.

64. Saugeen clay from Wallace & Son's yard, North Bay; requires sand.

65. Saugeen clay from R. Scott's yard, New Liskeard.

67. Saugeen clay from D. Clark's yard, Powassan. A good clay; about proper percentage of sand.

68. Saugeen clay from A. W. Evans' yard, Sudbury.

69. Saugeen clay used for red pressed brick by the Algoma Commercial Co. of Sault Ste. Marie.

Lacustrine Clays

The latest clay mentioned in our classification is the Lacustrine clay, formed since glacial times. Residual clays formed from decomposing rocks rarely rest on steep slopes, or on hill tops. Moreover, the running water after each rain storm shows

Fig. 20.—Sand and gravel laid obliquely, showing evidence of currents. Photo. of section of gravel bed at Owen Sound.

us that our glacial clays are being gradually carried off the higher gronnd to lower levels. By such means mixed clays, *i. e.* clays collected from very different sources, are washed down and deposited in new resting-places. As soon as the velocity of the stream is checked, and the water becomes free from currents, the particles begin to drop to the bottom, forming layer after layer of an even-grained, washed clay. Thus all our lacnstrine clays will be sedimentary and stratified. They will not be absolutely homogeneous, because all will not have a common sonrce. Moreover, the velocity of the current will not be constant the year round, hut there will he flow and ehb, depositing respectively coarser and finer material on any given area. Evidence is seen of currents in the layers of sandy clay or sand itself, showing ohlique stratification.

There is no difficulty in distinguishing a lacustrine clay from a glacial clay, because the former is free from stones or boulders and is distinctly stratified. It is distinguished from a residual clay by being entirely different from the underlying formation.

Not many workable deposits of lacustrine clay are found in Ontario. As most of our drainage channels are geologically new, *i. e.* post-glacial, the streams are more or less rapid, and thus the clay is carried into the larger lakes, which have not yet suffered elevation so as to expose the accumulation of clay. A few however, are to be found, *e. g.* the clays about Hamilton, the clays used in the brickyards of London,

Fig. 21.—Section of Iroquois beach exposed at Hamilton, showing relations of clay, sand and gravel.

the clay used in the brickyard at Conestogo, and some of the clay used about Toronto and the Don. It will not be necessary to describe these clays in detail as the method of their formation is sufficiently explained, and each deposit is a little different from every other. They show accumulations of sand, gravel, and clay interstratified in bands from 6 inches to 3 feet in thickness, many of which, as has been said, show cross-bedding or oblique stratification. In some cases fine beds of gravel will overlie, or be interbanded with the clay, *e. g.* at London, where the overlying gravel from 3½ to 5 feet in depth is carted off for road metal, and the underlying clay is then worked for brick.

At Hamilton, a raised beach composed almost entirely of gravel now cemented into a conglomerate, formed a dam to the Dundas river. Behind this dam the water

collected in a lake-like expanse, and in this the clay carried down by the Dundas river was deposited, so that in the western part of the city of Hamilton is an area of clay about 8 feet deep lying on a terrace of gravel. This terrace is described in detail by Dr. Coleman in the 13th Bureau of Mines Report, 1904, in a paper entitled "The Iroquois Beach in Ontario." Many fine examples of cross-bedding of sand and gravel are to be seen here. For the relations of clay, sand and gravel see fig. 21.

Another deposit of lacustrine clay is found at London, and is used in the manufacture of white brick. This deposit occurs in the north eastern part of the city, and there are a number of brick yards operating upon it. Starting at the surface we find

Fig. 22.—Section of lacustrine clay at Builders' Supply Co's plant, London; four feet of gravel is removed from top for road purposes. The light band is a very strong clay.

from two to four feet of very clean gravel. This is used by the city authorities for road metal. Immediately below this gravel is about two and a half feet of very strong clay (note light band in fig. 22), below which is a mild sandy clay, about two feet deep, and below this are several bands of clay and sand inter-layered. Beneath this whole section we find the Erie blue clay, an unconformity existing between the two. That this overlying clay is not Saugeen is shown by the lack of the alternate bands, the great thickness of the beds, and in its burning to white brick, instead of to red. Moreover, this clay is quite local in its distribution. The bands of strong clay have to be thoroughly mixed with the bands of sand in order to make the whole section workable.

A third occurrence of lacustrine clay of economic value is found about seven miles northeast of Berlin, in a bend of the Conestogo river. Mr. H. D Dalmer operates a yard on this deposit, which is located in a hollow, and at a bend of the river which formerly formed a small lake. In this flat is an accumulation of excellent red-burning clay, varying from 4 to 8 feet in depth. It is very uniform in character, and is free from stones or boulders. It is used extensively in the manufacture of red brick and tile, and yields a very excellent product. No doubt there are many other examples of lacustrine clays, but these were the only ones noticed by the writer during his investigation, as being unmistakably of this origin. Moreover, these were the only deposits which were being used in manufacture of clay products, and have been mentioned for that reason.

Eastern Ontario Clays

We will now turn our attention to the eastern part of the Province, or that part of the Province lying east of a line drawn roughly from Prescott to Ottawa. In our classification above, we have first the unlerlying rocks which here are chiefly limestones

and sandstones, of Cambrian and Ordovician age, together with igneous rocks of pre-Cambrian age. We have no shales in this part of the Province which can be used in the manufacture of clay products. The result is there are no pressed brick made in this district.

Regarding the next formation, namely the residual clays, nothing further need be said in addition to the discussion above. The residual clays here will naturally have suffered in the same way as those in the West, *i. e.* they would have been completely removed and mixed up with foreign material by the advance of the glaciers, as has been described.

23.—Boulder clay on the face of an excavation at Ottawa.

Boulder Clay

We therefore find resting immediately upon underlying rocks for the most part a formation of stiff boulder clay. Concerning this formation, Dr. H. M. Ami says,[1]

"No special formational name or designation has as yet been ascribed to the series of boulder clays which vary in thickness from a few inches or feet, to upwards of 100 feet in thickness, and which overlie the subjacent, glaciated and striated surface of the ancient, Palæozoic rock formations in the Ottawa district. * * * This formation is met with throughout the Ottawa district, and the materials which compose it consist of accumulations of the more or less travelled, broken, ice-scored, and rolled fragments of all the rock formations which the great Labradorean glacier and all its lateral ramifications met along its way, and deposited in its different stages until the close of the glacial period. * * * * These boulder clays, as is well known, were deposited for the most part at the time when land ice prevailed in and about Ottawa; when great accumulations of snow and ice in the form of glaciers, had gathered on the Chelsea hills and north of Ottawa, and spread to the south and carried along whatever loose materials or easily-broken rocks could be detached, in their progress along and deposited them in the valley of the Ottawa, which for the time being must have been filled with rock and ice. as well as the country to the south of the river."

The boulder clay here differs somewhat from that in the West, having many more igneous boulders mixed with it. This is accounted for by the proximity of this area

[1] Geology of the Principal Cities in Eastern Canada, p. 137.

to the igneous Laurentian area immediately north of Ottawa. Again, the eastern boulder clay appears to be distinct and separate from the overlying Leda clay, whereas in the West, the boulder clay appears to pass imperceptibly into the Erie clay. In the East, then, we find an unconformity between the boulder clay and the next overlying formation. This is well shown in a sewer which was being dug in Ottawa during the writer's visit. Here the underlying boulder clay could be seen in the lower parts of the sewer in several places, and lying unconformably upon it was the later formation of Leda clay. Concerning the relation of these deposits, Dr. Ami says that at the close of the glacial period the Champlain period of submergence began. It was at this time that the boulder clay formation was modified and considerably denuded, carried away and redeposited, forming the Leda clay and Saxicava sand overlying.[1]

The Leda Clay

The next overlying formation above the boulder clay is the Leda clay. This corresponds very closely with the Erie clay in the West, but it differs in some respects, one of which is mentioned above, *i. e.* it is a separate formation lying unconformably upon the boulder clay. It has the same blue color, and is a stiff strong blue clay, which at first sight would be taken for the typical Erie blue clay. Upon examination, however, it is found to be quite low in lime, and in this respect is in marked contrast to the Erie blue clay of the West.

ANALYSES OF LEDA CLAYS.

Sample No.	Silica. per cent.	Alumina. per cent.	Ferric Oxide. per cent.	Lime. per cent.	Magnesia. per cent.	Soda. per cent.	Potash. per cent.	Sulphur trioxide. per cent.	Loss by Heat. per cent.
32	58.54	17.02	5.48	6.36	2.22	2.18	2.95	.56	3.42
33	56.00	17.07	8.27	4 17	4.55	1 81	2.57	.59	4.89
60	57.96	19.00	6.18	3.78	3.82	1.87	3.81	.35	3.18
61	62.06	15.54	5.70	4.91	3.11	1.92	2.38	.14	4.01
62	52.86	17.42	8.85	3.69	3.37	1.85	3.12	.58	3.03
63	52.17	19.40	9.19	3.88	3.72	1.96	3.16	.52	5.65

32.—Leda clay from a bank 14 feet deep, worked by the Cain Brick Co. of Ottawa. Burns to rich red brick.

33.—Leda blue clay taken from a similar bank at Morris and Ballantyne's yard at Ottawa. The upper part of this bank is quite sandy, but is mixed with the lower, stronger clay, and yields a rich, red brick.

60.—Leda clay, used chiefly in the manufacture of red tile by William Baker at Arnprior.

61.—Milder clay taken from the same bank and manufactured into red brick, by William Baker of Arnprior.

62, 63.—Samples of Leda clay taken from a very stiff bank, which is worked by the International Portland Cement Co., and used with limestone in the manufacture of cements at Ottawa.[3]

From the above analyses we notice that its percentage of ferric oxide is about the same as the Erie blue clay, viz. about 6 per cent., and this with the low percentage of lime causes this clay to burn to a red color. In many places it reaches a depth about as great as that of the Erie clay. For instance, at Ottawa, where the foundations were being dug for the new Geological Museum, a splendid exposure of strong, blue Leda clay is to be seen. The foundation for this building had to be placed in a bed of this clay, as borings showed it to be 94 feet deep, at this point. Thus in many respects is resembles the Erie blue clay of the west. There is, however, one great difference. The Leda clay was laid down in salt water, whereas the Erie clay was deposited in fresh water. This is proven by the presence of fresh water organisms found in the sands associated with the Erie clay, whereas the shells of marine organisms are found through-

[1] "Geology of the Principal Cities in Eastern Canada," p. 136.

[3] Information and analyses kindly supplied by the chemist of the works at Hull, Que.

out the Leda clay. Dr. Ami reports from this formation the following marine fossils, Leda artica, Mallotus villosus, Fucus digitatus, Byrrhus Ottawaensis, Craniella Logani, and many others, all of which prove that this clay was laid down in salt water.

Towards the close of the glacial period it is believed that a large ice dam formed about Prescott, to Ottawa, turning the fresh water of the upper lakes down through the Hudson river. Thus the water west of this dam was kept fresh by the constant melting of the glacier, whereas east of it the St. Lawrence valley was a wide gulf, which, together with the Ottawa valley was covered with salt water to a height of probably 600 feet above the present water level. In this salt water the Leda clay, which was largely the resorted boulder clay, was deposited. It is therefore now found comparatively free of calcium carbonate, but abounding in the shells of marine life. Through the clay are many glacial boulders which were no doubt dropped from floating ice, as were those found in the cleaner parts of the Erie clay in the western part of the province.

The Saxicava Sand

We have said above that this Leda blue clay is a strong, stiff clay. This description is correct for the most part, but the upper part of the deposit is quite sandy, so much so that it has been divided, and called by two distinct names, the lower or strong part is called the Leda clay, while the upper, sandy part is called the Saxicava sand. In Geology of Canada, we find the following reference.[4]

"The valleys of the St. Lawrence and the Richelieu in Canada East, and a considerable portion of the region between the St. Lawrence and the Ottawa, to the east of the meridian at Kingston, are occupied by stratified clays; which, unlike those of western Canada, contain abundance of marine shells, for the most part identical with the species now living in the lower St. Lawrence and the Gulf. These clays are in many cases overlaid by sands, occasionally interstratified with clay, which also contain marine remains. The two are regarded as forming parts of one formation. * * * * Dr. J. W. Dawson, who has carefully studied these deposits in Canada, distinguishes the lower as Leda clay from one of its characteristic shells; and the upper, for a similar reason, as the Saxicava sand. He considers the one as having been formed in shallow waters, and the other as a deep water deposit."

Concerning the same formations Dr. Ami says,

"This formation is divisible into two series, one a marine clay, the other a marine sand formation. The 'Leda clay' appears to occupy the lower levels of the St. Lawrence immediately overlying the boulder or glacier clays. * * * * * These clays vary from a few inches in thickness to several feet, reaching 50 feet in certain localities, and also carry boulders disseminated throughout the mass. They are for the most part bluish gray, fine-grained, more or less plastic or stiff clays and muds, * * * * * * and hold both vegetable and animal remains in a fossilized condition. * * * * * * The Saxicava sand consists for the most part of light yellow and ferruginous sands immediately overlying the Leda clay, of which it may be considered, in a perfectly logical way, as the littoral or shore deposit. It varies in thickness from a few inches to several feet, and is marked by the presence of Saxicava rugosa, Mya arenaria, M. truncata, Macoma fragilis, Macoma calcarea. These are amongst the most conspicuous and characteristic marine organisms."

We thus see that the upper part of the Leda clay, like the upper part of the Erie clay, is usually more or less sandy, but we find more sand associated with the eastern deposits than with the western.

In using this clay, for the manufacture of brick, etc., the upper red clay with the yellowish sand and sufficient of the underlying strong blue clay, are worked together to prepare a proper mix. The upper parts alone, on account of the abundance of sand, would prove too lean, so that a section from 12 to 20 feet is usually worked for the manufacture of brick, tile, etc. A series of analyses is given on page 31, which can be compared with those of the Erie blue clay given on page 14. Nearly all the red brick of the eastern part of Ontario are made from the Leda clay; only a few of those made in the more northerly parts of this area being from a still later formation, namely, the Saugeen.

[4] Geology of Canada, 1863, page 915.
[5] Geology of the Principal Cities in Eastern Canada, p. 163

Saugeen Clay in the East

Overlying the Leda clay and the Saxicava sand we have another clay, which resembles in every way the Saugeen clay of the western part of the province. It bears the same relation to the Leda clay in the East, as it does to the Erie clay in the West. We mentioned above that if a line be drawn from Lake Huron via Walkerton, Paisley, Bracebridge and Pembroke, to Ottawa, then southeasterly to Casselman and on to the St. Lawrence river, it would form roughly the southern border of the Saugeen clay

Fig. 24.—Twenty feet of Leda clay, Ottawa. Note strong clay at base; also weathering of the top along roots, joints, etc.

area. This clay is found in the eastern part from 4 to 20 feet deep, thinly interlaminated as in the West and of similar character, except that it is more sandy in the East than in the West, just as we found the Leda clay more sandy in the East, than the corresponding Erie clay in the West. At the base of this Saugeen series in the East, we find the hand of grayish sand, as we did in the West. It also lies unconformably upon the Leda clay. There seems little douht that all this Saugeen clay was laid down contemporaneously, and represents a deposition of clay in the retreating or melting stages of the glacial period. The sand layers are an evidence of slight flood, whereas the clay layers represent the quieter waters of a less rapid melting, *i. e.* each layer of clay and sand combined would represent the deposition for one season. As in the Saugeen clays of the West, the individual hands of sand and clay are rarely over three-

quarters of an inch in thickness. This Saugeen clay is worked in the East in some of the largest yards, notably at Pembroke, Arnprior, Casselman, Plantagenet, Vankleek Hill, etc., and yields excellent red brick and tile.

The latest clay in eastern, as in western Ontario, would be lacustrine clay, but the writer saw no deposits of this character during his investigations in this part of the Province. No doubt some exist here, but they are purely local in their distribution, and do not need further discussion. They have of course been formed almost entirely from one or other of the clays collected during glacial times.

Physical Properties of Clay

We have now discussed the classification, the distribution, and in a general way the chemical composition of our Ontario clays, but there is another important series of properties which deserve attention. These are the physical properties of clay. By this is meant such characters as plasticity, tensile strength, shrinkage, slaking, fusibility, etc. These are the more important properties considered under this heading

Plasticity

In our definition above we found that a clay when moistened becomes plastic, which allows it to be moulded or shaped as desired. It has been generally thought that the fatter a clay, the more plastic it would be, while on the other hand the leaner it was the less plasticity it would have. But this is not altogether correct. Some very fine-grained clays, even if quite fat—for example, many washed clays—are nevertheless not so plastic as one might expect from their composition alone. Plasticity seems more closely associated with the fineness of grain in the clay, or in other words, with the completeness of the disintegration of the clay particles, than with the actual percentage of clay material. On this point Heinrich Ries in his report on the clays of New Jersey says:[6]

"A residual clay was compared with a sedimentary clay of the same composition. The residual clay was found to possess less plasticity than the sedimentary clay, the particles of which had been transported long distances and had thereby been more or less rubbed and ground together previous to their deposition. Inasmuch as the kaolinite particles, as shown by the microscope, are more or less bunched, it is to be expected that the rubbing and grinding action during transportation would break up the bunches to some extent, and it is believed that the increased plasticity of the sedimentary clay is due to this cause. This conclusion is in accord with the facts noted by Prof. George H. Cook, who found that by rubbing a mass of kaolin in a mortar the bunches were easily broken apart and that the mass afterwards showed greater plasticity."

Since nearly all our Ontario clays were laid down during glacial times and suffered a great deal of rubbing and grinding action by which each little bunch of clay was pretty thoroughly disintegrated, we are not surprised to see that our Ontario clays, especially the Erie clay, is particularly plastic.

Tensile Strength

The next point mentioned is tensile strength. By this is meant ability to withstand a pulling strain; in other words, ability to adhere when subjected to a pulling test. This is an important property, in that it enables the freshly made brick when air-dried to stand the handling, piling, and to some extent the superincumbent weight to which they are subjected in setting a kiln, although this latter property is more closely associated with a crushing test. The tensile strength is measured by moulding the moistened clay into briquettes, whose shape is about that of the figure 8 and which are made of such a form that their smallest diameter is an inch; their thickness is also an inch. In this way their smallest cross section, and the place where they will

[6]Clays and the Clay Industry of New Jersey H. Ries.

naturally break when subjected to a pull is one square inch. The test is made with a machine so constructed that brass clips grip either end of the briquette. The strain is then put on and the force required to pull the brick apart is registered on a dial as so many pounds. Our cross section being a square inch, the tensile strength is reckoned as so many pounds per square inch.

It was found impossible to make physical tests of all the clays mentioned in this report from the various yards, but a number were made by the writer at the School of Mining, Kingston, using several examples of each of the clays which have been described in this report. The briquettes were moulded in little brass moulds to the size and shape indicated above. They were then allowed to air-dry until thoroughly dried. They were then placed over coils and afterwards in a hot air bath at a temperature of 105° C. (or 221° F.) One set of tests was made on the clays as taken from the clay banks at the various yards mentioned below. Another set of tests was made on the same clays when the percentage of sand in them had been increased to 33. These tests were made for the purpose of seeing what effect the addition of sand to our clays would have on their tensile strength. As the table below shows, it reduced the tensile strength, but not materially. Moreover, the percentage of sand was a little too great. All these clays were brought up to 33, which is a little too high, but the tests show that the addition of sand up to 25 per cent. would be a great advantage to all of our clays. The advantages of the addition of sand have already been discussed fully in this report, and need no further mention. The tests show that the clays rich in sand have a lower tensile strength, but here again we find that the very finest grained clays, as was the case in plasticity, are also low in tensile strength. From this it appears that too great a percentage of coarse material, for example, sand, or even too great a percentage of the finest material, or in other words a clay almost free from sand, has a small tensile strength, while the clay of intermediate composition, that is, a clay with a fair proportion of sand, say 25 per cent., gives the most desirable results. The numbers used in the following tables are the same as used under the lists of analyses, so that the locations can be identified under the lists of analyses for each class of clay mentioned.

TENSILE STRENGTH OF CLAY BRIQUETTES UNBURNED.

No.	Class of Clay.	Percentage of sand contained.	Strength of Sample 1.	Sample 2.	Average strength.
2	Erie	15	190	165	178
2	"	33	140	140	140
3	"	25	100	90	95
3	"	33	60	70	65
8	"	15	155	130	142
8	"	33	115	130	122
12	"	24	115	120	117
12	"	33	100	100	100
25	"	14	120	130	125
25	"	33	140	115	127
27	"	15	120	115	117
27	"	33	90	105	97
30	"	20	120	135	127
30	"	33	60	65	62
31	"	27	140	130	135
31	"	33	115	150	132
5	"	21	150	165	157
5	"	33	120	130	125
1	Red-top	40	148	160	152
1	"	33	140	155	147
7	"	30	130	125	127
7	"	33	175	180	177
29	"	23	190	170	180
29	"	33	170	180	175

TENSILE STRENGTH OF CLAY BRIQUETTES UNBURNED.—*Continued.*

No.	Class of Clay.	Percentage of sand contained	Strength of Sample 1.	Sample 2.	Average strength.
34	Saugeen	21	155	170	162
34	"	33	135	200	167
35	"	27	160	185	172
35	"	33	135	155	145
59	"	17	145	170	157
59	"	33	130	110	120
32	Leda	21	140	115	127
32	"	33	120	110	115
33	"	21	200	190	195
33	"	33	200	180	190

TENSILE STRENGTH OF BRIQUETTES BURNED.

Sample No.	Class of Clay.	Percentage of Sand contained.	Strength of Sample 1.	Sample 2.	Average strength.
2	Erie	15	250	210	230
2	"	33	250	265	257
3	"	25	320	365	342
3	"	33	270	290	280
5	"	21	250	270	260
5	"	33	340	290	315
8	"	15	290	325	307
8	"	33	340	325	332
12	"	24	200	180	190
12	"	33	200	285	242
25	"	14	300	340	320
25	"	33	390	300	345
27	"	15	210	170	190
27	"	33	200	230	215
30	"	20	225	300	262
30	"	33	210	240	225
31	"	27	220	265	242
31	"	33	215	290	252
1	Red-top	40	300	310	305
1	"	33	280	295	287
7	"	30	320	295	307
7	"	33	326	300	310
29	"	23	380	350	365
29	"	33	320	350	335
34	Saugeen	21	350	375	362
34	"	33	300	330	315
35	"	27	330	350	340
35	"	33	360	400	380
59	"	17	235	270	252
59	"	33	200	210	205
32	Leda	21	290	260	275
32	"	33	230	180	205
33	"	21	295	320	307
33	"	33	125	150	137
9	Shale	19	430	470	450
18	"	25	360	310	335
21	"	20	370	365	367
22	"	19	540	500	520
23	"	33	370	400	385
24	"	20	580	610	595

It will be noticed from the above figures that increasing the percentage of sand lessened in almost every case the tensile strength of the raw clay, but not very materially. The addition of the sand is consequently a great advanatge, in that it aids the working of these clays, rednces the shrinkage both in drying and burning, and assists also in the bnrning by tending to keep the brick in its original shape.

From the second set of figures, that is, the tests of the tensile strength of the same clays when burned into briqnettes, it is evident that the addition of sand again reduced in about half of the cases, the tensile strength of the resulting briquette, while in a corresponding number of cases it increased the tensile strength of the burned brick. This would indicate that the addition of sand to our Ontario clays is a great help to them. It was pointed out above that the addition of sand up to 39 per cent. was a little too much, but the addition of sand up to 25 per cent., that is one part of sand to three parts of clay, makes a first-rate mix. Notice No. 3, 1, 7, 29, 34, 35 and 33. These clays each contain abont 25 per cent. sand in their natural state, and the tensile strength of the burned brick made from them is the highest, or abont the highest, in the list. The tensile strength of the six shales is high. This is probably dne to the uniformity of the material, and to the even grain of the finely pulverized shale.

From these tests it is clearly evident that the addition of sharp clean sand to about one-qnarter of the whole bulk is a great advantage to our clays. The many advantages have been mentioned in this report several times, but it is necessary to correct the prejudice prevailing in a great many minds, that the addition of sand to clay is an adulteration which depreciates the value of the clay. As will be seen from the above tests this is not true. Of course this addition of sand must be made judiciously and should not exceed 25 per cent.

After making the tests of tensile strength of our clays, the writer thought it advisable to make a few tests of the crushing strength, that is, the ahility of burned clays or brick to withstand pressure of burden placed upon them. For this purpose small bricks were made in the shape of a cube, each of whose edges would he one inch. In his way, the test pieces were one cuhic inch, and the surface exposed to the pressure was one square inch. The small bricks or blocks were then placed hetween the jaws of a crushing machine and pressure applied. These tests were made in the cement testing laboratory of the School of Mining, Kingston, hy Prof. A. McPhail, and the results are given in the table below. It might be added that for comparison's sake tests were made of well-burned red face-brick as sold in commerce, and these gave on an average of four tests, 2,460 pounds to the square inch. This figure is given as a standard for comparison.

CRUSHING TESTS ON CUBES BURNED.

Sample No.	Class of Clay.	Percentage of sand contained.	Strength of Sample 1.	Sample 2.	Average strength.
2	Erie	15	3,150	2,820	2,985
2	"	33	3,790	3,700	3,745
3	"	25	1,875	1,765	1,820
3	"	33	967	925	946
5	"	21	2,783	3,340	3,061
5	"	33	2,640	3,060	2,850
8	"	15	2,900	2,580	2,740
8	"	33	2,510	2,310	2,410
12	"	24	3,190	3,390	3,290
12	"	33	3,050	3,010	3,030
27	"	15	2,620	2,760	2,690
27	"	33	2,310	1,675	1,992
31	"	27	1,465	1,480	1,472
31	"	33	1,965	2,440	2,200

CRUSHING TESTS ON CUBES BURNED.—*Continued.*

Sample No.	Class of Clay.	Percentage of sand contained.	Strength of Sample 1.	Sample 2.	Average strength.
1	Red-top	30	2,410	3,195	2,802
1	"	33	3,740	3,220	3,550
7	"	30	2,610	3,020	2,815
7	"	33	2,460	2,600	2,530
29	"	23	3,310	225	2,617
29	"	33	3,390	3,570	3,480
34	Saugeen	21	4,340	4,720	4,540
34	"	33	3,800	3,740	3,770
35	"	27	2,990	3,390	3,190
35	"	33	3,400	2,760	3,080
59	"	17	4,480	2,390	3,435
59	"	33	1,980	2,400	2,180
32	Leda	21	2,760	3,190	2,975
32	"	33	3,615	2,880	3,247
33	"	21	3,250	3,580	3,415
33	"	33	4,610	3,020	3,815
9	Shale	19	3,710	3,410	3,560
18	"	25	3,640	4,370	4,005
21	"	20	4,740	5,340	5,040
22	"	19	5,660	6,510	6,085
23	"	33	4,600	4,060	4,330
24	"	20	9,200	6,290	7,745

From the above table it will be readily seen that the addition of sand up to 33 per cent. does not materially affect the ability of these clays to withstand pressure, or to carry loads, when burned to good hard brick, so that it is again demonstrated that the addition of sand, within reasonable limits—up to say 25 per cent.—is a decided advantage, and not a detriment, especially when we remember the increased facility in working that the addition of sand to a clay gives.

The table also shows the great carrying power of bricks made from shale. Probably this is caused by the homogeneity of the raw material, resulting in a brick of perfect uniformity, whereas in making brick from clay it is impossible to get the product absolutely homogeneous. Sand was not added to these shales since they are all worked by the dry method for the manufacture of pressed brick, and the addition of sand in this process would not only be much trouble, but would be hard on the machinery on account of its grinding action.

Shrinkage

The next physical property mentioned was shrinkage, and under this heading we have to consider two phases, one known as air-shrinkage and the other as fire-shrinkage. Whether brick are made by the soft-mud, stiff-mud, or even the dry-press method, they contain more or less moisture. This moisture is disseminated throughout the clay around and between all the particles. After the brick are made they are set to dry by one or other of the methods mentioned below. In the drying process the moisture leaves the interspaces and the particles of clay come together to take the place of the water. This means a shrinkage in the size of the brick as a whole, and this is what is meant by air-shrinkage. See fig. 70.

But even when this moisture has been driven off and the little particles of clay touch each other they do not form a perfectly compact mass, for there are still small spaces amongst the grains in which the water can lie, and this moisture remains until

driven off by heat. This is the moisture that escapes during the "water-smoking," or "steaming" as it is often called by brick-makers. There is even yet additional moisture present in the chemical make-up of the kaolin, which is not driven off until the heat reaches 400° C. (752° F.) This causes the greater part of the fire shrinkage, although other things, such as the loss of carbon dioxide, etc., from clays rich in lime, have their effect. The amount of shrinkage which a clay will undergo is lessened by the addition of sand. The air shrinkage is low in lean clays and high in very plastic clays. Soft-mud brick usually shrink more than stiff-mud brick because the former are mixed with more water and are not pressed so compactly as the latter. At the same time soft-mud brick, which contain considerable sand, shrink less than soft-mud brick which contain less sand. This is a matter of experiment, and clearly proves that the addition of sand within certain limits, is a decided advantage from the standpoint of drying the brick, and preventing excessive shrinkage which so often causes the brick to crack or shake, thus pulling themselves to pieces. The kind of sand used, that is, whether coarse or fine, or its color, etc., does not matter much so long as it is clean, that is, free from limestone and organic impurities.

Slaking

Another physical property of considerable importance is slaking. If a lump of clay, however hard, be moistened, it will slake or break to pieces. Sandy clays powder up more readily, whereas the fat or strong clays will slake very slowly, and sometimes may only scale or chip off gradually. This property of slaking is of considerable importance, because it forms a method of thoroughly disintegrating the clay. Many of our clay-workers take advantage of it by digging up their clay in the fall, and letting it lie over winter exposed to the rains and frosts. In the spring when the frost has left it, it will be found to powder readily, and can be dug and wheeled directly to a machine even without the use of a pug-mill.

This property of slaking is of a special advantage to those brick-makers using the Saugeen clay. This clay, as we have seen, occurs in layers, and when dug breaks out into large stiff lumps or cakes; in many cases also it has nodular concretion-like forms enclosed in it. Upon exposure to the air, however, these lumps and cakes break up completely. Many of the brick-makers do their tempering and mixing the sand with the clay by this process. The clay and sand are dug and dumped in layers in a heap. The clay afterwards slakes so completely that when the heap is dug over the clay and sand are very readily mixed, and can be sent directly to the soft-mud machine without having to be put through a pug-mill at all, although a pug-mill is always of the greatest advantage in tempering clay.

Fusibility

The last physical property mentioned in our list was fusibility. After the clays have been water-smoked and as the heat continues to be raised, as soon as a temperature of about 400° C. is reached, the combined water is given off. After this point is passed and the heat raised to about 900° C., or perhaps a little higher, the particles of clay fuse and knit to each other, forming a perfectly coherent mass which on cooling retains its hardness. In the manufacture of ordinary brick this fusing temperature must not be passed, or the brick will become viscous and the whole mass will fuse together into great lumps within the kiln. It is therefore important that brick should be burned till incipient fusion begins, but not materially above this point.

In order therefore to test a kiln, or to be able to control the temperature, an excellent method was devised as far back as 1886, by Dr. Herman Seger. This consists in the preparation of a series of pyramids or cones known as Seger cones. Their preparation and use is well described by Prof. Edward Orton of Ohio State University, Columbus, Ohio, from whom the cones may be had at one cent each. In a pamphlet advertising these cones Prof. Orton says:

"The fundamental idea of this system is to prepare a series of silicate mixtures which melt in progressive order, from a low temperature to a high one, and then to use these melting points as a scale for comparison in the burning processes of the clay industry. . . . . It has been clearly proven that the Seger cone is the best, the most accurate, and most reliable means of controlling the burning process of clays. The cones should be set erect on a slab with plastic clay. The clay should be refractory enough to stand the heat of the kiln without melting. Place the slabs of clay, each containing an assortment of cones running from low numbers up to high numbers, in different parts of the kiln you desire to test. When the burn is over and the kiln is drawn note the condition of the cones. If the heat range covered by the cones was large enough some of the cones will be melted flat, others bent over, others erect and unaffected. Suppose that numbers ranging from 08, 07, etc., down to 1 were used, and suppose that Nos. 08 to 03 were down flat and 02 was bent, but not completely melted, while 01 and 1 were practically unaffected. The required tempera-

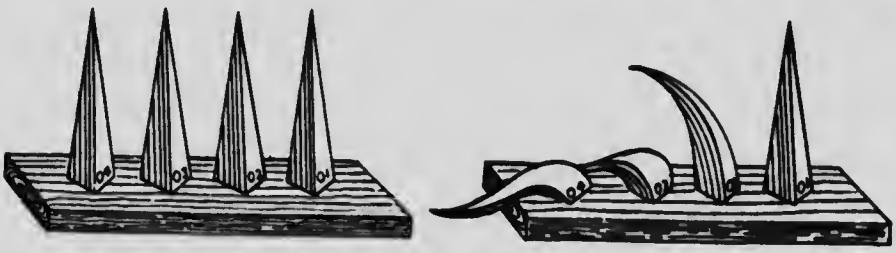


Fig. 25.—Examples of Seger cones (1) placed for fusion test, (2) after fusion test, etc.

ture would be recorded as 02. If other slabs in other parts of the kiln all show the same result, we would conclude that the temperature reached was quite uniform throughout the kiln, and if the burn turned out a good one we would conclude that cone No. 02 indicated the proper finishing point for our conditions, *i. e.*, 1110° C. (or 2030° F.) Having determined the proper cone, say 02, to continue our illustration, it should always be used for every burn as follows: Make up slabs containing cones 04, 03, 02 and 01. Make several of these slabs so that they can be placed in several parts of the kiln in view of peep holes. When the first cone 04 does down it is a warning that the heat is approaching the proper point. When 03 goes down get control of your fire so that if 02 begins to bend you are prepared to check the heat quickly so as to prevent over-firing and fused kilns."

We thus see that in our kilns the cones required would not exceed 30 or 40, and as we have pointed out the cost of the cones is one cent each, so that the extra security obtained, and the closer check on the burning is worth many times the cost.

These cones were used by the writer in testing our Ontario clays, and it was found that in most cases clays fused between cones 08 and 05, so that in buying cones the numbers required in Ontario would vary between 010 and 02.

TABLE OF OFFICIAL MELTING POINTS OF CONES.

Cone No.	Degrees Centigrade.	Degrees Fahrenheit.	Cone No.	Degrees Centigrade.	Degrees Fahrenheit.	Cone No.	Degrees Centigrade.	Degrees Fahrenheit.
010	950	1742	5	1230	2246	19	1510	2750
09	970	1778	6	1250	2282	20	1530	2786
08	990	1814	7	1278	2318	21	1550	2822
07	1010	1850	8	1290	2354	22	1570	2858
06	1030	1886	9	1310	2390	23	1590	2894
05	1050	1922	10	1330	2426	24	1610	2930
04	1070	1958	11	1350	2462	25	1630	2966
03	1090	1994	12	1370	2498	26	1650	3002
02	1110	2030	13	1390	2534	27	1670	3038
01	1130	2066	14	1410	2570	28	1690	3074
1	1150	2102	15	1430	2606	29	1710	3110
2	1170	2138	16	1450	2642	30	1730	3146
3	1190	2174	17	1470	2678	31	1750	3182
4	1210	2210	18	1490	2714	32	1770	3218
						33	1790	3254

PART II.—THE MANUFACTURE OF CLAY PRODUCTS

The uses to which clays and shales are put are varied and widespread, and only those which are of more importance in Ontario will be considered. Among these the manufacture of brick, whether face, common, or pressed, plays the most important part. Other uses are the manufacture of hollow-block, terra cotta, roofing tile, drain tile, sewer pipe, paving brick, chimney flues, terra-cotta lumber, pottery, and Portland cement. Brick are made in Ontario from all the classes of clay mentioned above, as well as from the various shales, these latter being used in most cases in the manufacture of pressed brick.

In brick manufacture there are three processes known, (1) the soft-mud, (2) the stiff-mud, and (3) the dry-press; and all three processes are in use in Ontario. We will consider these in order.

Mining the Raw Material

The clay is as a rule simply dug with pick and shovel and transported by cart or car to the machine. In other cases, the clay is dug at the end of the brick-making season and thrown in a heap, where it is allowed to freeze and disintegrate throughout

Fig. 26.—A novel method of mining and transporting clay from pit to machine; Watson and Hutchison's yard, Bracebridge.

the winter. This serves to thoroughly break up the clay, and in the spring it is taken direct from this heap to the machine. In still other cases, the clay is collected by an automatic clay-gatherer, which is a revolving drum, hauled by a team of horses, and in passing over the clay bed, loads itself. This method of clay gathering is confined however, to dry clay, when the horses are driven over the surface of the whole bed of clay

In mining the shale, it is always necessary to blast. This is done in the usual way, by drilling a hole, either by hand or with machine drill, to a suitable depth. The hole is then charged with powder or dynamite, and blasted in the usual way. In some cases the surface of the shale, which on exposure to the air powders up or slakes is simply ploughed, and on being left, thoroughly disintegrates to a powdered form which can easily be worked in the machines. Those shales which are blasted require crushing before they can be used in any of the classes of machine used for brick-making. This crushing may be done in one of three ways. First, by passing the shale through a pair of jaw crushers, but this method does not produce a product of even grain, and is therefore unsatisfactory. A second method in more common use, is the use of rolls. These consist of two steel rolls, usually of unequal diameter, revolving in opposite directions, and with different velocities. The surface of the rolls may be smooth, corrugated, or pebbled. This machine works much better, but its capacity is not great enough. It is especially useful for clays which contain a few pebbles, as it crushes

Fig. 27.—Clay brought over the tops of the hacks by clay cars and cable, F. Entricken's yard, Stratford.

these, but allows the pieces to mix throughout the clay. The third, and most satisfactory method of crushing the shales, is the pan-mill, which consists of a large pan with a perforated steel bottom, so that the ground material may fall through when sufficiently pulverized. In the pan two large roller-like wheels revolve by the friction of the pan which turns below. The pan in turning carries the pieces of shale beneath these rollers, and these crush by their weight, which ranges from one to two tons and a half per wheel. Two scrapers are placed in front of the rolls, to throw the material in their path. A machine of this kind has capacity of eight tons per hour, or better.

Ridding the Clay of Stones

One method for removing the stones, is to crush them, but this is not very satisfactory, especially if the pebbles be limestone, for the pieces whether large or small remain in the clay, and on burning are converted into lime, which invariably expands, bursting the brick. The only proper method is to remove the stones entirely, and

this is a difficult problem. A first-class machine for the removal of stones from ordinary sun-dried clay, is the Bechtel disintegrator, manufactured by Bechtel Brothers, of Waterloo, Ontario. The stones here are removed by centrifugal motion, by which the stone, being heavier than the clay, is thrown to the outside, while the lighter pulverised clay works down, passing out through the bottom. This is an excellent machine, but can only be worked on dry clay. The only method in use in Ontario for the removal of stones from wet clay, is washing. The clay is dug and dumped into a circular pit, which may be from twenty to thirty feet in diameter, about three feet in depth and lined round the side with boards or brick. In one side a sluice-gate is left, which can be closed or opened at will. The clay is thoroughly wet, and round and round the pit a horse travels, turning a beam on which may be hung drags or wheels, which will thoroughly mix the water and clay. In a very few hours the whole of the mass will be thoroughly mixed and the stones will have settled to the bottom. The sluice-gate can then be opened and the upper soft clay slurry can be run off to a clay dump. This process at once removes the stones, and thoroughly tempers or mixes the clay. The cost of this operation will not exceed 35 cents per thousand of brick, and in every case adds at least 50 cents per thousand to the price obtainable as compared with bricks even from the same yard, made of unwashed clay.

Tempering

By tempering the clay is meant mixing it with sufficient sand, loam or other material to render it less strong or fat, and thereby bring it to a workable consistency.

The materials added to clay for this purpose, are often spoken of as "grogs," and many different kinds are used according to the ease with which they can be procured. Sand is by all means the best, as it mixes thoroughly with the clay and does not have any effect on the brick in burning, as the sand itself does not fuse. Unfortunately, however, sand cannot always be procured within reasonable distance, and then resort must be had to other means. In many cases a mild loam is used for red brick, and it not only tends to make the clay less strong but also improves the color of the brick by deepening it. In other cases, ground brick-bats are used, that is all the broken brick of the yard are ground up and added to the raw clay.

It is a serious mistake to use a strong clay without something to temper it, for the brick will almost invariably crack either in the drying or burning. Most of our Ontario clays, unless the bank be already sandy, will stand from a quarter to one-third their bulk of sand or other grog. In other countries, saw-dust, ground coal, charcoal, etc., are used.

The tempering may be done on an old mixing floor, which was the earliest method, by simply digging the clay over with a shovel. This has now been largely replaced by more modern methods. One of these is the ring pit, a description of which was given above in connection with the removing of stones by washing. Another process, still used to some extent, is the soak pit. The clay with its mixture of sand, etc., is dumped into a pit, a good supply of water poured over it, and the whole allowed to soak over night. This thoroughly softens the clay but does not in any way mix it. This has to be done entirely in the machine, and is not at all satisfactory. Both of these methods require so much handling and labor that new methods employing machinery have replaced them almost entirely.

The best of these is the pug-mill. This consists of an ordinary steel semi-cylindrical trough, which may be of any length, but usually from five to eight feet. Running lengthwise through the trough is a shaft on which are a number of knives or blades, set at such an incline that in revolving they mix the clay, sand, etc., thoroughly and at the same time keep feeding it along the trough towards the exit. Here the clay can be wet and tempered to the exact consistency desired. The machines take about six horse power and very little space, and can be placed so as to discharge directly into the moulding machine. They have therefore replaced almost all other methods of tempering.

Moulding

In discussing moulding we have now to consider the three processes of brick manufacture mentioned above, that is the soft-mud, stiff-mud and dry-press.

In the soft-mud process the clay, sand, etc., are mixed with sufficient water to make a soft mud. This is forced into moulds the shape of a brick. But since this soft mud would stick to the sides of the mould, they must be sanded each time before being filled. The earliest method was hand-moulding, that is a small mould was filled by hand, scraped off, and dumped, the mould resanded and filled again as before. This was the old method of brick making, and is still in use in a very few yards.

It is very slow, so that machines have been devised which will mould five or six bricks at a time. This machine consists of an upright box, either wood or iron, within

Fig. 28.—Hand moulding plant, Mouldy Bros., Kingston; one man moulds 2,000 brick per day.

which is a vertical shaft set with blades which mix the clay and at the same time force it downwards. At the foot of the shaft is a large arm with a flat face, which forces the clay into the press box. As each mould is filled it is automatically shoved out of the machine, where a man scrapes the whole mould free of surplus clay, then lifts the mould and dumps the six brick, when it is ready for re-sanding and filling again.

The sanding is sometimes done by hand, but is usually now done by machine. The sanding machine consists of a trough-like steel cylinder in which are a number of blades. The mould is dropped in, and one of these blades catching the mould carries it around with it in a revolution. The bottom of the cylinder is filled with dry sand, and the mould in passing through it is thoroughly covered.

In the stiff-mud process the bricks are not moulded into shape in individual moulds, but a column of clay is made and is cut off into the required shape. The clay is

tempered with less water and is consequently quite stiff, as the name would indicate. This clay is thrown into a cylinder-like machine, larger at one end than the other. Within this machine a shaft revolves on which blades are set, which form an auger. At the smaller end of the cylinder a steel die is placed, and through this the clay is forced by the auger movement within the cylinder or barrel. The shape of this die is varied according to the class of article produced, that is, a column of clay may be required which can be cut along the largest face into brick, that is the brick would be cut along their broad, flat faces. These are known as side-cut brick; or again a column of clay may be required which can be cut across the ends into end-cut brick; or again even rectangular hollow bricks or blocks may be required; in all these cases the nature of the die can be changed to suit the requirements.

On account of the very solid nature of the stiff-mud clay, a great deal of friction against the sides of the die results, so much so in fact, that the outside of the column of clay is retarded more than the centre, which interferes seriously with the uniformity of the resulting brick. To overcome this trouble, the die is often heated by steam, a hollow jacket around the die serving for this purpose. Or again, it may be lubricated the oil being fed through small apertures or cuts facing the front of the die, so that the clay cannot enter them.

Fig. 29.—Bechtel automatic end-cut cut-off machine in operation at Stratford Brick, Tile and Lumber Co's yard.

The column of clay on leaving the die is cut into brick by means of a stiff wire. In the first or side-cut machines, these wires, usually four in number, are set on a frame, and when sufficient clay has passed through the die to make four brick, the frame is drawn across the column of clay and the brick are lifted off. For side-cut brick the wires are sometimes increased to eight.

Recently, two or three methods of automatically cutting off the brick, have been devised. The first of these consists in a large frame with eight or more wires attached, which can pass from side to side across the column of clay. When the bar of clay has issued to a sufficient distance to press a lever, the frame is forced to cross and the brick are then removed in the ordinary way. The method is used chiefly in the side-cut process. A new and improved method is now used for both side-cut and end-cut brick. This consists of a delivery table, the floor of which is a series of small rollers. As the clay is shoved over these, the machine is operated, so that it makes no difference at what rate the column of clay comes from the machine, the speed of the cut-off is regulated by it. A spool-like reel is set above the column of clay, and on each bar of

the reel a wire is stretched. As the clay passes beneath the reel, these wires are forced through the column, cutting it up into end-cut or side-cut brick as required. The machine is manufactured by Bechtel Brothers of Waterloo.

In the moulding of dry-press brick we have the clay almost dry, as the name would indicate. Thus the shape of the brick has to be produced entirely by pressure. As we have seen above, dry-press brick are usually made from shale, which requires to be ground up by one of the processes described above. This dry or nearly dry pulverized shale or clay is then fed into steel moulds, which are heated by steam to prevent the clay sticking to the mould. A plunger descends, pressing the clay into the mould, at the same time the bottom of the mould rises, so that all the pressure will not be exerted on one face of the brick. A pressure of about eighty tons is thus put upon each brick, four being made at a time. As the plunger rises, the made brick are shoved ahead and the moulds are refilled. A machine capable of making four bricks at a time is made by the Berg Company of Toronto, and has a capacity of about twenty thousand brick for a day of ten hours.

Fig. 30.—Slop-brick plant in operation, Crediton. The brick are dried in the open yard as shown in the photo.

The great advantages of the dry-press process are, that with one operation there is produced a dry, hard brick with sharp corners and edges, and one capable of carrying an immense load. It is thus especially well adapted to large buildings with high walls.

We occasionally find that soft-mud or stiff-mud bricks, after their preliminary moulding are considerably improved by being subjected to a re-press process. This requires the use of a small steel mould about the size of an unburned brick, which has a movable top and bottom. The brick can be placed in this and subjected to a re-pressing process, the top being lowered by means of a screw and the bottom raised by a screw or lever. Most of these machines used in Ontario are small hand-power machines, with which a man, with a helper, can re-press about 3,000 brick per day. The stiff-mud brick can be re-pressed at once at the time of moulding, but the soft-mud brick have usually to be dried from three to six hours before being subjected to the re-press process. This method is not much used, unless a very few choice face brick are required, and the dry-press brick have practically made the re-pressing of ordinary brick entirely unnecessary. The chief value of re-pressing was to straighten the edges, square the corners, and to increase to some extent the strength of the brick.

Drying

Brick that are made by either the soft-mud or stiff-mud process have to be freed from most of their water before they can be burned. This is done in several ways. The original method of drying brick and that still used in hand-moulding yards, is to simply lay the brick on their flat surfaces on a level sanded yard, and allow them to dry in the sun. The moulds containing the soft brick are turned out on this yard, and the brick are allowed to dry here for five to eight hours, when they will be sufficiently dried to stand handling. They are then picked up and "hacked" out in the ordinary way. This method is cheap, but has several disadvantages. It requires too much yard space and extra handling, and should a shower of rain fall on the brick they are spoiled entirely. Once the brick are hacked they can be covered by hacks or a few loose boards, but it is a common thing to see a whole yard of bricks spoiled by an hour's rain. This method then, is almost entirely displaced by new processes of drying.

Fig. 31.—Rack and pallet yard, Cain Brick Co's yard, Ottawa. The kiln shed is in rear.

The first advance over the old method is the covered yard, that is, a series of narrow scoop-roofs are so arranged that they can be thrown open to the sun or quickly closed down in case of rain. They are commonly pivoted, so that they can be turned to any position to meet a storm from any quarter whatever. Their chief disadvantage is that a driving rain will beat under the edges of the roof, and spoil several of the lower courses of brick. A further disadvantage is, that each brick has to be laid or hacked separately, and this not only is rather slow work, but requires considerable skill, and it is not easy to get men to do this part of the work.

The result is, that a new system of drying, known as the "rack and pallet" system has almost entirely replaced the open hack-yard. For this new system a series of covered frames is erected about five feet and a half in height, and from one hundred

to two hundred feet long. Beneath each of these roofs cleats are so placed that from seven to ten pallets, each capable of holding six brick, can be set like a series of shelves, to dry. When the brick are dried they are lifted from these pallets, and taken to the kilns as usual, while the empty pallets are returned to the machine to be refilled. This yard has the special advantage of being easily handled, as anyone can lift a pallet from the barrow ,and place it on the rack. The chief disadvantage is that it requires a large number of pallets, but as these are made from rough lumber or strips of any kind, lath for example, and do not wear or get destroyed in any way, they are not expensive.

These are the only systems of open air drying in use in Ontario, but there are other systems of artificial drying which are becoming quite popular. The first of these in the tunnel dryer. For this system a yard is supplied with cars, capable of holding from three hundred to three hundred and sixty newly made brick. These care are

Fig. 32 —J. Logan's yard, Greenwood avenue, Toronto; showing Sheldon dryer and down-draft kiln.

loaded at the machine; they are then run into a tunnel, closed in on all sides, and through the tunnel a blast of warm air is forced by a fan. The wet brick enter at the cool end of the tunnel, and as car by car of dry brick are taken from the opposite end of the tunnel, these damp brick are brought nearer and nearer to the hot blast. In this way the wet brick are prevented from being cracked and checked by being exposed directly to a hot dry blast. This forms a very good system of drying, its only disadvantage being that it requires a large number of cars, since the brick are not unloaded from the time they leave the machine till they reach the kiln yard. But as these bricks can be dried in thirty-six to forty-eight hours, the rapidity with which the brick are dried, counteracts to a great extent the disadvantage of requiring so many cars. This system of drying is installed by the Sheldon & Sheldon Co., of Galt, Ontario, and is the best system for drying ordinary stock brick seen in the Province.

Another system of drying is known as the Bechtel Carless Dryer, which overcomes the difficulty of providing so many cars. A series of three or more shallow trenches are made in the floor of a shed, well closed in. Into the end of these trenches a blast of warm dry air is forced by a fan, and by means of dampers the blast can be turned into one or other of these trenches as desired. The newly made brick, if made by the stiff-mud process, are piled on a single pallet, say eighty to one hnndred brick, or if made by the soft-mud process each mould is dumped on a separate pallet, and eight to twelve pallets are piled one on another in a heap. Lifts on the ends of the pallets prevent them from touching the under brick. These piles of brick are then wheeled in by a specially devised truck, and are set in a row over one of these trenches. They are then covered by a loose canvas and the blast of air is turned into that trench.

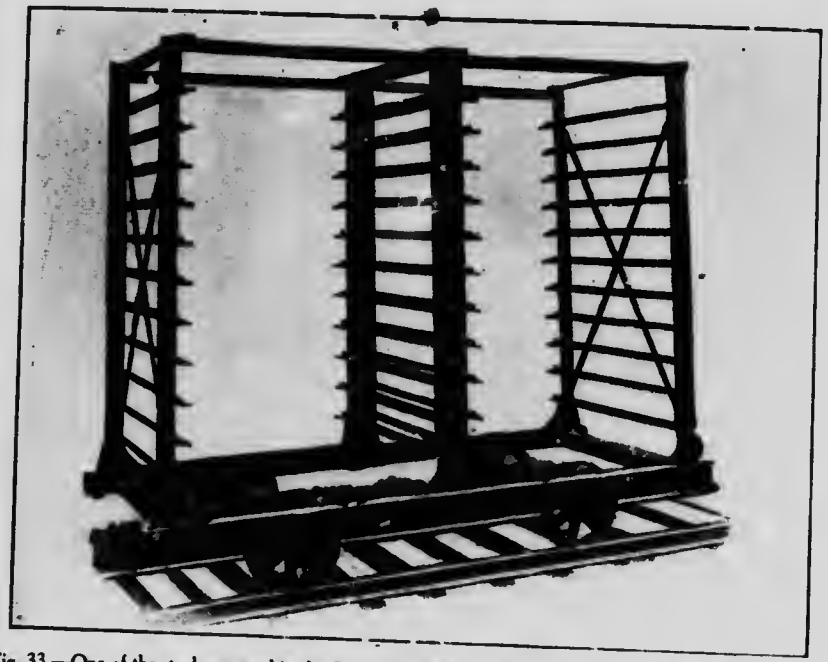


Fig. 33.—One of the steel cars used in the Sheldon and Sheldon tunnel dryer, capacity about 330 brick.

This air distributes itself from end to end throughout the trench, and in rising through the moist brick escapes through the loose canvas, thereby drying the brick. This method is especially well suited to the drying of wire-cut brick, as it combines quick handling and rapid drying with few pallets required. Furthermore, the brick when dried can be picked up by these trucks, eighty to one hundred at a time, and wheeled to the kilns. This dryer is made by Bechtel Bros. of Waterioo, Ontario.

The only other system of artificial drying in use in Ontario is the open floor dryer. This consists simply of an open floor, beneath which are placed a series of iron pipes, or a series of flues, or even a blast of warm air may be blown. The heat and accompanying rising air passes up through the floor and dries the brick. This method is not in much use, as it is too expensive and where employed at all only the exhaust steam is used. This system is somewhat used in the drying of tile. For brick, the distribution is too unequal, and too much labor is required in handling the brick.

Burning

The last step in the manufacture of brick is the burning. After the brick have been dried by any of the methods mentioned above, they are wheeled in to the kiln-yard, where they are placed for burning. The commonest method for burning, is in the open-shed scoved kiln, or as it is commonly called, the Dutch clamp kiln. For this method a perfectly dry kiln-ground is required. This can be easily attained by drainage, etc., or if the ground is slightly damp, a couple of courses of burned brick may be used as a floor, or what is cheaper and quicker still, a layer of tar paper may be used to good advantage. On this the dried brick are piled, leaving spaces on all sides through which the heat may rise freely. Fire arches are built of the unburned brick, to a height of two feet and a half to three feet at the crown, the arches being usually placed the length of four brick from each other, and run right through to the opposite side of the kiln. The brick are set on edge and are piled thirty-two to thirty-six courses high, air spaces being left all through the kiln. There are many different methods of piling these brick, the commonest of which is to pile the brick

Fig. 34.--Open shed scoved kiln, showing method of setting and nature of arches. Note wheels on base of uprights of shed, to enable it to be moved over the kiln ground from kiln to kiln; W. Hedden's yard, Crediton.

six on two, that is six sideways on two lengthwise, and dividing the space proportionately. Around the outside of the kiln the spaces are usually made greater, as it is difficult to get the heat to the outside, the tendency being to chimney in the more central parts of the kiln, which would leave the outside brick soft. No attempt will be made to describe how these brick should be piled, as no two brick men are entirely agreed on this matter, but each one varies the piling to suit the particular behavior of his clay. When the kiln is built, an outside cover or "scoving" of burned brick is placed round all four sides, wider at the bottom than at the top. The top of the kiln is left open, or is at least covered loosely with a floor of burned brick, known as the "platting." Around all four sides, outside of the scoving of burned brick, a coating of wet mud is placed, which prevents the heat from escaping through the sides, and also prevents the entrance of any cold draught through the sides of the kiln. In this way the whole kiln can be raised to a temperature of 2,000° Fahrenheit. Over the kiln an open shed is usually built, to prevent the rain from chilling the brick, and from washing off the mud from the scoving, which would then admit cold air. When the kiln is burned, this scoving is torn down, when the burned brick can be shipped as

required. This building up and tearing down of the scoving each time entails a great deal of labor and expense, as it requires a great many brick and most of these are soon broken and rendered useless. Hollow blocks are now used to a great extent instead of brick for scoving, with the advantages of quicker building and tearing down, less handling and less breakage.

The next step in advance of this style of kiln was the building of two permanent walls, in which the fire holes were placed, while the ends were left open. Such a kiln could be filled to any desired size, and the two ends scoved up as usual. This style of kiln is becoming very popular, and saves the building and tearing down of two walls at least, each time a kiln is burned.

Still another step in advance was the building of four permanent walls, leaving only doors for charging and discharging the kiln. The fire arches are also permanent, and run from side to side beneath the kiln proper. The heat rises up through the floor and through the unburned brick.

Fig. 35.—Permanent walled up-draft kiln, capacity 250,000 brick; London Builders' Supply Co., London.

These are all examples of up-draft kilns, that is, the heat enters the bottom, rises through the brick and escapes from the top.

The next great step and one which marks a big advance over the old method, was the introduction of down-draft kilns. These are becoming very popular throughout the Province. They may be round or rectangular in shape, but the principle underlying them is the same. They are necessarily permanent kilns. The fire holes are placed outside the kiln and extend just through the wall. The heat then rises through a pocket, which may be built of unburned or of burned brick, to the top of the kiln, striking the dome. It then passes down through the unburned brick, and out through the floor which is left open, beneath which a series of flues connect with the chimneys. Thus we see the course of the heat here is exactly reversed, and the great advantage of this style of kiln is, that by the use of dampers, the heat can be thrown to any part of the kiln, so that the whole of it can be burned alike. Moreover by dampering, the fires can be so regulated that the brick are not fused, as was often the case in the other style of kiln, nor is there much waste heat. In kilns of this kind, the burning can be so regulated that over ninety per cent. of the output will be good, hard face-brick. Again, where two or three of these kilns are placed in a series, the waste heat from one in the cooling stages, can be drawn through another, to warm it up, preparatory to burning.

So much then may be said for the types of kiln commonly used throughout Ontario. There is one other system, however, in use in two places. It is known as the continuous kiln. A series of chambers are arranged side by side, in a large circle or

Fig. 36.—Round down-draft kiln, five arches, with chimneys outside; capacity 60,000 brick.

Fig. 37.—A rectangular down-draft kiln, capacity about 120,000 brick.

sometimes in an oval. Two or three of these are filled and the fire is started under say No. 1. By a system of dampering, the waste heat from No. 1 is drawn through No. 2 and 3. In the meantime No. 4, 5, etc., are being charged. By the time No. 1

is burned, the fire has been gradually coaxed into No. 2, and so on, the process is repeated throughout the circle, so that once the fires are lighted, they are never let out, but are drawn round and round the kiln, from chamber to chamber, some chambers being burned while others are being charged, and still others are being discharged. This is known as a continuous kiln, and its advantages are apparent.

Fig. 38.—16-chambered continuous down-draft kiln, capacity 340,000 brick ; Port Credit Brick Co.

The Question of Fuel

The first step in the burning of every kiln, is the removal of a certain amount of moisture, which remains after any one of the systems of drying mentioned above. This process is known as steaming, or water-smoking. This should always be done slowly, as too rapid heating will burst the brick, either by the escaping steam or by forming a crust or shell around the brick which prevents the moisture from the centre escaping. The water-smoking should be done with wood as a fuel, or coke, for if coal be used the soot will lodge in the spaces between the brick and choke the kiln. After the water-smoke is off, any fuel may be used for the burning, but dry fuel should always be used as far as possible.

A great deal has been said on this subject and the question is commonly asked, "Which do you find cheaper to burn, wood or coal?" The answer to this depends entirely on the kind of wood or coal burned. Unfortunately, the majority of brick-makers get the poorest class of wood to be had in the neighborhood. This is a great mistake. The brick-maker should get as good wood as possible, and particularly dry wood, that is wood that has been cut for at least a year. Each 10 per cent. of moisture

in wood detracts 12 per cent. from its heating value, and since wood which has been cut even for a year, contains 25 per cent. of water, 30 per cent. of the heating value is used in driving off this moisture, before any of the heat is available to burn the brick. This being the loss with dry wood, how much greater is the loss when wet, punky wood is used?

Another point not generally known, is that one kind of dry wood has the same heating value as another, when considered weight for weight; that is one pound of dry pine has the same heating value as one pound of dry hickory or maple. To compare these with coal, it is found that taking air-dried wood:

1 cord of hickory or maple, weighs	4,500 lbs. =	1,800 lbs. soft coal.
1 cord white oak, weighs	3,850 lbs. =	1,340 lbs. soft coal.
1 cord beech or red oak, weigh	3,250 lbs. =	1,300 lbs. soft coal.
1 cord elm, weighs	2,350 lbs. =	940 lbs. soft coal.
1 cord pine, weighs	2,000 lbs. =	800 lbs. soft coal.

From the above it will be seen that one pound of soft coal is equal to about two and a half pounds of any kind of dry wood, and that pound for pound, one kind of wood is as good as another, if dry. Again, one cord of maple is as good as two and one-half cords of pine, and one cord of pine is about as good as a cord of elm. Other comparisons are obvious. It would appear, however, since a cord of dry maple is not equal to one ton of soft coal, which rarely costs over three dollars and a half, that coal is the cheaper fuel to use. Moreover, coal takes less handling and less yard-room.

The burning of clay in the manufacture of brick, is probably the most important part of the industry, for the best of clay can be spoiled by poor burning. Two classes of brick are made in Ontario, red brick, and buff brick, commonly spoken of as white brick. The red color of the brick is caused by the iron in the ferric state. Strange to say, the clay from which red brick are made and the clay from which white or buff brick are made, have in Ontario, practically the same percentage of iron, but the difference in the result of burning is caused by the high percentage of lime in the clay used for white brick. This lime prevents the iron burning to the ferric state, and thereby prevents the brick from burning to a red color.

The word ferrous comes from the Latin root "ferrum," meaning iron. Iron has the power of forming two classes of compounds; for example, it can combine with oxygen in the ratio of 1 to 1, forming the compound FeO, known as ferrous oxide. Or again, it can combine with oxygen in the ratio of 1 to 1½, but as we have no half quantities in chemistry, this formula must be doubled, thereby being written Fe_2O_3; this is known as ferric oxide. Thus the "ic" compounds are the more highly oxidized. Hence the statement above that the red color of clay products is due to some compound of iron in the ferric state. These two conditions are brought about by the character of the atmosphere of the kiln in which the goods are burned, *e. g.* if a kiln be burned with the drafts well opened, so that plenty of air is admitted, we will have an oxidizing atmosphere within the kiln, and this will tend to produce ferric compounds, which as we see would be red. On the other hand if a kiln be burned in which the drafts are not kept freely open, a scant supply of oxygen is admited, and this is not more than is required by the burning fuel. The result will therefore be that the kiln will be filled with reducing gases, and this will produc buff-colored goods. Therefore in burning red brick, tile, or other products, a liberal ount of air is required, while in burning white brick, tile, etc., too much air should not be admitted.

Flashing

One other point in connection with burning, which requires special attention, is flashing. Many bricks used for the fronts of large buildings, especially where pressed brick are used, are purposely flashed. This consists in darkening the edges, while the

centres of the faces are left the proper color. This darkening is caused by a special treatment in firing, that is by so placing the brick that the edges to be flashed are exposed to reducing conditions at some stage in the burning. In this way the iron is reduced to the ferrous state, and at a later stage they are suddenly exposed to an oxidising action, which darkens the edges to a rich reddish-brown, or even a greenish tint. The oxidation usually takes place in the cooling stages of the burning. If all the brick are desired a light grey color, the cooling should be done with all the air entrances closed.

The flashing, to which special reference should be made, is not that referred to above. The trouble, as most of the brick-makers in Ontario know, consists of red flashes or streaks on white brick and tile, and is due to some of the iron in the clay having been oxidized to the ferric state. The Erie blue clay mentioned above as occurring over the greater part of Ontario, has roughly 5 per cent. of iron. If this could all be burned to the ferric state, the brick would be red, but the presence of so much lime in the clay prevents this. Where the percentage of lime is three times or over the percentage of iron, it will prevent the iron being burned to the ferric state. Instead of that we have ferrous carbonate, and this gives the buff color to the goods. If anything should happen to cause the oxidation of a little of the iron to the ferric state, a red streak or flash would be produced. In following a kiln of white brick, we see that first the water- smoke is driven off by a slow fire, then the kiln is heated up; between fires when the kiln is going well, the doors are closed and in many cases they are even mudded over. The consequence is a scarcity of oxygen, and a reducing atmosphere within the kiln. This as we have seen forms ferrous oxides, carbonates and silicates. This is quite correct, and should be the condition for white goods. The flashes, however, occur in the cooling stages. After the kiln has been burned, as we have seen above, it is closed up, and allowed to cool for a couple of days, *i. e.* the drafts are all closed up. But as the kiln cools it naturally contracts, *i. e.* the bricks in cooling contract as well as the air within the kiln. The result is, they tend to occupy less space within the kiln. Cold air must therefore get in to fill the unoccupied space. It cannot enter through the doors, since they are closed and mudded up, it therefore comes down through the chimneys, and through the flues, rising through the floor it meets hot brick, whose compounds we have seen, are in the ferrous state. This fresh air at once oxidises some of the ferrous compounds, especially the oxides to the ferric condition, and a red flash is produced. This of course all applies to those burning in down draft kilns, and it is in these that the difficulty is met. We thus see that to prevent flashing white goods, we must prevent oxidising drafts coming in contact with the hot brick. Probably the best way to overcome this difficulty is to keep one or two fires burning lowly during the first day or so of the cooling, thereby allowing the kiln to cool off gradually, and at the same time enabling a reducing atmosphere to be preserved till the brick have cooled to a point where the admission of air can no longer oxidize them. For burning red goods just the reverse is required, that is, a plentiful supply of air must be admitted throughout the whole of the burning and cooling.

For burning brick with coal, it is always best to water-smoke with wood, and even to heat up from four to six hours with wood before going on to coal.

One other point should be mentioned in connection with the cooling of the kiln. This should never be hurried, for if brick are cooled too quickly the outside of the brick cools too quickly for the interior, and the result is that the kiln is "shaken," or in other words, the brick will be all cracked.

In burning brick in open-shed scove kilns, great difficulty is experienced in distributing the heat evenly throughout the kiln. A great many devices have been tried to overcome this difficulty. In the old country the raw clay has been mixed with sawdust, ground charcoal, or powdered coal, so that in burning, these combustible products would help distribute the heat. In Ontario, powdered coal has been used in this way

for the bricks placed in the heads of the kiln, the user claiming good results from the practice. There is never any difficulty in getting sufficient heat up through the centre of the kiln, but it is difficult to get sufficient heat to pass up through the heads to burn them to hard brick. This is accomplished to some extent by leaving the spacing wider in the heads than in the central part of the kiln in piling the brick, but this is not altogether satisfactory. A very ingenious method and one employed to some extent in Ontario, is to place a small ridge of hard coal screenings around the edge of the kiln on top of the platting. After the fires have been started, and the heat has worked pretty well up to the top, the kiln man goes up with a small wedge-like poker, and works the bricks slightly so as to allow a little of the screenings to trickle down through the heads. These take fire, and by their heat not only help to burn the brick, but induce a little additional draft up through the heads, drawing more of the kiln-fire to those parts of the kiln. This operation is repeated every hour, only a little of the coal screenings being allowed to trickle down each time. This must be carefully watched so as not to allow too much to enter, so as not to block or choke the drafts through the heads. In the kilns where this is used, excellent hard face brick were taken from against the scoving, and the process seems entirely to prevent the occurrence of soft brick in the heads. The coal is piled about eight inches deep, and sixteen inches wide, at the base, tapering down from the crown to the [illegible]

PART III.—THE CLAY INDUSTRY IN ONTARIO

Having now dealt in a general way with the subject of clays and their occurrence in Ontario, let us take up the industry in more detail.

To do this we will discuss it connty by county. It was found impossible to call at all the brick and tile yards and all the potteries in each county, but as many as possible were visited, and suggestions were made and samples were collected at many of these.

A detailed description of the plants found at the various yards is given in order that those directly interested in clays may see points in which their plant, or processes of manufacture are perhaps capable of improvement. The clays will each be referred to its proper class as described in the former part of this report, viz.: Red-top clay, Erie clay, Saugeen clay, etc.

Addington

J. Sauls, Tamworth: This yard is situated in a hollow about two hundred yards from Tamworth station. There is about three feet of Red-top clay lying on Erie clay, and this is dug by hand and carted to a tempering heap close to the machine; here it is mixed with sand, and wheeled in barrows to a Martin machine run by horse power.

The brick are "hacked" out to dry and are burned in up-draft scoved kilns with wood as fuel. Red brick only are made here.

Algoma

W. A. Evans, Sudbury: This yard is situated about two miles west of Sudbury on the Copper Cliff road. A very excellent clay is found here. In some places it is rather sandy, especially on top; but these spots are quite local, and the clay as a whole is excellent. The Saugeen clay is dug directly from the bank and hauled by car and cable to two Iron Quaker machines. These are run by steam power, the hoisting also being done by steam. The brick are hacked out in the usual way to dry in open yards, and are then burned with wood in open-shed scoved kilns, also one case kiln. The output of this yard is about three million per season; all red brick.

A new use for this clay has recently been found by the Canadian Copper Company

at Copper Cliff. In lining their converters, fire clay was always used, but running short of fire clay they got some of this clay from the brick-yard, and on trying it found it to give very good satisfaction. The result has been that they have been using it since, and it is claimed to work quite satisfactorily, although, of course, not the equal of fire-clay, but when it can be dug within two miles of the works, at comparatively little cost, it is considered to be no small advantage. The analysis of this clay is given as No. 68, page 26 of this report.

M. McVittie, Whitefish: This is a small yard situated at Whitefish on the Sault branch of the C. P. R. There is the usual section of Saugeen interbanded clay, which is dug in the fall, put in a heap and allowed to slake. It is then wheeled to a Martin machine run by steam power. The brick are hacked out in the ordinary way to dry, and are then burned with wood in open-shed scoved kilns. A good quality of red brick is made, and the output is about 700 thousand per season.

The Algoma Commercial Company, Sault Ste. Marie: As we work westward from North Bay we find the clay becoming much stronger, the bands thicker, and very much redder in color, so much so that by the time we reach the Soo the clay is quite red in color, resembling very much the Medina shales worked at Milton, Hamilton, etc. At the above mentioned yards a very high bank of red Saugeen clay is found. This bank was exposed in making a cutting for the Algoma Central railway, and was acquired by the Algoma Commercial Company for the manufacture of the brick required for their many beautiful buildings at the Soo. They, however, installed a dry-press plant, which has not worked altogether successfully. The trouble appears to be that the clay was not ground fine enough, nor was the burning quite hard enough, as all the softer brick upon exposure to the weather, especially to moisture, have been found to crumble readily.

The clay was dug from the face of a bank in places twenty feet deep. It was hauled by car to a long shed, the floor of which was composed of steam-heated coils. The clay was dumped on this to dry, after which it was taken in cars and dumped to a hopper from which an elevator took it to storage bins. These in turn fed a pan-mill, where the clay was ground; but the grinding does not appear to have been fine enough. This is the difficulty which all makers using clay instead of shale are experiencing as yet in Ontario. The clay must be ground to a very fine powder. The ground clay was then fed to a Simpson dry press, and the brick wheeled directly to a series of six rectangular down-draft kilns. The water smoking was done with wood or coke and the final burning with soft coal. Those brick which were composed of fine enough material and which were burned sufficiently hard are a very superior brick, and there is little doubt that with these two points improved an excellent product would result from this clay, as the color, etc., was excellent. This plant is not working at present. The analysis of this Saugeen clay is given above, No. 69, page 26 of this report.

Charles Lethbridge, Sault Ste. Marie: This is a small yard situated about three-quarters of a mile northwest of the last mentioned yard, where there is the usual section of Saugeen clay, here very red in color. This is dug and carted to a pug-mill feeding a new Quaker machine. The bricks are dumped on pallets and dried by the rack and pallet system, after which they are burned with wood in open-shed scoved kilns. The output is about 500 thousand per season, all stock brick. Pressed brick is made from the same clay by the Algoma Commercial Company. Here we have stock brick made from it by the soft-mud process, and in the yard to be described next we will have wire-cut brick made from the same clay by the stiff-mud process.

Elliot & Sons, Sault Ste. Marie: This is one of the most interesting yards in the Province. Mr. Elliott, who was a brick-maker in England, came with his family to Canada, and he and his several brothers have had brick-yards in various parts of the Province; for example, at Wingham, at Thedford, Glenannan, Bluevale and the Sault. At the last named place it was found difficult to get a machine, so Mr. Elliott

built a little furnace, bought scrap-iron, and after melting his iron, made his own machines completely from his own patterns and ideas. Everything in his yard in the way of equipment has been designed and manufactured on the place, and a better equipment would be difficult to find in the Province. He manufactures wire-cut side-cut brick, also tile and block, all of excellent quality. His clay is dug and hauled by cars with a horse to the machine of his own make, which resembles very closely a Kells machine. The brick are then piled on pallets and dried in a rack and pallet yard, and are then burned in open-shed scoved kilns and also in one rectangular down-draft kiln of Mr. Elliott's own design. This is not a large yard, making only about 800 thousand brick, with some tile, etc., but the originality displayed by Mr. Elliot in every part of his yard is a great credit to him.

Brant

Wm. Blacker, Brantford, makes white brick only; this is an old yard. The clay is got from the face of a large hill, which is composed of a very sandy blue clay. It is blasted out in winter and allowed to slake until spring, when it is carted to a

Fig. 39.—Double rectangular down-draft kiln, one set of chimneys for both kilns; F. Entricken's yard, Stratford.

Martin brick machine which turns out a first-class stock brick. The brick are dried in a rack and pallet yard, and are burned in a double long walled rectangular down-draft kiln. There are two kilns placed side by side with a row of chimneys between the two, which serve for both kilns. The fire holes, ten in number, are all located in the outer wall of each kiln.

Brantford Brick Company, Limited, Brantford: Manufacture red stock brick from a very sandy red clay which has been collected locally and varies in depth from three to twelve feet. It is underlaid by the Erie blue clay, but this is not used. The clay is dug in the fall or early spring, and is piled in heaps interlayered with proper proportions of sand. The whole section is then cut down and wheeled to a Martin machine. The Bechtel Carless dryer is used to dry the output of 12,000 per day, and the dry brick are burned in ordinary scoved kilns, and are of very fine quality.

Sam Allen runs a red brick yard at Brantford, and uses a similar red clay to that at the Brantford Brick Co.'s yard. He hauls his clay by cart from about three-quarters of a mile, and heaps it with sand in proper proportions to temper. It is then

put through a Baird pug-mill and a Quaker soft-mud machine. The brick are dumped on small pallets and are hacked out in open hacks to dry. The burning is done with wood in scoved kilns, and the output is about 8,000 per day.

These are the only red brick yards in Brantford, but there are two white brick yards.

J. Workman, Brantford, makes white brick. His clay, like that in Mr. Blacker's yard, is a very sandy blue Erie clay, which is picked out and loaded into Baird automatic dump-cars; these are hauled by cable to a Martin machine and a good stock brick results. Drying is by the rack and pallet system, and the brick are burned by wood in open shed kilns.

N. B. Card, Harrisburg, has from one to three feet of good Red-top which is burned to red brick. Beneath this is the grayish blue Erie clay, which burns to white brick and tile. He uses horse power and a Martin machine, and makes about one-half a million brick per year. The deposit is a good one and is worthy of much more extensive use.

Bruce

Reid Bros., Hepworth, manufacture white end-cut wire-cut brick from a very stiff blue Erie blue clay. This is hauled by cart to a pair of rolls feeding a Kells No. 2 machine; the Bechtel automatic cut-off is used and Bechtel trucks to open hacks. The burning is done by wood in four round down-draft kilns. The clay here is a very fat, stiff clay, with little or no sand, but burns to a good close brick or tile. This yard manufactures about a million brick per year.

Fig. 40.—Bell Bros' yard, Paisley.

Bell Bros., Paisley, have from a foot to a foot and a half of the Red-top clay, lying on a brownish red clay, and this in turn on the blue Erie clay. This reddish brown laminated clay corresponds with the yellowish brown clay of southwestern Ontario lying between the Red-top clay and the blue Erie clay proper. Bell Bros. use the first eight feet of reddish brown and Red-top clay, digging it together, and cart to a Kells machine, making first-class white brick and tile. The brick are then cut, and wheeled on Bechtel trucks to open hacks. The brick are burned in open shed kilns and the tile in round down-draft kilns, the fuel in each case being wood.

The Erie clay here is very deep, the Saugeen river flowing between high banks of blue Erie clay.

William Adamson, Walkerton, manufactures only red tile and hollow block, using an English plunger machine. He burns in a square down-draft kiln, with a mixed fuel of wood and coal. The clay here is the typical Saugeen clay described above. The thin bands of reddish brown clay and grayish sand alternate from top to bottom of the bank, making a very odd but interesting section. The bands are not over half an inch in thickness, and give a perfect mixture when the cliff is dug from top to bottom. The individual bands of clay would be much too strong to work by themselves, even could they be obtained, so that the alternating bands of sand are the salvation of the deposit. The bank itself is eight feet thick and rests on a bed of white quartz sand, the upper two inches of which have become cemented into a flag of sandstone by the calcareous material derived from the overlying clay; beneath this the sand is quite soft and granular. The clay is dug and wheeled to a pug-mill which mixes it thoroughly; it then drops to a cotton belt carrier which feeds the plunger machine. The tile produced are very smooth and free from cracks, and are claimed to stand the frost and burden admirably.

L. Yaack, Walkerton: This yard is situated about one mile northeast of Adamson's yard, but strange to say contains quite a different clay. It is situated on the opposite bank of the Saugeen river at about forty feet higher altitude. The clay here is the usual Erie blue clay with the yellowish brown top, from which white brick only are made. The clay is ploughed in the fall and scraped into heaps, where it is allowed to freeze during winter. It is then wheeled to a Close machine making side-cut wire-cut brick. The clay is practically free from stones, and works up well after freezing. The brick are piled six on a pallet and are dried by the rack and pallet system. They are burned in one round down-draft Cornell kiln, and in one square down-draft kiln with permanent side walls and open ends which are scoved up as usual.

Carleton

Morris & Ballentine, Billings Bridge, have a great depth of red burning clay. The first five feet is quite strong; this is followed by about seven feet of milder yellowish brown sandy clay; below this is the typical blue Leda clay which corresponds to the Erie clay in the west. It has the same blue color, is equally tough and strong, and at Ottawa is ninety-four feet deep; burns to red goods, but differs in having the marine shells as described in the preliminary part of this report. The red, the yellowish, and sufficient of the underlying blue clay are all dug together and loaded to antomatic dump-cars which are dumped into a Baird pug-mill. This feeds a pair of rolls, which crush any small stone present, and the product is fed to two machines, one being a Martin, and the other a Standard, manufactured in Ohio. The brick are then piled, one hundred to a car, which is run to the rack yard where the pallets are piled off as usual. The dried brick are again piled on the cars for "wheeling in." The burning is done in open shed kilns, scoved as usual, the fuel used being wood. This company manufactures over two million brick per season.

H. Mulligan, Harvard, Ottawa, has a deep bank of the Leda clay on the shores of the Rideau canal. The clay is dug in the winter time to about water level, and is piled in heaps to freeze; it is then hauled in cars which dump to a pug-mill, which in turn feeds a pair of rolls, and Hercules six-brick machine. This is a good type of soft-mud machine; it is built entirely of steel, and is open to view all the time, so that any change of temper can be readily effected. The bricks are dried by the rack and pallet system, and are burned with wood in open-shed kilns, and in one round down-draft Cornell kiln. Only red brick are made and the output is about one million and a quarter per season.

The Ottawa Brick Manufacturing Co., Harvard, Ottawa: This company operate a large yard and manufacture about two and one-half million brick per year. They have the same clay as Mr. Mulligan, and the description of it will apply to

all the Ottawa yards. The clay is dng in winter, and heaped to slake; it is then wheeled in barrows and dnmped into three pairs of rolls, which in turn feed two pug-mills and one belt conveyor; these feed three Martin machines, the brick are dried by the rack and pallet system.

The bnrning is done in one large twenty-four arch, permanent walled np-draft kiln, capable of holding four hnndred thousand brick. In addition to this, open shed scoved kilns are nsed, the fuel in both cases being wood. Three independent gangs operate in this yard, giving an output of four million red brick of first-rate quality per season.

Odell Brothers, Ottawa: The same olay is fonnd here as in the other Ottawa yards, so that a description of it is not necessary. The clay is dug in the winter as usual and allowed to slake; it is then wheeled to a Quaker, and a Martin machine, the brick are dried by the rack and pallet system, and are bnrned with wood in scoved kilns without sheds. In case of rain the kiln is covered with loose boards. The operator claims that the time saved in loading and unloading the kiln, together with the advantage of building his kiln at any point on his yard more than makes np for the extra handling of lnmber and loss in case of storms. For his yard he would reqnire a mnch larger shed than he cares to build. He mannfactnres about two million brick per year.

Cain Brick Company, Ottawa, has the clay described above, whioh is dug in winter and mixed with the proper proportion of sand for tempering, and allowed to stand until spring. It is then wheeled to two Martin machines, making a good stock brick. The brick are dried by the rack and pallet system, and are burned with wood in open shed kilns. The ontput is abont two million and a half per year, and the brick are of excellent qnality.

T. O'Reilly, Harvard, Ottawa, has the usual section of Ottawa clay, that is, a Red-top clay, qnite strong, which overlies roughly five feet of a milder sandy olay, which in turn overlies a great depth of stronger Leda blue olay. The Red-top clay, with the mild clay and three to five feet of the blue clay, is dug in winter and heaped to temper nntil spring. It is then wheeled to a pair of rolls which feed a png-mill that in tnrn feeds a Martin machine. The bricks are dried by the rack and pallet system and are bnrned with wood in open shed scoved kilns. The output is about one million red brick per year.

Dufferin

Thomas Cook, Orangeville, manufactures only red stock brick, nsing a Martin machine and horse-power. He works abont three feet of strong Red-top clay, which is taken directly from the bank to the machine. The brick are "hacked" out to dry, and are bnrned with wood in open shed scoved kilns. The output is only abont three hundred thousand per year.

Durham

R. H. Hambly, Bowmanville, has three feet of strong Red-top clay nnderlaid by blne Erie clay which is also very strong and free from atones. Both these clays are worked, the Red-top clay being made entirely into brick with a Martin machine and horse-power. The brick are dried by the rack and pallet system, and are bnrned with wood in open shed scoved kilns. The output is abont five hnndred thonsand red brick per season. The blne Erie clay is also dug and made into tile by a Kells machine. The tile are of an excellent quality and are creamy white in color. A few hollow blocks are also made from the blue clay by the Kells machine. These are very strong, and are becoming quite popular in building fonndations for barns or other frame buildings. The ontput of tile from two and one-half to five inches in diameter is about sixty thonsand per year

Crowhurst Bros., Port Hope: This is a small yard, manufacturing only seven hundred thousand red brick per year, hut they are of the very finest quality, and the yard is one of the best in the Province. There are from two and one-half to five feet of Red-top clay practically free from stones, hut immediately below this is the Erie hlue clay, and strange to say, this is quite stony. The Red-top clay only is used, and is manufactured hy a Martin machine with horse power into stock hrick. The hrick are hacked out in the usual way to dry; they are then burned with wood in open shed scoved kilns, and it is in this respect that this yard excels all others seen in the Province; the hurning is so carefully done that even the arch hrick are in excellent shape, and are sold readily for face hrick. These kilns are a good example of what can be done by the hrickmakers themselves, if they would study their burning more carefully. Prohahly one secret of this firm's success is that the arches are huilt much higher in the crown than those seen in most yards.

Elgin

William Light, Aylmer, has an excellent deposit of Red-top clay in some places locally collected to twelve feet in depth. This is manufactured into red hrick, tile, and hollow hlock, especially the latter. The burning is done in open shed scoved kilns with wood for fuel. Ahout four hundred thousand hrick per year, and one hundred thousand tile and hollow hlock constitute the output from this yard. These are purely for local consumption.

E. C. Becket, Orwell; F. Davenport, Orwell: These two yards lie side hy side with a fence between and as the clay is the same in hoth, as well as the method of manufacture, a single description will apply to hoth. The chief output is tile and hollow hlock, with just sufficient wire-cut hrick for the pockets in the kilns. All the goods are creamy white in color and of excellent quality, smooth, hard, and free from cracks. The Erie hlue clay here is overlaid hy only a foot of Red-top clay, and this is shovelled off and kept to re-cover the hlue clay with a soil which will preserve the farm. The hlue clay only is used. The hurning is done in round down-draft Cornell kilns, the pockets are built each time of green wire-cut hrick arranged in a semi-circle with their ends to the fire. The remainder of the kiln is filled with tile or hollow hlock. All sizes of tile are made, from two a. d one-half to twelve inches in diameter, and in filling the kiln these are so "nested" as to give large capacity. The hrick, tile and hollow hlock are all made hy the Kells machine. The water-smoking is done with wood, after which the kiln is fired up from four to six hours with wood. This is to drive off the last traces of moisture before going on to coal, and prevents to some extent the red flashes so often seen on white hrick and tile. Both these gentlemen by this method of burning, turn out goods of a beautiful cream white color. The grates used in these kilns are thirty-six inches long, fifteen inches wide, and twenty inches high, and give first-class satisfaction.

D. McGibbon, Shedden, manufactures white hrick, tile and hollow hlock from the Erie blue clay. This is dug from a mound, on the top of which there is little or no Red-top clay, hut as we approach the hollow about the mound the Red-top clay begins to thicken and in places reaches three feet in depth. The hlue clay only is used This is carted to a Tecumseh machine, an American machine of large capacity, having an automatic cut-off, very much like the Bechtel cut-off. The Bechtel trucking system is used for wheeling out, and the drying is done in sheds. The goods are hurned in a down-draft Stuart kiln with wood fer fuel. The floor, the pockets, and tho fire holes are all built of fire hrick, making a very expensive kiln, but the goods burned in it are of excellent quality. This is a very neat, tidy yard, having granolithic walks from the machine to the drying sheds, and from these to the kilns.

Ponsford and Freek, St. Thomas; The operators of this yard are building contractors and use for the most part pressed hrick or stone for their outside work. They

manufacture their own brick for inside work, the result being that they pay little or no attention to the shape or color of the brick, so long as they are burned sufficiently for inside brick. They make only white brick by a Martin machine, dry by the rack and pallet system, and burn with wood in open-shed scoved kilns, their output being about one million brick per year.

Essex

D. Volkes, Comber, works two and one-half feet of Red-top clay which is dug and carted directly to a Kells machine with a pair of rolls to crush the small stones and lumps. Manufactures red wire-cut brick, tile and hollow block. The brick are wheeled out on Bechtel trucks to open air drying sheds, and the burning is done with wood in two round down-draft kilns. The output is about six hundred thousand red brick and about two hundred thousand tile and blocks. The quality of the goods is first class, and Mr. Volkes is aiming at making his yard much more efficient by studying and improving wherever possible.

H. Hallat, Comber: This yard is situated about half a mile west of Comber station, at what was formerly a charcoal plant, a series of bee-hive charcoal kilns being all that is left to mark the place of the former industry. Mr. Hallat attempted to use these kilns by putting in a series of fire arches and an open kiln bottom. Upon burning his first kiln, however, the charcoal in the floor, below his kiln bottom, burned out, allowing the kiln to settle unevenly, so that it choked in many places, and the burn was a failure. At the time of the writer's visit he was re-constructing the kilns, making them lower and otherwise attempting to avoid the former difficulty. His clay is the usual thickness—about three feet. This is hauled by automatic dump cars to a Baird pug-mill, which feeds a pair of rolls and a Kells machine. The Bechtel automatic end-cut cut-off machine is used here with good results. The brick are wheeled on Bechtel trucks to open air drying sheds. The fuel is wood for the water-smoking and heating up, and coal for the finishing. The yard has been in operation only two months when visited by the writer, and will no doubt prove a success with the improvements made by Mr. Hallat, as his brick plant is a good one, and is nicely arranged. The power used is a twenty-five h.p. gasoline engine.

Hill Brothers, Essex Centre: The clay bank here shows about two and a half feet of Red-top clay, underlaid by about two feet of more or less stony red clay, and beneath this about one hundred feet of typical blue Erie clay as shown by a well bored in the yard. The Red-top clay only is used. This is hauled in automatic dump cars to a hopper which feeds a Baird pug-mill, on which Mr. Hill has arranged a cone-pulley for three speeds, for brick, tile and hollow block. The Baird pug-mill feeds a pair of rolls on a Kells machine; the brick are cut off by an automatic end-cut machine of Mr. Hill's own manufacture. The bricks are dried in open hacks and are burned in two round down-draft kilns. A single large chimney placed between the kilns serves for both, and the heat usually lost in cooling off one kiln is used by Mr. Hill to help dry and warm up the green kiln. This is done by having a sheet iron plate on the top of his kiln, which is lifted off the green kiln, the drafts to the chimney are closed, and the heat is thereby drawn through the green kiln, escaping through its top. The kiln is then closed up and fired in the usual way. By this means a great deal of fuel is saved. Mr. Hill has a further simple, but very ingenious method of controlling his burning; by carefully watching he has found that when his brick have shrunk one-eighth they are sufficiently burned. To accomplish this without cracking or fusing the arches or pockets, he has found that his whole kiln should shrink one-quarter of an inch per hour; to regulate this he makes a small hole in the iron plate mentioned above and through this he stands an iron rod on end, the lower end resting on the brick inside the kiln; this rod is marked off into quarter inches. As the kiln shrinks this rod sinks through the hole and he can

hasten or slacken the fire as required. His water-smoking and first firing are done by wood, after which he finishes with soft coal. This yard turns out first rate red brick, tile and hollow block, and is a fine example of what can be done by each man studying the peculiar behavior of his own clay. The result to Hill Bros. is that over ninety per cent. of their output is first class face brick.

J. Wigle, Leamington, has two and one-half feet of Red-top clay underlaid as usual with the Erie blue clay. The Red-top clay only is used, and is made into red brick, tile and hollow block. About six hundred thousand brick and about three hundred thousand tile and hollow block are made per season. The clay is hauled in cars to a Baird pug-mill, which feeds a pair of rolls and a Kells machine for the tile and hollow block; and a Penfield U. S. side-cut wire-cut machine for brick. The tile and hollow block are dried in a hot air drier of Mr. Wigle's own design. He uses the exhaust steam through a series of iron pipes beneath an open slat floor. The tile and block are stood on end on this floor and dry much more quickly than they would in an open shed, and being away from winds they escape the cracking often caused thereby. His brick are dried in open hacks as usual, the tile and block are burned in down-draft kilns with green brick for the pockets, and the brick are burned in open shed scoved kilns.

William Curry, Sandwich, has about two and one-half feet of Red-top clay, which is used with Erie clay and iron-bearing sand, the whole burning to red brick. The clay is hauled by car to a six-mould plunger machine manufactured in Detroit. This machine has a large capacity and runs with very little power. The brick are dumped, six at a time, to a pallet, and thirty-two pallets are piled on a rack set on a car; thus each car holds 192 brick; these are run into the rack-yard, and the pallets are piled into the racks to dry. They are then re-loaded and run into the kiln yard. The burning is done with coal, coke being used for a water-smoking. The scoving is done with hollow block, which has several important advantages, for example, the scoving can be run up much more quickly than with brick; there is little or no waste in taking it down as the blocks are strong; and it can be used over and over. Mr. Curry claims that this method saves considerable fuel, the air space in the blocks preventing the escape of heat around the sides of the kiln. The output from this yard is about three million brick per year.

J. Robinet, Sandwich, has two feet of Red-top clay, underlaid by two feet of mixed red and blue Erie clay, followed by typical blue clay below. The whole section is dug about seven feet deep, and is mixed with some red sand, the whole burning to red brick. The clay is hauled about two hundred yards by mule and car which dumps to a hopper, feeding a plunger machine. The mould holding six brick are dumped on pallets, thirty-two of which are piled on a car, which is run to the rack yard and allowed to stand till dry. The cars are then run on to the kiln yard, so that the brick are not touched from the time they leave the machine till they are piled in the kiln, but this system requires over one hundred cars. The rails used throughout the yard are old gas pipe, which serves admirably, and have the advantage of being easily handled. The output is about eighteen thousand per day, and the clay for this is dug by two men and is all hauled by one mule, the men filling one car while another is being taken to the machine. The burning is done by coke and coal, as in Curry's yard, except that Mr. Robinet uses a grate four feet long in each end of his fire arches.

Frontenac

Mouldy Brothers, Kingston, have about two to four feet of Red-top clay lying on Erie blue clay. Both are more or less stony, the pebbles being for the most part limestone. These, in burning are converted into little pieces of lime, which when moistened expand and burst the bricks, so that it is necessary to remove the pebbles as far as possible by washing or crushing before the brick are made. The Red-top

clay only is used, but two methods of brick making are employed. Wire-cut brick are made with a Kells machine, using steam power, and stock brick are also made by hand. In this process the clay is mixed in an upright box by a series of blades which are turned by horse power; the mixed clay is then packed in single sanded moulds, scraped off on top and dumped one at a time on a small pallet, which is then hacked out in the ordinary way. Three men mould the brick in this yard, each one capable of turning out two thousand brick per day. This method differs from "slop" brick making, which is also a hand process, in that the moulds here are sanded, whereas in the slop brick method the moulds are washed each time they are dumped. This hand moulding makes a very fine brick, but the whole process, including the drying, is much too slow. The burning is done by wood, in one round down-draft Cornell kiln, and in open-shed scoved kilns.

Grenville

A. Clothier, Kemptville, has fully five feet of Red-top clay quite clean and free from stone. This is underlaid as usual by the Erie blue clay. The Red-top only is used, and is hauled by cars to a Baird pug-mill, which feeds a Quaker six-brick machine. The brick are hacked out in the ordinary way, but a change to the rack and pallet system is likely to be made. The goods turned out in this yard are of excellent quality, but the local market is easily supplied and the output is therefore small. The burning is done with wood in open-shed scoved kilns.

J. P. Wiser and Son, Prescott: This firm have an excellent bank of Red-top clay two to three feet in depth, used in the manufacture of red brick. Beneath this is a yellowish clay, a transition stage between the Red-top and the typical Erie clay below, which is used in the manufacture of tile and some light-colored inside brick. In the manufacture of brick, the clay is carted and dumped into a large circular "ring pit" capable of holding enough clay for a day's run. These are large circular vats from twenty to twenty-five feet in diameter and about three feet deep. They may be lined with boards, brick or concrete. Travelling around in a pit of this kind is an iron wheel about six feet in diameter, which at the same time moves back and forth along a shaft from the centre to the circumference of the pit, thus thoroughly mixing the clay. The clay is dumped into this pit, sufficient sand is then spread over it to give the correct temper, water is added and the whole thoroughly mixed in the manner described above. These machines take the place of the pug-mill, and are largely used in the United States, but this is the only one found in Ontario. Two of these pits are operated in this yard, each holding one day's supply, so that one can be mixing while the other is being discharged. The clay is wheeled from the pit to a six-brick machine made at Croton Landing, N. Y. This machine makes a first-class brick, but too small for the Ontario standard, being only 7 by 2¼ by 3¼ inches, instead of 8¼ by 2¼ by 4. The brick are dried by the rack and pallet system and are burned with wood in open-shed scoved kilns. The firm has also a re-press machine, but finds no demand in Ontario for this class of bricks.

Grey

J. Lowe, Meaford: This yard, situated about three and one-half miles from Meaford, has about 3½ feet of Red-top clay underlaid by yellowish gray clay passing gradually into Erie blue clay below. The yellowish clay is used in addition to the Red-top clay by Mr. Lowe in the manufacture of red stock brick. The clay is carted to a pug-mill feeding a Martin machine. The brick are hacked out in the ordinary way to dry, and are burned with wood in open-shed scoved kilns.

J. M. Scott, Meaford: This clay is similar to that in Mr. Lowe's yard, but in addition to the Red-top clay which he uses in the manufacture of red stock brick, Mr. Scott also uses the underlying Erie clay for the manufacture of white brick. Both these kinds are manufactured with a Martin machine using horse power, and are burned with wood in open-shed scoved kilns.

W. H. White, Owen Sound, has three feet of Red-top clay overlying yellowish gray clay, which in turn overlies the Erie blue clay. The Red-top clay only is used in the manufacture of red brick. The clay here is somewhat sandy, showing a mixed character. It also contains stones of many sizes from pebbles to boulders a foot or more in diameter. All three clays fill an old gorge of pre-glacial age which cuts the Medina and Clinton formations. The clays in the gorge have the same relation to each other as those on the general land surface outside the gorge, but there seems to be more local interruptions, causing the clay to be more or less mixed with sand. The Red-top clay in the gorge is hauled by car to a Baird pug-mill which feeds a Martin machine; the brick are dried by the rack and pallet system and are then hauled by horses on small trucks holding from two to three hundred brick, to open-shed scoved kilns. The loaded truck is left at the kiln while an empty truck is being re-loaded. The burning is done by wood and the output for the season is about two million brick.

Robert Wyllie, Owen Sound: This yard is situated in the same gorge as that of Mr. White, but the clay here is very sandy. About five feet of it is dug and used in the manufacture of red stock brick. The clay is carted to a Baird pug-mill, feeding a Monarch machine, which makes six bricks at a time. The bricks are dumped on pallets and are dried by the rack and pallet system. The burning is done with wood in open-shed scoved kilns. The clay here has become so sandy as to be practically unfit for brick-making, and the yard is being abandoned, but Mr. Wyllie will locate near Mr. White's yard and will continue operations there.

J. Boone, Thornbury; John Buell, Thornbury: These two gentlemen operate side by side, the former using the Red-top clay in the manufacture of red brick, the latter using the Erie blue under clay in the manufacture of white tile. The brick are made with a horse-power machine making four brick at a time; these are hacked out in the ordinary way to dry, and are burned with wood in a permanent walled up-draft kiln, the ends being scoved. Mr. Boone improves his burn by mudding over a piece in the centre on top of the platting, thereby driving the heat to the walls of the kiln, and burning the heads much harder than they would otherwise be. This mudding is done when the centre of the kiln is seen to be sufficiently burned, and thus only uses the last of the heat of the kiln to improve the outside. Mr. Buell's tile machine is a small hand one, and while making a good tile has but a very limited capacity. His burning is done by wood in a small round down-draft kiln.

Haldimand

McDonald and Company, Canfield, have about two and one-half feet of Red-top clay underlaid by the usual Erie blue clay. The Red-top clay is made into red brick in a horse-power machine, only a few being made each season. They are dried by the hack system. The tile are made from the blue Erie clay, in a Kells machine, using steam power. The brick and tile are both burned by wood in two round down-draft kilns.

Halton

Toronto Pressed Brick Works, Milton: This yard is operated by Mr. C. J. Lewis, and is situated on the C. P. R. about one mile and a half northeast of Milton. All classes of building material made of clay are turned out by this company, including red pressed brick, buff pressed brick, and all varieties of fancy building brick for cornices, mouldings, corners and decorative purposes, also all varieties of red or buff terra-cotta. This is the only large terra-cotta works in Canada. This part of the plant is in charge of Mr. J. Lewis, a brother of the manager, and the excellence of the products testify to Mr. Lewis' ability in this line of work. This company also produces all kinds of roofing tile and cornice decorations.

The raw material used in the manufacture of all these goods is the Medina shale, so common to this section of the country, and which is seen in many parts coloring

the soil quite red. The shale bank here is about fifty feet high, and about thirty feet from the surface is a band of bluish gray shale about two feet thick, which is used in the manufacture of the buff colored goods. The shale is drilled with steam drills and is blasted with dynamite. It is then hauled in carts to two pan mills, which are used

Fig. 41.—Medina shale bed worked for pressed brick and terra cotta by the Toronto Pressed Brick Co., Milton. Note light colored band half way up, which burns to buff brick; the remainder burns a rich, red color.

Fig. 42.—General view of The Toronto Pressed Brick Company's plant at Milton, Ont.

to grind the shale to a very fine powder, which is then elevated by belt carriers and dropped on an inclined screen. The "over-size" is returned to the pan-mills to be re-ground, that which passes through the screen drops to hoppers which feed four presses, two of which are built by the Goldie and McCulloch Company of Galt, the

other two by the Waterous Engine Company of Brantford. These machines receive the finely powdered shale and it is pressed in moulds in this dry form, each brick receiving a pressure of about eighty tons. They are lifted from this machine and wheeled directly to up-draft kilns.

This company has five of these kilns, each capable of holding from 146,000 to 190,000 brick. The kilns have permanent walls and fire arches, and are built in series, the raw brick being brought in on one side, and the burned brick taken out on the other and loaded directly into cars. The little water-smoking necessary is done with wood until the goods are perfectly dry, the remainder of the burning being done with coal. The output is about eight million per year.

In the terra-cotta department, the ground shale is pugged thoroughly and is then worked soft by hand, casts of plaster of Paris are then made from drawings of the required pieces of terra-cotta. From these casts, moulds are made of the pugged clay, these are further finished by hand and are set to dry. When thoroughly dried they are burned in a separate down-draft kiln, the firing being done first by wood, until all water-smoke is off, and then by coal till test pieces show the work to be completed.

Milton Pressed Brick Company, Milton: This plant, which is managed by Mr. J. S. McCannell, is situated about half a mile nearer Milton than the above mentioned yard. Red and buff pressed brick, and all varieties of decorative brick, are manufactured, including inside decorative brick for mantels, fire-places, columns, sills,

Fig. 43.—Medina shale bank worked for pressed brick by Milton Pressed Brick Co., Milton.

etc. The bank of Medina shale is similar in every way to that at the Toronto Pressed yard. The buff-burning band of shale is also found here. The shale is blasted out by dynamite and hauled in cars to pan mills; the red-burning shale is ground in two pans and the buff-burning shale in one pan. The material is elevated to a screen as before, and that which passes through is pressed in a Boyd machine. The brick are then wheeled directly to the kilns, some of which are down-draft rectangular kilns, while others, which are older, are permanent walled up-draft kilns similar to those of the Toronto Pressed Brick works, just described. The first burning is done with wood, and the final burning with soft coal. The Medina shale in this yard is overlaid by five to eight feet of a limy grayish red clay. This is dug and mixed with ground shale to ensure a red brick, and is used in the manufacture of wire-cut brick. The mixing is done in a pug-mill which feeds a Weese side-cut machine having an output of 22,000 per day. The brick are wheeled on Bechtel trucks to a Bechtel Carless dryer. These

brick are made for inside walls only, and the output of them is about 2,000,000 per season. The pressed brick plant is run winter and summer, and has an output of one million brick per month. These are sorted into four grades, and are shipped carefully packed in straw. The burning is done in nine kilns and the output keeps a staff of fifteen men continually loading cars, which are placed alongside the kilns.

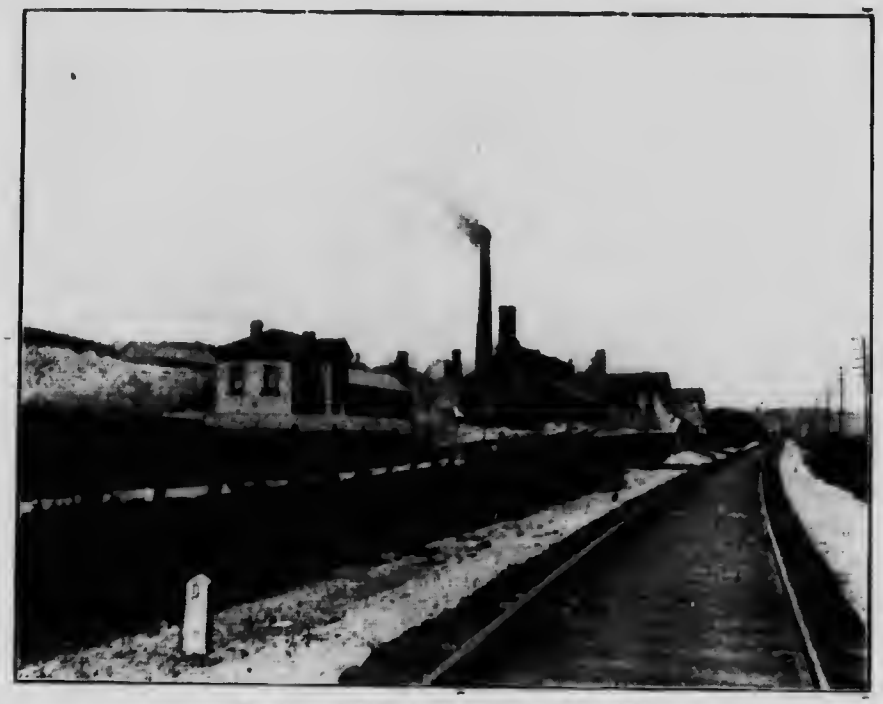


Fig. 44.—Milton Pressed Brick Co's plant, Milton.

Hastings

M. Lingham, Belleville, has three feet of Red-top clay which he uses in the manufacture of red stock brick. Below this is the typical Erie blue clay, but it is not used: the Red-top clay is wheeled to a Martin machine run by horse-power, making five brick at a time; these are hacked out in the ordinary way to dry, and are then burned with wood in open-shed scoved kilns. The output of this yard is about five hundred thousand per season.

E. Naylor, Stirling, has about three feet of Red-top clay underlaid by the Erie blue clay. The upper clay is used in the manufacture of red stock brick which are made in a Martin machine operated by horse-power. The brick are dried in open hacks, and are burned with wood in open-shed scoved kilns. The output of this yard is about five hundred thousand per season.

J. Hill, Madoc, has about two and one-half feet of Red-top clay which is made into red stock brick by the old hand-moulding process. The brick are made in small moulds, one at a time; the clay is mixed by horse-power and two men mould the worked clay by hand. The brick are then hacked out in the ordinary way to dry, and are burned with wood in open-shed scoved kilns. The output for the season is about three hundred thousand.

Fargey and Rollins, Tweed: This is the only yard operated at Tweed, those formerly run by Messrs. Lawrence and Countryman having been bought out by this firm. They have about two and one-half feet of Red-top clay lying on blue Erie clay. The Red-top clay only is used for the manufacture of red stock brick and red tile. The brick are made in a Martin and also an Iron Quaker machine, while the tile are made in a Kells machine. The brick are dried in the rack and pallet system, and the tile in open sheds. Both are burned in round down-draft kilns, one permanent up-draft kiln, and in some cases open-shed scove kilns are used. The burning is done with wood and a good grade of brick and tile is made. The clay being practically free from stones has very little lime in it, and the bricks are seldom burst after burning, as so many of the brick in this part of the country usually are. The output of brick is about five hundred thousand, and of tile about sixty thousand per season.

Huron

Frazer and Logan, Blyth: The Erie blue clay here is overlaid by a mixture of sand and sandy clay. The latter is made into white brick, but the chief output of this yard is in white tile from two and one-half to ten inches in diameter. The clay is dug and hauled by car to a pair of rolls feeding a Kells machine. The tile are cut off by hand and stood in open sheds to dry. The burning is done in three round down-draft kilns, the pockets are built each time of green brick, but the rest of the kiln is usually filled with tile. The water-smoking is done with wood, the remainder of the burning with soft coal. The blue clay here, as in many other yards in the Province, contains small pebbles of limestone. These are often spoken of by brick men as "ginger" probably because when the brick or tile are burned the little white pieces of lime resemble pieces of ginger root, and are, as brick men know, the cause of the brick or tile scaling or even bursting open. Although crushed in rolls, they still cause trouble, for instead of one big piece there are a great number of small ones. To obviate these bad effects, this firm throws in two or three shovelfuls of common salt, a little at a time, with the last three or four fires before cooling down; this kills the lime and thus prevents it doing any harm. The objection will probably be raised that it will glaze the tile, but this is not so, as the temperature reached in the kiln is not sufficient for this purpose. The tile turned out by this firm are smooth, strong and practically free from cracks and scales.

A. Wettlaufer, Blyth: While Messrs. Frazer and Logan are chiefly engaged in making tile, Mr. Wettlaufer manufactures only brick. The blue Erie clay is carted to a Martin machine making white stock brick. These are dumped on pallets and hacked out in the ordinary way to dry. They are then burned by wood in open-shed scoved kilns. This yard is a small one, making only about five hundred thousand brick per year.

Cruse Brothers, Seaforth: This firm uses the Erie blue clay in the manufacture of white brick, tile, and three-spaced hollow block. The clay is hauled by cart and dumped to rolls feeding a Kells machine. Side-cut wire-cut brick are made and are cut off by hand. The die is lubricated to prevent the centre travelling faster than the outside, thus obviating the warping so commonly seen in side-cut brick. Brick, tile and block are all burned together in round down-draft kilns, wood being used for the water-smoking and for the preliminary heating up, and soft coal for the finishing. The output of this yard is about one-half million brick, seven to ten kilns of tile, two and one-half to twelve inches in diameter, and about four thousand three-spaced block. The goods are all of excellent quality.

N. McClarty, Benmiller, has about three feet of Red-top clay, underlaid by about twelve feet or more of Erie blue clay. He uses both kinds, the red for the manufacture of brick, and the white for the manufacture of tile, both of which are made with the Kells machine. About half a million end-cut wire-cut brick are made

from the Red-top clay per season, and about one hundred thousand white tile, varying from two and a half to eight inches in diameter. The brick are dried in hacks and the tile in open sheds and both are burned together in down-draft kilns. Mr. McClarty is making several changes to increase his output.

Eli Elliott, Wingham, works a bank of Erie blue clay, making only white brick. The clay is hauled by cart to a pug-mill which feeds a pair of heavy rolls on a Kells machine. The brick are side-cut wire-cut, and the centre is held back by three iron rods inside the die, the friction of the clay on these helps to equalize the friction of the clay against the sides of the die, and thus prevents the centre from travelling faster than the outside. The burning is done by wood in open-shed scoved kilns.

Crediton Yards. In the immediate vicinity of Crediton is one of the oldest brick districts of Ontario, there being no less than eight yards operated here at present, by the following: **Fred. Kerr, George Hertzel, F. Hist, George Mantel, William Anderson, H. J. Kuhn, Russell Hedden, Wm. Hist.**

All of these yards turn out white brick, as all are manufacturing from the Erie blue clay. Two or three different methods of manufacture are used, and these will be described. Four of the yards use the "slop brick" method. The clay is dug and dumped from carts to a tempering box which is set beside a machine, in this box the clay is well mixed with water and allowed to stand over night. During the forenoon of the next day this soft clay is dug out, and put in a mixing box in which a horse-whim works to mix thoroughly. The soft clay comes out of a hole in the bottom of the box, where it is picked up by one man in masses large enough for one brick and is dropped into a mould. Four moulds are arranged in one block; as soon as these have been filled they are carried off and dumped on a sanded yard, exposed to the sun and wind to dry. This work is continued for half the day, by which time the brick first made in the morning are hard enough to stand handling, when they can be piled in hacks to continue drying. Thus the brick that are made in the forenoon are picked up and hacked in the afternoon; the remainder of the process is the same as for any hack yard, that is, the brick are wheeled in and burned as usual in open-shed scoved kilns.

The other four yards were formerly slop brick yards, but are now operated chiefly for wire-cut brick. Mr. Fred Kerr manufactures both brick and tile. About seven hundred thousand brick and about sixteen kilns of tile varying from three to twelve inches in diameter represent his yearly output. He uses a Kells machine making both end-cut and side-cut brick, the side-cut brick are perforated with thirteen small holes, made by that number of rods set inside the die for the purpose of holding the centre of the clay back in order that the brick will not warp in drying. This number of holes, each about as large as a leadpencil, scattered over the broad surface of the brick, aids the drying and the burning, gives a better hold for mortar and does not weaken the brick, as does the three larger holes so often used in side-cut brick. Brick having three large holes are weak across the centre hole, whereas the thirteen smaller holes do not weaken the brick to any appreciable extent. The tile are burned in two down-draft kilns, and the brick in open-shed scoved kilns. Mr. H. J. Kuhn manufactures brick and tile also. His output of brick is about one hundred thousand per season of both end-cut and side-cut brick. His side-cut brick are perforated in the same way as are Mr. Kerr's, that is, with the thirteen holes. Mr. Kuhn's chief product is tile, of which he makes about four hundred thousand per year, ranging from three to twelve inches in diameter. His tile are perfectly even and smooth, and show that he has this branch of the trade in excellent shape. Mr. Russell Heddon's yard is used chiefly in the manufacture of white brick, both end-cut and side-cut. The side-cut brick are perforated here as usual. He has the largest output of brick in this locality, being about twenty thousand per day. They are all wire-cut and made with a Kells machine. They are dried in open hacks and burned with wood in open-shed scoved kilns.

Kent

John Wardle, Blenheim, has about two feet of Red-top clay lying on Erie blue clay, which is here very thick. The red clay only is used in the manufacture of brick, tile and hollow block. The clay is hauled in carts and dumped to a seven-foot pug-mill which feeds a Martin machine. The moulds holding five brick are dumped on to large pallets, and are dried by the rack and pallet system. The output of brick is about five hundred thousand per season, and are of excellent quality and color. The tile and block are made with a Kells machine, and like the brick are of excellent quality. All three classes of goods are burned by wood in round down-draft kilns.

D. Jordan, Chatham: This yard is situated on the banks of the Thames river. There are from three to five feet of Red-top clay with Erie blue clay below, the Thames itself flowing between Erie clay banks. The Red-top clay only is used in the manufacture of red brick. The clay is carted and dumped to two pug-mills feeding Martin machines. The brick are hacked out to dry and are then hauled on horse trucks and are burned with wood in open-shed scoved kilns. This yard has an output of three million per year, many of which are shipped by boat via the Thames river and Lake St. Clair.

James Cornhill, Chatham: This yard is also situated on the bank of the river Thames, and in addition has the Pere Marquette railway running past one side. This enables Mr. Cornhill to load his brick on either boat or rail at his yard. His output

Fig. 45.—General view of James Cornhill's yard, Chatham.

is about five million brick per year. His clay is like that of Mr. Jordan's yard, but he makes two grades of brick. The top three feet of red clay is dug by itself, and hauled by Baird automatic dump car to a pug-mill feeding a Martin machine. This machine turns out red stock only, which are dumped on pallets and dried by the rack and pallet system. The balance of the Red-top clay with a little of the underlying blue Erie clay, making about two feet and one-half in all, is dug by itself and made in another Martin machine, by the method described above, and used for inside brick. The burning is all done by wood and coal in open-shed scoved kilns, which are so situated that the brick can be taken directly from the kiln into the car. Mr. Cornhill has also a Kells tile machine and one round down-draft kiln in which to burn tile. At present he is manufacturing only brick.

J. Hitch, Ridgetown, has over four feet of Red-top clay, but the lower part is rather stony; beneath this is the stony Erie blue clay. He uses the upper part of the red clay for the manufacture of red brick, tile and hollow block. The clay is hauled by cart and dumped to rolls feeding a Kells machine. End-cut brick are made, using a Bechtel automatic cut-off. The brick, tile, or block are wheeled away on a patent truck of Mr. Hitch's own design, which is so constructed that with a slight adjustment it can be used to wheel either of these products. The drying is done in open-shed, and the burning in three round, down-draft kilns. The water-smoking is by wood, and the kiln is then heated up from six to ten hours by wood, after which it is finished with coal. The output is about seven hundred thousand brick, and about three hundred thousand hollow block and tile. The quality of the goods and the color is good, but they could be improved by a more thorough mixing of the clay by pug-mill, as the Kells machine alone cannot be expected to thoroughly mix the clay.

D. Martin, Thamesville, has three and a half feet of Red-top clay almost free from stone, but below this the clay gets more stony as it passes into the Erie blue clay. Three feet of the top clay is dug and heaped to temper, after which it is mixed in a pug-mill which feeds a machine of a plunger type, making stock brick, which are dumped on pallets and dried by the rack and pallet system. Mr. Martin also makes tile and hollow block by a Kells machine. For this purpose the clay is not pugged, as evenness of color and grain is not so essential as in the case of brick. The tile and block are dried in open sheds, and with the brick are burned with wood in round down-draft kilns. His output is about five hundred thousand brick, and about two hundred thousand tile and hollow block.

G. Moody, Highgate: Mr. Moody, an ex-President of the Clay Workers' Association of Ontario, operates this yard, which is one of the neatest and handiest yards seen in the Province, and the brick, tile and hollow block are of excellent quality. Mr

Fig. 46.—Geo. Moody's Yard, Highgate, showing open hacks with pivoted roofs, filled with hollow blocks; also Bechtel dryer.

Moody has about three feet of Red-top clay, which becomes sandy towards the bottom and passes into sandy Erie clay. The clay is hauled by automatic dump cars to a Baird pug-mill, which feeds a pair of rolls on a Kells machine. The brick are cut off by a Bechtel automatic end-cut table, and are allowed to run over an oiled roller, which by oiling one surface permits the brick in drying to shrink on each other, without pulling apart and cracking. The brick are wheeled out in Bechtel trucks to a Bechtel Carless dryer, and are then wheeled from the dryer to three round down-

draft kilns. The water-smoking and six hours of hurning are done with wood, after which soft coal is used. For tile and hollow block a Kells machine is used in the ordinary way. The walks throughout this yard to the kilns, etc., are granolithic. In fact, Mr. Moody's yard is one of the most up-to-date in the Province.

Lambton

Martin and Company, Alvinston: The clay in this yard is an Erie blue clay, sandy in the upper part. Lower down the clay is much stronger, and practically free from sand. Above the Erie clay is about six feet of fine gravel; this is taken away by the puhlic for road metal and huilding purposes. The sandy hlue clay is used for the manufacture of white sand stock hrick, about five hundred thousand of which are made per season. The stronger blue clay is used for the manufacture of tile, which are of good color and very strong, ahout two hundred thousand being made per season. The Erie hlue clay extends continuously down to shale, which has the following composition:

	Per cent.
Silica	66.82
Alumina	11.66
Ferric Oxide	6.58
Lime	.62
Magnesia	.90
Soda	.38
Potash	2.58
Loss hy Ignition	10.59

F. Howlett, Petrolia, has from two to six feet of Red-top clay lying in a hollow which accounts for the great depth of red clay here, as it has been concentrated from the surrounding hills. Mr. Howlett's former hrick plant is now a pumping station for a series of oil wells. In his new yard are several wells in operation. He makes red stock hrick, using a Quaker machine, and also red wire-cut hrick and red tile with a Kells machine. His hurning is done hy wood in two round down-draft kilns, the output being about three hundred thousand hrick and about two hundred thousand tile per season.

H. Hales, Brigden: Mr. Hales has been making brick for about forty years, and has been largely responsihle for some of the best methods of hrick-making and burning now in use in Canada. He has about five feet of Red-top clay lying on Erie blue clay, which he has found to he 117 feet deep here. These two clays are situated on a high hill, past the foot of which flows a river with a broad low flat for its other bank. On this flat is an excellent deposit of red alluvial clay, which is used for the manufacture of red hrick. They are made in a Quaker machine with a pug-mill attached for mixing. The hrick are hacked out in the ordinary way, and are hurned with wood and coal in an up-draft kiln. The hrick are of a deep red color, and of an excellent quality. Leading from the top of the hill across the river to the low flat on the opposite side is a tramway up which Mr. Hales hauls the alluvial clay hy Baird cars to a pug-mill which feeds a Kells machine and uses it to make tile, varying from three to fourteen inches in diameter. Mr. Hales uses a very ingenious device for transferring his tile to the upper story of an adjoining huilding: on a broad helt which turns about four-foot pulleys, he has nailed shingles, with the thick ends together, so as to form a horizontal set of steps on the helt. As this helt slowly turns he sets a tile on end on each step, it is thereby elevated and carried to the adjoining huilding, thus obviating the lifting of the tile or wheeling them up hy hand. Mr. Hales hurns a round down-draft kiln, and in a rectangular down-draft kiln. These were built many years ago by Mr. Hales from his own plans, and the round one is in reality the same as the Cornell patent kiln, which has become so popular. Previous to huilding his rec-

tangular kiln, Mr. Hales built a very small kiln which would hold about five thousand brick, and strange to say this experimental kiln is almost identically like the latest patent kiln; finding that the small one worked perfectly, he built the large rectangular kiln which is still in use in his yard, and this kiln is in almost every particular identical with the Stewart kiln. This yard is filled with small labor-saving devices, and with appliances for improving the quality of the goods or increasing the output.

A. Elliott, Thedford, has about eight to twenty feet of Erie blue clay, underlaid by a blue Devonian shale, both of which have been cut and exposed by a small stream known as Decker creek. At a point where the blue clay was shallow, being not over eight feet deep, the Devonian shale was bared (see fig. 5), the high water of the creek in spring time performing a great deal of the work itself. At the contact of the Erie clay with the shale are many boulders, showing the lower part of the Erie clay to be a typical boulder clay. This Devonian shale is ploughed about six inches deep in the early spring and allowed to slake, and is then carted to a pair of rolls feeding a Kells machine. These rolls are necessary because the shale is filled with concretionary nodules and abundant Devonian corals, for example:—Zaphrentis, Cystiphyllum, Heliophyllum, Favosites, Crinoidea, and Spirifera mucronata, and many others. As the clay slakes these are found in abundance scattered through it. In addition to these are many small pieces of selenite, that is, calcium sulphate, the presence of which would hurt the clay for brick by causing an efflorescence, or white coating often called "soda," which appears on the brick after they are burned. The following is an analysis of this shale:—

	Per cent.
Silica	54.96
Alumina	19.15
Ferric Oxide	6.68
Lime	4.02
Potash	3.47
Sulphur Trioxide	.93
Loss by Ignition	8.48

It will be seen from this analysis that the percentage of sulphur trioxide is very high as compared with other clays and this feature would be very objectional in brick. It can, of course, be overcome by the addition of a barium salt which would form barium sulphate, this compound not being soluble would not discolor the brick.

This clay is particularly suited to the manufacture of tile and it is for this purpose that Mr. Elliott uses it. The tile are of excellent quality, being hard, even in grain, and very strong. The green tile can be stood in the rain without suffering any damage. This clay was used in the Toronto Exhibition for the manufacture of tile by H. C. Baird & Co. of Parkhill, in one of their Kells machines, when a tile twelve feet long was made and shoved along a board without cracking, thereby showing the tensile strength of this clay. The tile are burned to a beautiful dark red color in six days, the burning being done with wood in round down-draft kilns.

Lanark

G. A. Burgess, Carleton Place, has from three to eight feet of Leda clay, of which he uses only the upper three to four feet, that below being too wet. The clay is dug and mixed with sand as it is loaded to a car, hauled by horse to a Quaker machine making five brick at a time. These are dumped on a pallet and set in racks on cars which are run down the hack yards. The brick are then dried by the rack and pallet system, after which they are piled on cars three hundred to a load, and are run to the kiln yard, where they are burned with wood in open-shed scoved kilns. The burning is splendidly done, even the arch brick being easily saleable. The output

of this yard is fourteen thousand per day, and the power used is a 16-h.p. gasoline engine, which for this quantity of brick uses $1.15 worth of gasoline per day, and has the additional advantage that having been once started it needs little or no further attention.

Robert Scott, Perth, has from three to five feet of Red-top clay, in places quite stony. This overlies Erie blue clay, which is also stony. The red clay is used for the manufacture of red stock brick in a Martin machine, using horse power. The brick are hacked out in the old way, but Mr. Scott contemplates an early change to the rack and pallet system. The blue Erie clay is used for the manufacture of white stock brick, which are the finest brick of this class seen in the Province. This perfection is reached by washing the clay, the only way to get rid of the limestones and other pebbles so commonly found in Erie clay. This is a very common process in England in the manufacture of brick. A circular pit about twenty feet in diameter and probably three feet deep is lined with wood, brick or cement; at some point in the circumference about one foot and one-half from the top is a small gate which can be opened or closed at will. In this pit is a horse-whim pivoted at the centre, the beam reaching over the edge of the pit so that the horse can turn the whim. Suspended from the beam on either side from the centre is a wooden frame set with teeth much resembling those of a harrow. The stony clay is dug and dumped into this pit, water is then run in until the whole mass is semi-liquid, and the horse is started. In travelling round and round these drags agitate the whole mass, all stones, hard lumps, etc., sink to the bottom of the pit; the gate is then opened, and the upper slimes are run off. They can be deposited on level ground where they will naturally drain themselves and can be worked afterwards like an ordinary clay deposit. Mr. Scott does this work in the fall of the year when brick-making has ceased, and thus has a deposit of clay ready for the next season's work. Contractors are ready and willing to pay for a better quality of brick, provided they know they can be supplied with a uniform grade, and Mr. Scott has no trouble getting one dollar and a quarter per thousand more for this grade of white brick than he or others in the section can get for red brick, or white made from unwashed clay. The washing can be done for 35 to 50 cents per thousand.

M. Ryan, Smith's Falls: Situated on the bank of the Rideau canal, Mr. Ryan can work about five feet of Red-top clay down to water level. Below this is Erie blue clay as usual, and some of this was formerly used for the manufacture of white brick, but now the Red-top clay only is employed. This is collected by wheeled scrapers and dumped on a mixing floor. The necessary amount of sand is added for tempering, when the clay is dumped in a hopper and carried by an endless chain conveyor to the top of the mill, and dropped into a pair of rolls which feed a Baird pug-mill that in turn feeds a Martin machine. The brick are then dumped on pallets and dried by the rack and pallet system. The moulding sand is mixed with red oxide of iron which improves the color and aids the "shifting;" this costs about two and a half cents per thousand, but has the disadvantage that in handling after burning some of the red oxide rubs off, thereby making the contrast in color more noticeable. The brick are burned with wood in open-shed scoved kilns, and the output is about one million per season. The power used on this yard is electricity, and gives excellent satisfaction, as it can be started or stopped on a moment's notice, and when once started needs no further attention.

Leeds

R. J. Wilson, Gananoque, has from two to four feet of Red-top clay, which is very strong and practically free from stone. This is wheeled to two tempering pits, each capable of holding a day's run, thus while one is being emptied the other is being filled and allowed to slake and temper, the required amount of sand being added for this purpose. Water is then added, and the mass is allowed to soak over night.

From these pits the clay is wheeled to a Quaker machine making five brick at a time; these are dumped on pallets and dried by the rack and pallet system. The burning is done with wood in open-shed scoved kilns. Mr. Wilson is contemplating the use of round down-draft kilns next season. He uses a fifteen h.p. gasoline engine, which makes nine thousand brick per day and requires only five gallons of gasoline.

W. H. Wood, Brockville, has from three to five feet of Red-top clay overlying the Erie blue clay as usual, but the latter is not used. The Red-top clay only is used in the manufacture of red stock brick. The clay is carted to a pug-mill, which feeds a Quaker six-brick machine. The brick are dried by the rack and pallet system, and are burned in open-shed scoved kilns with wood as fuel. Mr. Wood also uses red oxide of iron in his moulding sand to improve the color and aid the shifting. He has also a Kells machine, and will add tile and wire-cut brick to his output.

Lennox

Geo. Whittington, Napanee: This yard is located in a hollow or gorge below a limestone ridge, and has a very fine deposit of clay. In addition to the ordinary Red-top clay resulting from the weathering of the underlying Erie, there is here an additional concentration of clay from the higher ground, which increases the layer of red-burning clay until with the little sand it contains it is nine feet deep. This admixture of sand makes the clay most desirable for stock brick, and since it is the result of washing from higher ground, it is practically free from stone. The clay is dug and dumped directly into a Martin machine run by horse power; the brick are dried by the rack and pallet system and are of excellent quality. Mr. Whittington has also a Kells machine run by steam power, and makes red tile from the stronger bands of the red clay. The brick and tile are both burned in round down-draft kilns of a large size, being six feet high and twenty-five feet across, inside measurement. The burning is done with wood, and the season's output is about five hundred thousand

Lincoln

J. M. Carter, St. Catharines, has about two feet of Red-top clay underlaid by the usual blue Erie clay. The Red-top clay is made into red stock brick with a Martin machine. The brick are dried by the rack and pallet system and burned in open-shed scoved kilns with wood at first, and finished with coal. The underlying Erie clay is manufactured into white tile. The clay is allowed to dry in the sun, and is then dumped into a Bechtel disintegrator which pulverizes the clay and throws out all stones larger than a pea. The product of the disintegrator passes through a pair of rolls feeding a Kells machine. This pulverizes all the smaller stones. The Bechtel automatic cut-off is used for end-cut brick and a hand cut-off for tile. The brick are wheeled out by the Bechtel trucking system to open sheds, and when dried are burned in open-shed scoved kilns. The water-smoking and first heating is done with wood, and the remainder with soft coal. The output for the season is about one million and a half.

Watt and Smith, Attercliffe: The clay in this yard is somewhat stony; but the upper two feet of Red-top clay is more or less free from stone, and is dug and piled in heaps and allowed to slake, when it is fed to rolls which in turn feed a Monarch six-brick machine. The brick are dried by the rack and pallet system, and are burned with natural gas in open-shed scoved kilns. This company was burned out this spring and this accounts for the very simple plant they are now operating. Previous to the fire they had a very complete plant, the clay being dug, pulverized with a pair of rolls which fed a Monarch machine. The brick were trucked by the Bechtel system to driers using a forced draft, which was heated by natural gas, the output at that time being about two million per year. The plant which they are now operating will shortly be improved. This firm has three flowing gas wells in its yard, and these are

used in all parts of the yard requiring heat. The power for example, is got from a steam engine, the boiler of which is heated by gas. A pipe leads beneath the boiler. the jet is lighted in the morning and once steam is up, the taps can be so adjusted as to require practically no attention for the remainder of the day. In burning the brick, an ordinary scoved kiln is built, in every way similar to those ordinarily built for wood or coal. Into either end of each arch an inch pipe leads; this extends not more than a foot. The doors are closed up, with the exception of a draft of about an inch around the pipe; the quantity of gas can then be regulated by taps just outside the doors. The brick are very uniform in color, and are of an excellent quality; the arch brick cannot be told from any of the others, all being alike in hardness and color. This is a very unique yard.

Fig. 47.—Plant of Beamsville Brick and Terra Cotta Co., Beamsville.

George Crain, Beamsville. operates the Beamsville Brick and Terra Cotta Company, which manufactures red pressed brick. and buff pressed brick, all sorts of fancy ornamental brick. and side-cut wire-cut brick for inside walls. The red Medina shale which outcrops here is used in the manufacture of these goods. The more or less decomposed surface shale is ploughed up, and allowed to slake further This shale has the following composition:—

	Per cent.
Silica	55.90
Alumina	18.46
Ferric oxide	6.60
Lime	3.82
Magnesia	2.65
Soda	.53
Potash	3.55
Sulphur trioxide	.31
Loss by ignition	8.74

The shale is fed to one pan mill, from which it is elevated and screened to a hopper, the over size returning to be ground again. From the hopper the ground shale feeds two Simpson dry presses. The burning is done in six down-draft kilns, two of which are round, and four rectangular. The preliminary burning is done with coke, and the remainder of the burning with soft coal. For the manufacture of the inside brick the ground shale is dumped to a pug-mill, which feeds a large auger machine of German manufacture, making side-cut brick. Thirteen brick are cut off at a time; these are then piled on steel cars (see fig. 33) four hundred and fifty to a load, and are run into long drying tunnels through which a draft of warm air is forced by a fan; the air is heated by passing through hot arches built of brick and heated with coal. At the end of twenty-four hours the dried brick on the same car are run out to the kilns, where they are water-smoked with coke, and finished with coal. The burned brick, especially the pressed brick, are sorted into four grades and are shipped as such. The dry-press plant has a capacity of thirty thousand per day, and the wire-cut plant an output of twenty thousand; the quality of brick made by this company is excellent, and the yard very neat and tidy.

Middlesex

H. James, Delaware, manufactures white end-cut wire-cut brick and tile from a fine bank of Erie blue clay. The clay is carted to a pair of rolls which feed a Baird pug-mill, which in turn feeds a Kells machine. A Bechtel automatic end-cut machine is used, and Bechtel trucks for wheeling out to open air-drying sheds. The tile are wheeled out and dried also in sheds. They are of excellent quality, and very smooth, hard and free from checks and cracks. The burning is done in two down-draft Stag kilns, rectangular in shape, the chimney being between the two and serving for both. The burning is done with wood.

James Richardson and Son, Kerwood, manufacture white brick and tile from the Erie blue clay. The clay is hauled by car and cable to a pug-mill feeding a Martin machine. The brick are wheeled out and dried in open sheds, and are then burned in large up-draft permanent-walled kilns. These are covered by a long kiln shed, along one side of which is the wagon road, and along the opposite side the railway siding, so that the brick can be loaded from the kilns right into the car. A separate plant is used for the manufacture of tile, which are made in a Kells machine producing all sizes from three to nine inch. These are cut off by hand, and elevated by an endless chain elevator to an upper floor where they are lifted off and wheeled away to dry. They are burned by themselves in a round up-draft kiln, using wood for fuel. The output of brick from this yard is about one million, and of tile about three hundred thousand.

C. G. Frank and Sons, Strathroy, manufacture end-cut wire-cut brick only from the Erie blue clay. The clay is dug and carted directly from the pit to a pair of rolls feeding a Kells machine. A Bechtel automatic end-cut cut-off table is used, and the brick are trucked by the Bechtel system to open sheds and hacks to dry. They are then burned in open-shed scoved kilns using wood for the water-smoking and first burning, and coal afterwards to finish. The output of this yard is about eight hundred thousand per season.

H. C. Baird and Son, Parkhill: This firm manufactures brick machinery, including pug-mills, rolls, Quaker brick machines, Kells tile and brick machines, automatic dump-cars, etc., and also takes the contract for building the Cornell patent down-draft kiln, in fact for fully equipping a brick yard. In addition to manufacturing brick machinery, Mr. Baird operates a brick yard, where all these machines can be seen at work. He has two feet of Red-top clay underlaid by sandy blue Erie clay, followed by a strong blue Erie clay. The upper sandy part is worked into stock brick; this is dug, hauled by Baird cars to two pug-mills which mix thoroughly. From this it feeds to an iron Quaker machine. The brick when dried are burned in two round down-draft Cornell kilns, the output being about one-half a million white brick per season. The stronger under Erie clay is hauled by car and used in the manufacture of white tile, hollow block and wire-cut brick. This clay, which is somewhat stony, is put through a pair of rolls feeding a Kells No. 1 machine. Tile are made from three to twelve inches in diameter, hollow block of one- and three-spaced patterns, also end-cut wire-cut brick. These are burned in round down-draft Cornell kilns. The output of this yard is not large, Mr. Baird's idea being to supply the local market only, and to have a place where the working qualities of his machinery can be shown. A glance over the yards of the Province will show the popularity of Mr. Baird's machinery, especially the pug-mills, and Kells tile and brick machines.

J. W. Cawrse, Walker and Logan, John McLaughlin, Waide Bros., Warwick and Son, London Brick Manufacturing and Supply Company, London.

The clay in use at these London yards is somewhat different from that found in the other yards of western Ontario. It here seems to be a local collection of more recent age than the Erie, as it is found on the surface overlying the true Erie clay below, as shown by borings and wells (see fig. 22). The area is possibly an expansion of the old Thames drainage basin; at any rate the clay is here inter-stratified with bands of sand, sandy clay, and blue quick sand; in some cases, even gravel bands are found. For example at Waide Bros.' yard the following section is shown:—

Gravel (stratified)	6 feet
Strong reddish clay	3 feet
Sand	3 feet
Sandy clay	4 feet
Strong blue clay	1 foot
Quicksand	1 foot
Blue clay	

From the above section it will be seen that this is an entirely different clay from those met in other parts of the Province and is purely a local accumulation. The gravel is cleaned from the top of the clay and carted away for road metal. This not only exposes the clay but is a source of revenue to the owners of the yards, as they receive 10 cents a load for the gravel. The ten feet of clay, sand, etc., down to the quicksand is wedged off and thoroughly mixed, with the result that an excellent quality of white brick is turned out by all these yards. The general method of manufacture is about the same for all of them; two or three examples will suffice.

The London Brick Manufacturing and Supply Co. has a very fine new plant, turning out thirty thousand brick per day, or about three million for the season. The section of clay is dug as described above, hauled in dump cars and dumped into a Raymond machine. This is an American machine which resembles the Monarch made by Baird and Son of Parkhill. It is a very powerful machine with a good pug-mill attachment, and makes six brick at a time. These brick are dumped on pallets which are piled on cars carrying three hundred and thirty brick at a load. These cars are run into long tunnels, through which a blast of hot air is forced by a fan. The cars all enter at one end of the tunnels, which is also the cooler end, so that the green

brick get least hot draft while they are wettest. As the dry brick are taken from the opposite or hotter end of the tunnel, each car moves down one length, so that at the end of forty-eight hours each car of brick is dry; the cars are then run into the large open up-draft kilns, three in number. These kilns have permanent side walls in which are placed the fire arches. Each kiln has twenty-five arches and is capable of holding five hundred thousand brick. The ends are open so that the kiln can be filled to any extent and scoved up as usual. (See fig. 35.) The burning is done with coal, and the water-smoking with wood. This is a new plant and one of the best seen in the Province.

Fig. 48.—Plant of London Brick Mfg. and Supply Co., London.

Walker and Logan manufacture about one million and a half white sand stock brick per season. Their clay is wedged off as described above, and thoroughly mixed in a Baird pug-mill, which feeds a Monarch machine making five brick at a time. The clay here is very sandy, and the brick have a tendency to lose their shape when wheeled out to the drying-shed. To overcome this the moulds are piled on barrows, eight to a load, and wheeled to the rack yard; here they are dumped on a pallet and set in the racks to dry. From here the brick are hauled on a truck waggon to open-shed scoved kilns, and to one sixteen-arch permanent-walled up-draft kiln. This is used, especially in the fall when the weather is bad and for the last big burn of the season; the water-smoking is done with wood, and the remainder with coal.

Waide Brothers operate a very neat, tidy yard. The section of clay is wedged off from top to bottom, and is hauled by car and cable to the machine house, where it is thoroughly mixed, and made into white stock brick. These are taken in the mould to the yard and dumped there for the reason given above. When dried, they are hauled by horse truck to open-shed scoved kilns, and one long permanent-walled up-draft kiln, for use in the fall and bad weather. This firm also manufactures a few tile. The upper band of strong reddish clay three feet in thickness is dug by itself and made into an excellent quality of tile with a Kells machine. It is much too strong, however, to be used alone for brick. The tile are burned with wood and coal in one round down-draft kiln. The output of brick is about one million and a half per season, and the tile are made as ordered.

Muskoka

Watson and Hutchison, Bracebridge: The clay found in the Bracebridge yards is typical Saugeen clay described in the first part of this report, that is, a finely laminated reddish brown clay, and reddish sand, the bands of which are rarely over three-quarters of an inch in thickness. This yard is situated on the top of a hill, in which the clay is from fifteen to twenty feet thick, and is underlaid here, as in other places, by white quartz sand. The gray bands of sand make this clay just lean enough to work well. The upper three feet of this bank contains many concretion-like nodules, which are of a shaly nature and very hard, and unless they are allowed to slake by digging the clay and exposing it to the air, or are crushed by being put through a pair of rolls, they go through the brick machine, and as hard lumps in the brick act like pebbles, bursting the brick either before or after the burning.

No. 49.—A 45-h.p. water wheel installed by Mr. Watson, Bracebridge, with which he operates his whole brick plant at a cost of about 10 cents per day.

Below this yard is a small stream with a small fall, and here a little water wheel has been erected by Mr. Watson (see fig. 49), which generates forty-five horse power. The power is developed and transmitted by a cable to the yard, a distance of about one hundred and fifty yards. The clay is dug and dumped in a bucket which is raised by a cable to a track, along which it is carried and dumped to a hopper. (See fig. 26.) This hopper dumps to a Baird pug-mill feeding a Martin machine. The brick are dried

by the rack and pallet system, and are burned with wood in a permanent-walled updraft kiln, and in open-shed scoved kilns. A new Kells tile machine has lately been installed for the manufacture of tile, hollow block, and wire-cut brick. These will be burned in round down-draft kilns now in course of erection. The plant as a whole is one of the neatest and most economically run in the Province; for example, the power necessary to manufacture thirteen thousand brick per day has been calculated, and found to cost less than ten cents per day. This plant is a comparatively new one, but with the cheap power and the fine deposit of Saugeen clay should have a bright future. The main difficulty to be overcome is the crushing of these nodular pieces mentioned above. This can be done either by slaking, which is a slow process, or better still, by rolls

Bracebridge Brick Company, Bracebridge: This yard is also situated on Saugeen clay in every way like that at Watson and Hutchison's yard. The clay is finely laminated with grayish sand, and in places reaches a depth of twenty-two feet. Below this is white quarta sand, which has been found in so many places underlying the Saugeen clay. The surface is ploughed and is left to slake, after which it is mixed with a little more sand and is heaped close to the machine. The clay is then worked in an Iron Quaker machine making six brick at a time; these are dried with the rack and pallet system, and are burned in open-shed scoved kilns. This clay also contains many of the objectionable concretion-like nodules. The brick made in this yard are of good quality, and the output is about seven hundred thousand per season.

Nipissing

Wallace and Son, North Bay: Saugeen clay occurs at this yard in a bank varying from three to ten feet in depth, and rests immediately on the polished granite surfaces of the old Laurentian formation. Most of the country about North Bay is bare and rocky, with the hollows usually filled by sand, gravel, and occasionally Saugeen clay. It is one of these hollows, with a variable depth of Saugeen clay, overlaid in places by a foot or two of red sand, that is worked for a brick-yard. Such hollows are comparatively rare, and especially hollows with clay sufficiently clean and free from over-burden of sand and gravel. The underlying layer of Erie clay usually found in other parts of the Province is entirely wanting here.

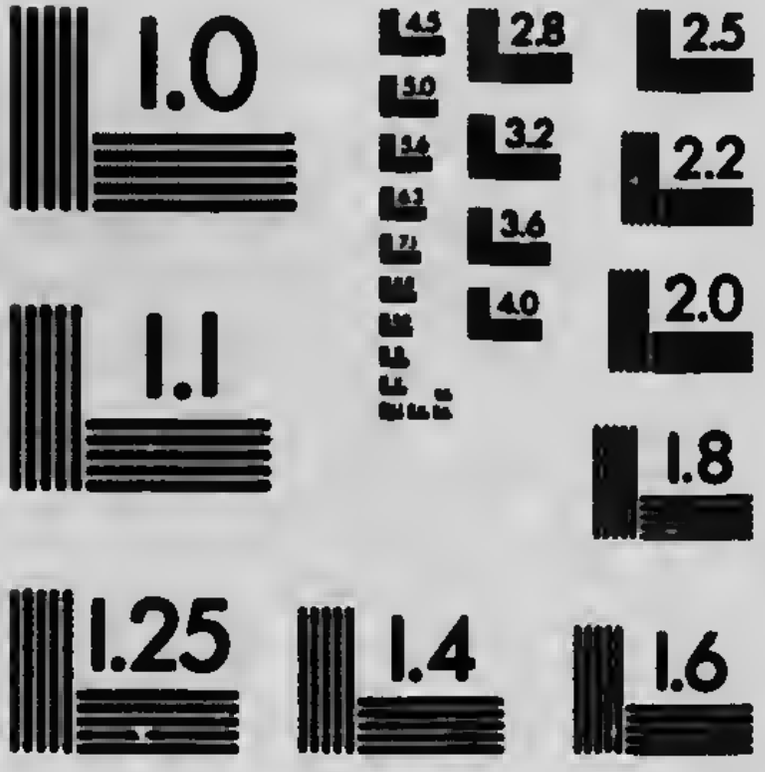
The clay is dug to a heap and allowed to slake, when it is wheeled to a Martin machine run by horse-power. The brick are dried in open hacks and burned with wood in open-shed scoved kilns as usual. The output for a season is about 800 thousand, all red. These brick are of good quality, but burn a little light in color. The analysis of this clay is No. 64 under Saugeen Clays, page 26 of this Report.

Standard Clay Company, North Bay: In another hollow this company have started the manufacture of brick, and built a more modern plant. They have the usual section of Saugeen clay with sufficient sand to render the whole quite workable. This clay is dug and carted directly to a Hercules machine. The excellent pug-mill attachment on this machine is of great service in thoroughly mixing the sand and clay. The brick are dumped on pallets and piled on steel cars, which are then run into tunnel dryers of the Sheldon and Sheldon type of Galt, Ontario. After drying for thirty-six hours, they are taken from the opposite end of the tunnel and burned in open-shed scoved kilns with wood as the fuel. Red brick only are made, and the output for the season is about one million. This plant is a very modern one, and with the brisk demand which the influx of people to New Ontario is causing, it should have a very much increased output in the near future. It may be further added that there is very little clay near North Bay save that worked by these two companies.

The Liskeard Brick, Coal and Lumber Company, New Liskeard: This is a new yard recently opened to supply the demand for brick in New Ontario, but the deposit is not uniform in character from top to bottom. The first six feet of typical interbanded

MICROCOPY RESOLUTION TEST CHART

(ANSI and ISO TEST CHART No. 2)



APPLIED IMAGE Inc

1653 East Main Street
Rochester, New York 14609 USA
(716) 482 - 0300 - Phone
(716) 288 - 5989 - Fax

Saugeen clay burns to a rich red color. The next four feet or so does not burn so rich a red, but rather a pinkish shade. Below this is a very blue laminated clay, free from stones, but containing considerable quicksand. This blue clay burns to a creamy white brick All these clays are very strong, so much so that they are only worked with the greatest difficulty. The drying is especially difficult, and if the brick be exposed to direct heat or draught, the outside dries so much more rapidly than the inside that the brick break badly. This could be largely overcome by the addition of red sand to the red clay, and gray sand to the blue clay; but unfortunately this sand is difficult to find. At present the clay is dug and hauled by truck wagon to a pug-mill, which feeds a Doig machine, making five brick at a time. The brick are dumped on pallets and set in large racks in a covered shed, or really a dry kiln, since this clay will not stand wind or sun drying. The sheds are closed in and a series of coils, steam heated, is placed in the floor. A little steam is even liberated into the tunnels at first, to prevent the outside of the brick drying too rapidly for the inside. The dried brick are burned with wood in open-shed scoved kilns.

In this yard there is also a Kells tile machine for the manufacture of tile, hollow block, and wire-cut brick. The wire-cut brick are trucked out by the Bechtel trucking system to open shed-dryers, after which they are burned in the usual way in open-shed scoved kilns. The output for this yard is expected to be about a million brick per season. They will make both red and white brick, and both sand stock and wire-cut brick. The yard is not in full running order, however, as yet. The analysis of this blue clay at the base of the Saugeen proper is given as No. 66, page 26 of this Report.

R. Scott, New Liskeard: Mr. Scott operates one of the first yards ever worked in New Ontario. He has the usual section of Sangeen clay, which he has been in the habit of digging over and allowing to slake, after which it is worked in a Martin machine using horse-power. The brick were dried by the hack system and were burned with wood in open-shed scoved kilns. This was a small yard with a yearly output of about 300,000. The building of the T. & N. O. railway rather damaged Mr. Scott's yard by running through it, thereby cutting off his supply of clay, but he has now crossed the railway and is establishing a bigger and better yard there. He is installing a new machine with the rack and pallet system of drying, and will no doubt increase his output materially. The analysis of his Saugeen clay is given as No. 65, page 26 of this Report.

The Imperial Land Company, Sturgeon Falls: This large plant was built some years ago by the Sturgeon Falls Power Company, now the Imperial Pulp and Paper Company. It was built for the manufacture of the brick required in the power houses, factories, offices, etc., required by this company at Sturgeon Falls. They have since continued to operate the yard for the manufacture of brick for the local market. The clay in this yard has given considerable trouble. There are in reality three different classes of clay in the deposit. Starting at the surface we find a layer of stiff blue clay about three feet thick. It is free from the inter-laminations seen in the Saugeen clay. It is also free from stones, but contains considerable quicksand. This clay, if dug and worked by itself, will yield a buff brick, and it should be worked by itself if used at all. At any rate, it should be kept out of the underlying laminated clays.

Immediately beneath this blue clay we have the Saugeen clay, the upper part of which is composed of alternate bands of a blackish brown clay, with gray clay, while the lower part of the bank is composed of bands of a rich chocolate brown clay with a dark gray clay. Both of these latter clays will burn to red brick, but are rather too fat of themselves, and would yield much better brick if mixed with about 25 per cent. of red sand. These three clays are at present dug to heaps where they are allowed to slake. They are then carted and dumped to a pug-mill feeding an Iron Quaker machine, making six brick at a time. The brick are dumped on pallets

which are piled on steel cars, and are then run into the tunnels of a Sheldon and Sheldon drier, where they are allowed to stand in a hot draft for thirty-six hours, after which they are burned with wood in up-draft case kilns, of which this company has three. The output is chiefly of red brick, but some white ones are also made. The total output for the season is about two million. The analysis of the upper blue clay which burns buff is given as No. 40, page 14. It is not an Erie clay, but like the latter burns white. The analysis of the underying Saugeen clay at this yard is given as No. 56, page 26 of this Report.

Norfolk

C. Mason, Simcoe, has the Red-top and underlying Erie clay, both rather sandy. The Red-top clay is used for the manufacture of brick, and the Erie blue clay for the manufacture of tile and end-cut wire-cut brick. The Red-top clay is made into stock brick by a Martin machine, the moulding sand is mixed with red oxides to improve the color, and aid in shifting, the brick are hacked out in the ordinary way to dry, and are burned in open scoved kilns and in round down-draft kilns. The white clay is worked by a Kells machine into tile and wire-cut brick, which are burned in the same way. The clays of this district are rather too sandy to turn out first-class goods. Mr. Mason has about three feet of good strong clay at the surface overlying sandy clay.

Northumberland

H. Hall, Cobourg, has been making brick for a great many years, during which time he has introduced many little devices for improving the products of his yard. He has about three feet of Red-top clay, which is dug in the fall, heaped over winter and allowed to freeze and slake. It is then manufactured in a Martin machine turning out five brick at a time. The drying is done by the rack and pallet system, and the brick are burned in scoved kilns; it is in this department that Mr. Hall has made his chief improvements. On top of the platting he places hard coal screenings in such position that at the desired time they can be allowed to trickle through the platting into the kiln, these screenings are placed over those parts only of the kiln which do not burn hard enough under ordinary conditions. This as a rule is around the walls and in order to allow the coal to trickle well down into the brick a row of "scintlers" are placed all around the kiln from the "checker" to the top. At intervals a little of the screenings are allowed to trickle down, and the burning of this coal causes a little additional draft in those parts which otherwise would have been under-burned. Mr. Hall has had first-rate results in this way, as he is able to tear down the scoving and start at once and ship face brick, hard brick being burned right to the heads. At the time of the writer's visit to this yard, a kiln had just been finished, the scoving was torn out and the very first brick were of excellent quality, and quite hard enough for outside brick. His output for the season is about six hundred thousand.

Jex and Company, Cobourg: This firm are building contractors, and manufacture brick almost entirely for their own work. They make red brick only, using the Red-top clay which is about two and one-half feet thick in this yard. The clay is heaped in the fall and worked the following spring to stock brick, using a Martin machine and horse-power. The brick are hacked out in the ordinary way, and are burned with wood in scoved kilns.

Oxford

Odell and Son, Ingersoll, uses the Erie blue clay in the manufacture of white brick, three-spaced hollow block, and tile from three to twelve inches in diameter. The clay is dug and dumped to a pair of rolls feeding a Kells machine. All the goods are made by this machine. The brick are side-cut, wire-cut, the flat-faced being perforated with three holes. The chief output is tile, especially large sizes. The Erie

clay here is excellently suited to the manufacture of tile. The power used here is a twenty-five h. p. gasoline engine, which Mr. Odell claims is a great saver of fuel and attention. The goods are burned in two excellent round down-draft kilns, the water-smoking is done with wood, and the first of the firing up is also done with wood, after which soft coal is used with the result that the goods are very hard, and of a beautiful cream white color.

Wm. Marshall and Son, Woodstock, use Red-top clay only in the manufacture of side-cut wire-cut brick, employing a Close machine which was made at Woodstock. The clay is dug in the fall and heaped near the machine; it is tempered with water containing red oxide of iron, which aids the color materially. The side-cut brick are perforated with three holes in their flat surface to prevent them from warping during drying. The brick are dried in open sheds and are burned with wood in kilns having the two side walls which contain the fire arches built permanently, while the ends are left open and scoved up whatever size required. (See fig. 35.) The brick turned out are of good quality, being quite hard and of dark red color. The output is about eight hundred thousand per year. The Close machine is of a plunger type which avoids the curly or rolled centre so commonly seen in wire-cut brick made in auger machines, but it has one defect especially for working Canadian clays, in that the die is lined with cloth which soon wears unevenly causing the brick to be mis-shapen Especially does it wear out in working our gritty and more or less stony Erie clay, and this is the class of clay usually manufactured into wire-cut stock.

E. Cherret, Woodstock: This yard was also visited, but is in every way the same as Marshall's. The same class of clay is used, and the same system of manufacture followed throughout.

Deller and Son, Norwich, has about two feet of Red-top clay underlaid by Erie clay. Both are used, the top clay for the manufacture of red brick, and the lower clay for the manufacture of white tile, three-spaced hollow block, and wire-cut brick. The clay is carted to a Baird pug-mill which feeds a pair of rolls on a Kells machine, the Bechtel automatic cut-off is used for brick, tile, and hollow block. Tile up to eight inches in diameter are cut off by this machine; above this size they are cut off by hand. The output of tile is about three hundred thousand, more particularly the large sizes. About sixty thousand three-spaced hollow block are made per season. and a few red and white brick, but this part of the trade is left largely to the next described yard at Norwich Junction. The brick, tile. and hollow block are all burned in down-draft kilns, one round and one rectangular, the water-smoking and first burning is done with wood, and the remainder with soft coal. All in all, this is an excellent yard, turning out first-class clay products.

James Irwin, Norwich, has from two to three feet of Red-top clay, below which is the Erie blue clay as usual. The top clay is made into red brick by a Kells machine. The brick are wire-cut end-cut, cut off by a Bechtel automatic end-cut machine, are dried in hacks and burned with wood in open-shed scoved kilns. The output is about one million per season.

John Kaar, Brownsville, uses the Erie blue clay in the manufacture of white tile, hollow blocks and end-cut wire-cut brick. The clay is used dry, and wheeled to a Bechtel disintegrator which breaks the lumps and throws out all stones. The product is fed to rolls, wich crush the clay to powder; it is then screened, and that which passes through the screen is fed to a pug-mill which in turn feeds a Kells machine. The brick are cut off by a Bechtel automatic end-cut machine, and are wheeled on Bechtel trucks to a carless dryer built by Bechtel Bros. The tile are piled on end on racks having four shelves, and when each rack is filled it is picked up by a gig and carried as a whole into the Bechted dryer. Here the racks are placed in a row, a covering of tar or felt paper is laid over them, and a blast of warm air blown on. When dry, the goods are burned in round down-draft Cornell kilns. Here Mr. Kaar uses an artificial blast from a fan in his drying house; this blast is used after the

water-smoking is finished. A three-inch tile main is led to the kilns and around the outside; opposite each fire hole is a small iron pipe leading under each grate and this forms the draft flues. The air having been previously warmed insures an even draft, a quicker fire, and a more uniform burn. The drafts usually found in brick kilns depends largely on the direction of the wind; where this artificial draft is used all other is sealed up so that the wind has practically no effect. This is one of the most thoroughly equipped yards in the Province, and Mr. Kaar has spared neither time nor money to make his yard first-class in every particular. The result is that his goods are also among the best seen in the Province.

Fig. 50.—Beaverton Brick and Tile Co's yard, Beaverton. Note round down-draft kilns burning coal.

Ontario

The Beaverton Brick and Tile Company, Beaverton: This is a large yard making red and white stock brick and white tile, chiefly in sizes from two to ten inch. There is about two fe[illegible] Red-top clay which is used in the manufacture of red stock brick; beneath t[illegible] the usual Erie blue clay having the following composition:

	Per cent.
Silica	37.50
Alumina	10.31
Ferric oxide	3.59
Lime	22.56
Magnesia	2.61
Soda	1.11
Potash	2.34
Sulphur trioxide	.12
Loss by heat	19.60

The Red-top clay is mixed with sand for red brick, the next three feet of grayish blue clay is mixed with one-third its volume of sand, to make white stock brick; below this again is the typical blue Erie clay, which is made into tile of all sizes. All three classes of goods are of excellent quality. The tile are burned in three round down-draft kilns using wood for the water-smoking, and soft coal for the remainder of the fire. The red and white stock brick are burned for the most part in up-draft permanent walled kilns, the ends being scoved. The output of brick is about one and a half millions per season, and the output of tile is about seven hundred thousand, varying from two and one-half to ten inches in diameter. This company's output, especially its tile, is sent all over eastern Ontario, and even to Quebec.

William Gilmore, Whitby: Mr. Gilmore, who is eighty-seven years of age, has been operating this yard for the past fifty years. He makes red brick, about one-half a million per year, and sixty to one hundred thousand white tile, varying in size from two and a half to nine inches in diameter. The brick are made from Red-top clay in a Martin machine using horse-power. They are hacked out in the ordinary way, and are burned with wood in open-shed scoved kilns. The tile are made from the underlying Erie clay in a Kells machine using steam power. When dry, these are burned in an old fashioned up-draft kiln, having an open floor. The fires are run from one side to the other beneath this open floor, so that the heat passes directly from the fire places up through the open floor into the tile and out at the top. This makes a kiln which is very hard to control, and is the only one of its kind seen in the Province. The goods turned out by Mr. Gilmore are of excellent quality, and show that his long experience has made him a first-class brick-maker.

Parry Sound

D. Clark, Powassan, has a section of about twelve feet of Saugeen clay, quite free from stone, but containing the usual amount of interbanded sand. This sand dug in with the clay renders the whole quite mild, making it an excellently workable deposit. The clay is dug over in heaps and is allowed to slake during the winter with the frost and rain. It is then loaded into small dump-cars, which are hauled by cable and which dump automatically into a Monarch six brick machine. The brick are then hacked out to dry, and after drying are wheeled to Case up-draft kilns, where they are burned with wood in the usual way. A very handy method is used here in setting the kiln, which avoids throwing up the brick. An elevator is placed at one end of the kiln, and the barrows when wheeled on to it are raised to the required height, the brick being set directly from this. The elevator is movable, and as the kiln is built, it is gradually shifted so as to always be handy to the setting.

The burning is done in three of these up-draft kilns, and the brick produced are of an excellent red color. The output per season is from a million and a half to two million, all red brick. The analysis of this clay is given as No. 67, page 26 of this report.

V. Russel, Burk's Falls: Mr. Russel is successor to Mr. F. Kerr and is rebuilding the yard, adding a steam plant and additional drying space to the yard as formerly run by Mr. Kerr. He has from six to ten feet of Saugeen clay with its usual bands of sand, which render the whole quite mild and easily workable. The clay is dug as usual into a heap and allowed to slake in the weather. The advantage of this method of disintegrating, or pulverizing clay, is readily seen by exposing a piece of tough, hard clay to the weather, especially if it be frozen. It will be found that the stiff lump upon being exposed and frozen will crumble readily to an earthy powder. This is taken advantage of by brick-makers geenrally through the Province.

Mr. Russel wheels his cley from the heap to a Doig six-brick machine. The brick are then hacked out in the ordinary way, and when dry are hauled by truck-wagons

to open-shed scoved kilns, where they are burned with wood in the ordinary manner. Red brick only are made, but a good quality of these, the annual output being about 800,000 to a million.

L. H. Ware, Huntsville, has the usual section of six to ten feet of Saugeen clay somewhat fatter than that of Burk's Falls, but not so fat as that of Bracebridge. This is dug to a heap and allowed to slake as usual, when it is worked in a Martin machine using steam power. The brick are dried by the rack and pallet system, and are then burned in open-shed scoved kilns. The output for the season is about 700,000 red brick.

Peel

A. Norton, Bolton, manufactures red brick from the Red-top clay colored by red oxide. The brick are made in a Martin machine using horse power, are dried by the rack and pallet system, and are burned with wood in open shed kilns. Beneath the red clay is the usual supply of Erie blue clay, which is made into white tile with a Close machine. This machine is also run with horse power. Although the output is small, the goods are of excellent quality. Mr. Norton makes about one hundred and fifty thousand tile per season, varying in size from two and one half to eight inches. They are burned with wood in a rectangular down draft kiln.

Brampton Pressed Brick Company, Brampton: This yard is managed by Mr. Packham, who previously owned the yard himself, but it has been considerably enlarged and it is about to be moved to a new locality and further enlarged. The Medina red shale is used in the manufacture of red pressed brick. The shale is blasted and hauled by car to a pan mill, and the ground product is elevated to a set of screens placed at an angle of about forty degrees to the horizontal. The over size is returned to the pan mill to be re-ground, while that which passes through the screen is fed to a Boyd press. From the press the brick are wheeled directly to permanently-walled up-draft kilns, where they are burned in the ordinary way at first with wood, then by coal and wood, and finally by coal alone, the whole process lasting about two weeks. The output of pressed brick is about one million and one-half per season. On top of the shale is a coating of mixed clay and shale which is dug and used in the manufacture of red tile; about three hundred thousand of these are made per season and are burned in a round down-draft kiln. Mr. Packham is now moving his yard to the Credit Valley branch of the Canadian Pacific railway, where he intends to install two more presses, which will increase his output by two or three million per season. The shale used in this yard for the manufacture of red pressed brick analyzes as follows:—

	Per cent.
Silica	56.52
Alumina	15.21
Ferric Oxide	5.82
Lime	6.86
Magnesium	2.82
Soda	.56
Potash	3.59
Sulphur trioxide	.20
Loss by ignition	8.79

As will be noticed by the above analysis, this shale is comparatively free from sulphur, so that the brick made from this shale do not show the efflorescence or "soda" so commonly seen on pressed brick, after they are built in the wall.

The Port Credit Brick Company, Port Credit: This yard, which is under the management of Mr. Thos. Buchanan, is used in the manufacture of red pressed brick and is one of the largest and best run yards in Canada. It is situated on the shore of Lake Ontario about half way between Toronto and Hamilton. The brick are made

from a mixed shale, the upper part being reddish; below the shale is yellowish brown, and lower down it is blue. The whole section is used in the manufacture of brick. The shale is blasted from the top to the bottom, and is hauled by car to two pan mills, the ground shale is elevated to screens, the oversize returning to be re-ground. The screened shale is then used in the manufacture of brick with a Berg press. The shale, when ground, has the following composition:—

	Per cent.
Silica	56.46
Alumina	18.19
Ferric oxide	7.43
Lime	2.56
Magnesia	2.93
Soda	.63
Potash	3.54
Sulphur trioxide	.15
Loss by ignition	8.52

This analysis shows a high percentage of iron well fitted to produce the red color of the brick, together with a low percentage of lime, which, therefore, does not counteract the iron. The percentage of sulphur trioxide is very low, consequently the brick are practically free from the so-called "soda," usually found on red pressed brick.

Fig. 51.—Port Credit Brick Coy's pressed brick plant, Port Credit, showing large continuous down-draft kiln.

The brick are wheeled from the machine directly to a Hoffman continuous kiln, consisting of eighteen chambers arranged continuously in an oval. The waste heat from one chamber passing through the adjoining chambers first dries off the brick, then, as the fire is led nearer, it heats them up; finally the fire is led right into the new chamber, and so the process continues round the oval of eighteen chambers, so that when the fire is once kindled, it is never let out, but some chambers are being charged while others are burning, and still others are being discharged. Each chamber

is capable of holding about twenty thousand brick; thus the whole kiln will burn three hundred and eighty thousand in one round; and this can be done in sixteen days, once the fire is up. The firing is done from above through small sand holes about five inches square. A good sized handful of cracked coal is dropped down each hand-hole every twenty minutes, a large flue serving for all the chambers passes along the centre of the kiln with a small flue connecting it with each chamber, and in the outer end of each of these is a hand damper by which the fire can be regulated from one chamber to another.

This plant runs night and day, making thirty-eight thousand brick in twenty-three hours, or about eight million for the season. In addition to the Hoffman kiln a few permanent walled up-draft kilns are used to burn the surplus brick, but at the time of the writer's visit the foundations were dug for five new round down-draft Stewart kilns. Several other additions to the plant were being considered, among them being two more presses and an endless chain conveyor for the shale from the bank to the plant. This machinery, in fact, was already on the ground, electrical power was about to be acquired from Niagara, when the lighting, power, and electric rock drills were to be used. It will be thus seen that this plant is one of the finest and most thoroughly equipped in Canada.

Perth

Stratford Brick, Tile and Lumber Company, Stratford: This yard was formerly operated by Keller Bros., but has recently been rebuilt and enlarged and is now worked by the above named Company, although it is still managed by C. S. Keller. It has from two to four feet of Red-top clay, below which is the typical blue Erie clay. The Red-top clay only is used as yet, but the company expects to manufacture white brick and tile as well. The Red-top clay is dug and carted to a Kells machine. The Bechtel automatic end-cut cut-off is used. The brick are dried in open hacks and are burned in down-draft kilns, and occasionally in open-shed scoved kilns. The company has attempted the manufacture of dry pressed brick from this Red-top clay. It is dug as usual and left in the sun to dry, when it is hauled to a clay shed. Here it is put through a Bechtel disintegrator; the powdered clay is elevated to screens, and the over-size returned to be re-ground. This machine is excellently adapted to stony or lumpy clays, but does not pulverize the clay finely enough for pressed brick. A Berg press is used, and at the time of the writer's visit, a few pressed brick had been made, but the material was too coarse that the brick were mealy in grain, the particles not having fused together. It is quite likely, however, that when a machine is got that will pulverize the clay finely enough, a good pressed brick will result.

The clay used for the manufacture of these red pressed brick analyzes as follows:—(No. 1.)

	No. 1. Per cent.	No. 2. Per cent.
Silica	69.12	40.16
Alumina	14.03	13.76
Ferric oxide	4.81	5.58
Lime	1.94	15.74
Magnesia	1.10	3.78
Soda	1.53	.70
Potash	2.05	2.00
Sulphur trioxide	.10	.17
Loss by ignition	4.80	17.48

No. 2 is the Erie blue clay immediately below No. 1, and burns to white goods on account of the high percentage of lime. Since the writer's visit this blue clay has been made into dry pressed brick and specimens shown at the Clay Workers' Conven-

tion at Hamilton were very superior buff brick. This is the first case reported in Ontario of pressed brick being made from this Erie blue clay, although pressed brick have been made from very similar clay in the Province of Manitoba at Lac Du Bonnet[7] from re-assorted boulder clay whose composition is as follows:—

Silica	45.43
Alumina	10.67
Lime	10.50
Ferric oxide	4.78
Magnesia	6.03
Potash	3.04
Sulphur trioxide	.13
Loss by ignition	17.07

By comparing this clay with the Erie blue clay found in Ontario (see page 14), a close resemblance will be noted; both are assorted boulder clays, and it would appear that there is a good future for the manufacturer of buff-colored pressed brick from our Ontario blue clay. The brick made by Mr. Keller from this clay were of excellent quality, and speak much for his enterprise in this new departure of brick-making in Ontario.

For pulverizing this clay, Mr. Keller constructed a very simple machine which beats the clay to a fine powder. The machine can be built at a very low cost and has a very large capacity. He will no doubt be pleased to furnish information on inquiry.

Fig. 52.—Part of Close Brick Co.'s plant, Stratford, showing a Baird clay-car bringing clay to the machine.

The Close Brick Company, Stratford: This yard has recently been established on the eastern limits of the city of Stratford. It manufactures red stock brick from the Red-top clay, beneath which is the stony blue clay which at present is not used. The clay is dug and hauled by car to a Monarch soft mud machine; the brick are trucked by the Bechtel system and are dried in a Bechtel Carless dryer. The

[7] Industrial Value of the Clays and Shales of Manitoba, by J. W. Wells, Geol. Surv. Can., 1905.

output is about fifteen thousand per day, or two million for the season. The brick are burned in up-draft scoved kilns, the water smoking is done with wood and the remainder by coal. Mr. Close, the manager of the yard, superintended the erection of the plant and has a very up-to-date one, producing a good red stock brick.

F. Entricken, Stratford: This yard is situated at the little lakes, three miles east of Stratford, and was formerly run by Mr. John Jarvis, now of Dorchester, one of the oldest brick-makers in the Province. These little lakes, three in number, represent pool-like basins in a former drainage channel which fed the Avon river, a small drain only remaining to mark the course of a former stream of considerable size. They are at present twenty-four to forty feet deep. It is supposed by the people of the district that they are connected by underground channels, but this cannot be the case, because the Grand Trunk Railway Company's pump house, situated on the shore of one of them, can lower the water in that lake without affecting the level of the other two. Moreover, the second lake level is twelve feet below that of the first. These lakes are the deep remnants of a former channel, which can be traced from above the first lake through the second and third and on over the country until it joins the present valley of the Avon river. At present the water is received from

Fig. 53.—Laminated Erie clay beds at F. Entricken's yard, Stratford.

the surface drainage of the surrounding country. Mr. Entricken's yard is situated near the shore of one of the lakes, in fact his clay is dug from a pit which is below the level of the water in the lake, and a centrifugal pump is required to keep the pit dry. The clay, however, is excellent, it being very free from stones, and just sandy enough to be nicely tempered. Its analysis is as follows:—

	Per cent.
Silica	45.46
Alumina	9.73
Ferric oxide	3.83
Lime	15.80
Magnesia	5.06
Soda	.78
Potash	1.85
Sulphur trioxide	.12
Loss by ignition	17.37

The clay is dug and taken direct from the pit in cars to a Monarch soft-mud machine; the brick are dumped on pallets, dried by the rack and pallet system, and burned in three down-draft kilns with wood. The output for the season is about two million brick.

Fig. 54.—A double rectangular down-draft kiln at F. Entricken's yard, Stratford. No. 1 is being fired, while No. 2 is being discharged.

W. B. James, Mitchell, has from two to four feet of Red-top clay, underlaid by the Erie blue clay, which has been proven to be over twenty feet deep. He manufactures both red and white brick and tile, the chief output being red brick, of which he makes about one million per year, and in addition about eight kilns of tile running from two and one-half to ten inches in diameter.

For brick the clay is dug and carted to a pug mill, feeding a Quaker machine. The moulds are sanded by ground "bats," which are pulverized in a ball mill. The brick are dried by the rack and pallet system, and are burned by wood and coal in two round down-draft kilns. For tile a Kells machine is used.

W. H. Barnard, Monkton; J. Johnson, Monkton: These two yards, situated almost side by side, are working the same clay, namely, the Red-top clay, both making brick and tile. The brick are made by a Kells machine using the Bechtel automatic cut-off; they are then hacked out to dry and are burned in round down-draft kilns, using wood as fuel. The brick from these two yards were among the finest seen in the Province, especially on account of their rich, uniform, red color.

Peterborough

Curtis Brothers, Peterborough, have about two feet of Red-top clay, which is underlaid by sandy Erie blue clay. Both are used in the manufacture of red and white brick, and tile and paving block. In this yard are two Iron Quaker machines and one Martin machine, all run by steam power. The clay is hauled direct from the pit in automatic dump-cars which feed Baird pug-mills, which in turn feed the brick machines mentioned above.

The brick are hacked out to dry and are burned in two square down-draft kilns, and in large open-shed scoved kilns. The output of this yard is about four million brick per year. The tile and hollow block are made on a Close machine, the hollow block being used for raised barns and stable floors. This is one of the largest yards in the Province and the goods manufactured are among the best.

There are two other yards in Peterborough, run by H. Butcher and T. J. Welsh, respectively. They are both small yards using horse power, and have an output of about five hundred thousand each per year.

Fig. 55.—Curtis Bros' yard, Peterborough.

Prince Edward

D. Sullivan, Picton: There is just one brick yard operating in this county, and this is situated at Picton. There are from three to five feet of Red-top clay underlaid by Erie clay, having the following composition:—

	Per cent.
Silica	34.48
Alumina	9.11
Ferric oxide	3.71
Lime	23.33
Magnesia	4.83
Soda	.90
Potash	1.76
Sulphur trioxide	.19
Loss by ignition	22.30

This analysis shows an extremely high percentage of lime and magnesia, with a relatively high loss by ignition; the silica, on the other hand, is very low, the inference being that this clay carries a very high percentage of ground-up limestones. The red

clay is used in the manufacture of red stock brick by means of a Martin machine and horse-power. The brick are hacked out to dry, and are burned with wood in open-shed scoved kilns. While the green brick are being set in the kilns, hard coal screenings are scattered through the heads to aid in the burning. The output of the season is only about four hundred thousand, as the demand is purely local.

Renfrew

Wm. Baker, Arnprior, has from three to eight feet of very strong clay; this is underlaid by six feet of a mild, grayish clay, and below this is Leda blue clay to an unproved depth. The same section is thus exhibited as is shown in the other northeastern parts of the Province, for example, at Ottawa. A section of about fifteen feet is worked; the clay is hauled by horse and car to the foot of an incline, where it is elevated by a cable, and dumped to a pug-mill feeding a pair of rolls, from which it passes to a second pug feeding a new Quaker six-brick machine. In this way the strong top clay and the mild under clay are thoroughly mixed and an excellent product results. The brick are dumped on pallets and piled in racks on iron cars, which are run to a tunnel drier; the cars of dry brick are taken from the opposite end of the tunnels, to four round down-draft kilns, and occasionally to open-shed scoved kilns. The strong top clay is also used by itself in the manufacture of red tile; the clay is pugged, then passed through rolls to an English tile machine. An automatic cut-off is used, and the tile are stood on end on pallets placed in the same cars; they are also dried in the tunnel dryers and are burned in the down-draft kilns.

This is an excellent yard, and has an output of about twelve hundred thousand brick and tile per season, the power being steam and a sixty-horse compound engine. The clay here instead of being mixed with limestones, contains a corresponding number of hardheads or igneous boulders, carried by the glaciers from the igneous area to the northeast.

J. A. Thibadeau, Pembroke: Here we have another area of Saugeen clay, differing only from the others in being much more sandy. The section is dug and carted directly to a Martin Machine run by steam power. The brick are hacked out to dry, and are burned in open-shed scoved kilns with slabs. The brick are of a good color, but the clay is so sandy that it should be thoroughly pugged before going to the Martin machine. The output of this yard is about seven hundred thousand per year.

J. Johnson, Pembroke. This yard works on the same Saugeen clay as the last mentioned, the bank being in every way similar. It is operated in the same way except that horse power is used instead of steam. The output of this yard is only about four hundred thousand per season.

The Saugeen clay at Pembroke has the following composition:—

	Per cent.
Silica	62.30
Alumina	16.51
Ferric oxide	5.65
Lime	3.16
Magnesia	2.68
Soda	2.25
Potash	2.61
Sulphur trioxide	.40
Loss by ignition	3.60

Thomas Henderson, Renfrew, has two to three feet of Red-top clay, underlain by a grayish yellow clay which soon passes into Erie blue as usual. The Red-top clay is made into red stock brick, the under clay, which of itself will burn to white brick, is mixed with a coloring (of Mr. Henderson's own invention and for which he has

applied for a patent), and is burned also to a red brick. These are made with a Martin machine using electrical power; the tile are made in a Kells machine. The dried brick and tile are burned together in three round down-draft kilns. This yard has an output of about five hundred thousand brick, and about three hundred and fifty thousand tile per season, all being red. Mr. Henderson contemplates several improvements, among them being an artificial drier, and two more down-draft kilns.

F. Hilliard, Renfrew, has from two to three feet of Red-top clay lying on grayish yellow Erie clay, again underlaid by Erie blue clay, these layers representing the different stages of weathering. Mr. Hilliard uses only the Red-top clay in the manufacture of red stock brick and also red tile. The clay is carted to a Quaker machine moulding five brick at a time; these are hacked out in the ordinary way to dry, and are burned with wood in open-shed scoved kilns. For tile the clay is put through a pair of rolls feeding a Kells machine. The tile are burned with wood in two round down-draft kilns and an excellent quality of goods results. The output of bricks is about six hundred thousand per year. and of tile about three hundred thousand. This is a neat yard, and the goods are first class.

Russell

Merkley Brothers, Casselman: In this yard we find about four feet of a reddish iron-bearing sand underlaid by eight feet of Saugeen clay, this again being underlaid by white quicksand, and the whole by blue Leda clay. (See fig. 19.) The Saugeen clay is used with the sand in the manufacture of brick. The clay has the following composition:—

	Per cent.
Silica	59.34
Alumina	17.68
Ferric oxide	6.74
Lime	2.94
Magnesia	3.36
Soda	2.13
Potash	3.07
Sulphur trioxide	.47
Loss by ignition	4.60

The Saugeen clay, dug with the sand and hauled in cars to a pug-mill, is thoroughly mixed, the pug-mill feeding a Monarch six-brick machine. The brick are dumped on pallets, which are piled on cars, each of which carry four hundred and thirty brick. These are run into a Sheldon and Sheldon dryer capable of holding about sixty-four thousand brick. The day's output is about twenty thousand. These are dried in a little over forty-eight hours.

Up to the present year this yard ran about eight months for a season, and had an output of about four million brick, but this year the proprietors are trying a new and ingenious method to enable them to work through the winter months. A few large stringers, boom timbers for example, were laid on top of the ground parallel with the clay cliff, one coming very near the edge of the bank. Rough lumber was laid on these, and on top straw or other material; the lumber was allowed to project over the face of the cliff like a roof, and the face of the cliff was all boarded in so as to just leave working space on the face of the cliff. A door was made for the car track to enter the shed, the rest all being weather tight. An exhaust steam pipe was then run from the boiler into this shed and each night when the men quit work the shed was closed up and live steam blown into it until it was filled, this would prevent the clay freezing over night, and the men could start in the morning on fresh clay. As the bank is

dug back the long boom timbers support the roof and the work continues as in a big room. To prevent freezing while the brick are being made, the machine is placed between the drier and the boiler room; in this way the men are kept comfortable, and the clay is kept from freezing. The cars are run into the drier, of course, as before. The burning is done with wood in scoved kilns.

Fig. 56.—Merkley Bros' yard, Casselman; showing the scoved kilns and dryer.

From the above it will be seen that this is a modern yard; the brick turned out are of good quality and the proprietors are endeavouring to make still further improvements.

Baker Brothers, Casselman: This yard, which is situated beside Merkley Bros.' yard, is also an excellent one. The clay is exactly like that just described, and the process of working is the same, with this difference, that Baker Brothers run night and day and have two dryers, one for each shift. The output of this yard is therefore about six million brick per year, which may be increased if operated in the winter. A very striking point about this yard is that nothing is allowed to go to waste, even the smoke from the power boilers is drawn by fan through a series of eight-inch iron pipes, over which the air for the dryer is drawn, the heat from the smoke being almost sufficient to heat the air for one dryer. The fan is run by a separate small steam engine, and this is automatically regulated from the large steam boiler. If the steam is down in the boiler, it opens a little guage on the small engine, admitting more steam and the engine runs faster, thereby producing a stronger draft for the fires, so as to raise the steam. In proportion as the steam is raised, the supply to the smaller engine is lessened, and the latter slackens its speed. In this way the connection is entirely automatic. Again, all the steam used for the drier is completely condensed, and the hot water from it is used over and over again in the boilers.

A spur from the Canada Atlantic railway runs into both these yards, which.

although situated in a village, are two of the best yards in Ontario. This shows what can be done if brick-makers will only manufacture the right goods. Here we have two yards situated in a village, which, with the immediate surroundings, would not require three hundred thousand brick per year, nevertheless these yards turn out about ten million brick, and these are shipped all over the Province.

Simcoe

W. J. Norton, Allliston, had about two and one-half feet of Red-top clay overlying the grayish yellow and blue Erie clay. The Red-top clay has been all used for the manufacture of red brick; the grayish yellow clay is now being drawn upon, and this and the sand are mixed with a coloring of iron oxide to give the red color to the brick. The clay is dug and hauled by car to a Baird pug-mill which feeds a Martin machine. The brick are dumped on pallets and are dried by the "rack and pallet" system. The output is about 10,000 per day. The burning is done with coal in a square down-draft kiln, as well as in open-shed scoved kilns. The water-smoking is done by wood as usual. Mr. Norton also makes tile from this grayish yellow clay, but does not use any coloring, as the color of tile does not signify. These tile range from two and one-half to ten inches in diameter and are of excellent quality. They are burned with wood and coal, in a rectangular down-draft Stewart kiln, and also in a simple rectangular down-draft kiln of Mr. Norton's own construction. (See fig. 37.)

W. Freek, Barrie, has about three feet of clean Red-top clay, below which is stony red clay passing gradually into stony Erie clay. The clean top clay only is used in the manufacture of stock brick. It is hauled in carts to a Martin machine, and the brick are dumped on pallets and dried by the rack and pallet system. They are burned in two square down-draft Stag kilns, and in one round down-draft Cornell kiln. The output is about one million per year. The brick made in this yard are of excellent quality, and the percentage of face brick got from each kiln is extremely high; as many as forty-nine thousand face brick have been taken from a kiln holding fifty-two thousand. This is got by tightening up the first three courses above the flues, and leaving the rest of the kiln more open. These three courses serve as a check to hold the heat throughout the kiln, when a good temperature has been reached. This tightening is done by piling three on three for three courses high from the top of the flues; these are taken out each time a kiln is burned. Mr. Freek claims to have had excellent results with this style of kiln bottom.

Thomas Bembrose, Beeton, has two and one-half feet of Red-top clay overlying yellowish gray Erie clay, the whole underlaid by Erie blue clay. The Red-top clay is used for brick and the balance for tile. The brick are made in a Quaker machine using horse power; they are hacked out to dry and are burned in a permanent up-draft kiln and an open-shed kiln. Mr. Bembrose burns almost entirely with coal, even to the water-smoking. The tile are made in a Kells machine, and are burned in a down-draft square kiln. Roofing tile is also made.

The output of the yard is about five hundred thousand brick and three hundred thousand tile.

Ridler Brick Company, Penetanguishene: In this yard there are about three feet of red sand, underlaid by four feet of clay. These seven feet are dug together and thoroughly mixed in a pug-mill and burned to a red brick. The Baird pug-mill feeds a Martin machine operated in one yard; the brick are hacked out to dry in the ordinary way and are burned in open-shed scoved kilns.

This firm has erected a new plant alongside the old one, a Hercules machine made by Doig and Co., Toronto, being used. The brick are dumped on pallets and are dried by the rack and pallet system. The dried brick are piled on truck wagons carrying from two hundred and fifty to three hundred and fifty brick to a load. They are

hauled by horse to the kiln ground and built up to the checker floor; a little straw is then spread over the checker, and on this inch boards are laid. The trucks are then hauled by horse on to this, and the kiln is continued to the top. This method is very handy and does away with all pitching up, as the men building the kiln take the brick off the truck as they want them; an empty truck is taken away each time a loaded one is left. (See fig. 53.) The output of this yard is about two million and one-half per season, and the grade is first class.

J. Blanchard, Penetanguishene, has from three to five feet of red clay and sand like that in Ridler Brothers' yard. The clay is carted to a Martin machine making five brick at a time; they are then dumped on pallets and are dried in open sheds. The burning is done with wood in open-shed scoved kilns. The output of this yard is about eight hundred thousand brick per season. The red sand in this clay adds much to the color of the brick, and they are, all in all, a very superior hard brick.

Chew and Pratt, Midland: This plant is situated on the side of a hill on the brow of which is about eight feet of rather sandy red clay. The clay and sand, however, are very fine-grained, so much so that in working a very close mud results, which can be only shifted with difficulty, and which will then lose its shape on wheeling out to the hack yard. The writer suggested the addition of coarse sand, some of which was got from the shore of Georgian Bay. This was pugged with the clay, when the latter was found to shift much more easily, to retain its shape in wheeling out, and to dry faster by not being so compact. The brick are made in a Martin machine, dumped on pallets and dried by the rack and pallet system. They are burned with wood in open-shed scoved kilns, and the output for the year is about one million.

Victoria

S. J. Fox, M.P.P., Lindsay: Mr. Fox, who is president of the Ontario Clay Workers' Association, has one of the neatest, handiest, and most thoroughly equipped yards in the Province. For years he has been spending much time and money on improvements, many of which were of an experimental nature. He now has an excellent yard. There are about two and one-half feet of Red-top clay, which is underlaid, as usual, by the Erie blue clay. The top clay is made into red brick, and the Erie clay into white stock brick and tile. For the tile, however, a little of the stronger Red-top clay is mixed with the Erie to improve the quality. The clay is gathered by a Quincy clay gatherer and carried to heaps beside the machines; the brick are made in a Martin machine and are dumped on pallets on an automatic turntable; the pallets are then piled on short-hinged harrows, and wheeled to a series of racks, where they are dried by the rack and pallet system. This rack yard is the finest seen in the Province. It is so constructed that there are no posts in the ground to heave with the frost, but the whole system is bolted together as one large square frame work, which rests on the ground. The covers are also hinged, so that the whole yard can be thrown open or closed up tight in four minutes, which is an advantage in case of thunderstorms. The dried brick are taken by horse trucks to open-shed kilns, the horse being taken right up on to the checker floor, with straw and inch lumber used to protect the brick. These are removed, board by board, as the kiln is built.

The brick are also burned in a series of six down-draft kilns, capable of holding two hundred and eighty thousand brick. These kilns are rectangular in shape, and are built in a series side by side, so that one flue wall serves for two kilns, the firing being done on the ends.

The mixed red and blue clay is made into tile, from two and one-half to eight inches in diameter, by a Close machine. The tile are all burned in the down-draft rectangular kilns and although mixed with the red clay, burn white. The burning is done entirely with wood, and the output of the yard is about one and one-half million brick, and about three hundred and fifty thousand tile per season. One of the

Fig. 57. –Rack and pallet yard of Mr. S. J. Fox, M.P.P., Lindsay.

Fig. 58.—Mr. S. J. Fox, M.P.P.'s brick yard and workmen. Note method of trucking dried brick to kiln setting.

chief features of Mr. Fox's yard was the fine state of repair in which everything was kept. For example, his drying racks, described above, have been up for fourteen years and are as square and upright as ever; his kilns are the same, his machinery, engines, shafting, etc., have been running twenty years and are apparently in as good condition as ever. This is all the result of repairing every break at the time.

F. Curtin, Lindsay. In addition to Mr. Fox's yard there is another smaller yard located at Lindsay and run by Mr. F. Curtin. Both the Red-top and underlying Erie blue clay are used in the manufacture of brick. The clay is hauled by cart and put through a Baird pug-mill, which feeds an Iron Quaker machine. The brick are hacked out by the old system, and when dried are burned in open-shed scoved kilns with wood for fuel. Mr. Curtin has one round down-draft kiln, but does not use it; it was built for tile, and is at present idle. The output of this yard is about eight hundred thousand of both red and white brick per season. The output is small, but the quality of the brick very good.

Fig. 59.—A former "hack" yard replaced by a Bechtel Carless dryer; Brantford Brick Co's yard.

Waterloo

Bechtel Brothers, Waterloo, have operated their yard for many years and now possess a first-class brick plant; at the same time they have been gradually improving their machinery until now they have one of the largest brick manufacturing establishments in Canada. Among the machines patented by Mr. Byron E. Bechtel which are now on the market and in very general use throughout the Province are the following:—The Bechtel Disintegrator, for the removal of stones and pulverizing lumpy clay; a Lubricating Die for use on side-cut wire-cut brick machines; an Automatic Wire-cut Cut-off machine for either end, or side-cut brick (see fig. 29); a System of Trucks for handling brick or tile; an Automatic Wire-Cut Cut-off for hollow block and tile from two and one-half to eight inches in diameter; the Bechtel Carless Dryer.

In connection with the factory for making these machines Mr. Bechtel runs a brick yard where they can all be seen in operation. He works an Erie clay bank for the manufacture of white brick. The clay is gathered dry by a Quincy clay gatherer, an American machine for which Mr. Bechtel has the Canadian agency. With this machine one man and a team bring in sufficient clay for twenty thousand brick per

day. The clay is dumped to a Bechtel disintegrator, which pulverizes the lumps, and removes all stones. The powdered clay is then passed through rolls to a pug, where it is tempered and enters a Kells No. 1 machine. A lubricating side-cut die is used, and an automatic side-cut cut-off; this works admirably. Ninety brick are then piled on a pallet which is removed by the Bechtel trucking system to a Carless drier, the brick are taken directly from this to a series of rectangular down-draft kilns, up to which the railway comes. Mr. Bechtel's yard is thus one of the most thoroughly equipped in the Province, and one well worth visiting by those contemplating changes. The following analysis will serve for purposes of comparison by those who purpose working Erie clay beds, and it will be seen that this clay is about the average of other Erie clays in the Province:—

	Per cent.
Silica	44.30
Alumina	11.21
Ferric oxide	4.05
Lime	16.10
Magnesia	3.81
Soda	.93
Potash	2.09
Sulphur trioxide	.26
Loss by ignition	17.74

Fig. 60.—General view of Mr. F. Schaefer's brick yard, Breslau.

F. **Schaefer, Breslau,** manufactures white brick and tile from Erie blue clay. This is dug from the face of a clay bank in a hill. The clay is hauled in cars which dump to a hopper feeding a pug-mill; this in turn feeds a pair of large rolls; the powdered clay is then further pugged before being put through a Kells No. 1 brick machine. The result is a very thoroughly mixed clay, and a very smooth uniform brick. The clay is blasted out of the bank with black powder, in large masses, and two men bring in all the clay for twenty thousand brick per day. The brick are dried by the Bechtel Carless Dryer, and are burned in a series of four round down-draft kilns. The greater part of the plant is new, and is strictly up to date. The output is about two million brick per year, and ten kilns or more of white tile from three to ten inches in diameter. This is a very complete yard as shown in the accompanying cut, fig. 60.

W. Collard and Son, Waterloo, manufacturers of white wire-cut brick, use Erie clay with the same composition as that in Bechtel Bros' yard, whose analysis is given above. A fine new plant has been installed in this yard, which is now turning out about two and one-half million per year. The clay is scraped on to a platform, and dumped through a hopper to a clay car, which carries it to the clay shed. It is then worked dry in a Bechtel disintegrator, the product passing to a Baird pug-mill, and a Kells No. 1 brick machine. The Bechtel automatic end-cut wire-cut machine is used, and the brick are then piled on to steel cars, which are run to a Sheldon and Sheldon dryer. The dried bricks are taken from the opposite end of the tunnels to the kiln yard, where they are burned with coal after water-smoking with wood. This is also one of the most complete yards in the Province.

Michael Ott, Berlin, manufactures white wire-cut brick from the Erie blue clay which in this yard is very sandy. The clay is gathered with a wheel scraper, after being sun dried; it is then dumped into a Bechtel disintegrator. The product passes through rolls to a Kells No. 1 brick machine. The Bechtel automatic end-cut cut-off is used and Bechtel trucks to an open-air drying shed. At the time of the writer's visit Mr. Ott was contemplating the installation of an artificial dryer, which would largely increase his present output of one and one-half million per year. The burning is done with coal, after water-smoking with wood, in four circular down-draft kilns.

H. D. Dalmer, Conestogo: This yard is situated at a bend in the Conestogo river, on a flat which appears to have been formerly a flood plain of this river. Here is a first-class accumulation of Red-top clay), which is remarkably free from stones, and uniform in character. It is thicker here than in most parts of the Province, being an accumulation from the surrounding country. The analysis is as follows:—

	Per cent.
Silica	65.06
Alumina	14.15
Ferric oxide	4.67
Lime	2.36
Magnesia	2.18
Soda	1.48
Potash	2.66
Sulphur trioxide	.32
Loss by ignition	6.76

Mr. Dalmer manufactures red brick and tile only. About one and one-half million brick, and about seven hundred thousand tile per season is his output. His clay is carted to rolls feeding a Kells machine. An automatic end-cut cut-off is used, and the Bechtel trucking system to open-air dryers. The brick are burned in down-draft kilns, and also in open-shed scoved kilns using wood for fuel. Mr. Dalmer also operates a white brick yard at Elmira, where he makes one and a half million white wire-cut brick. These are burned in a square down-draft Stewart kiln, using wood for fuel. Taking into account his two yards, Mr. Dalmer has one of the largest outputs of brick and tile in the Province.

Welland

D. D. Hooker, Welland, has about three feet of Red-top clay, underlaid by Erie blue clay. The Red-top clay is somewhat stony. The pebbles are removed by passing the clay through a Bechtel disintegrator; the product from this passes by carriers to a pug-mill, which feeds a Martin machine. The brick are dumped on pallets, and are dried by the rack and pallet system; the burning is done in open-shed scoved kilns, using wood for fuel. Mr. Hooker also makes red tile and hollow block; the pugged clay for which is used in a Kells No. 1 machine. The tile and hollow block are dried

in open sheds, and burned with wood in a round down-draft kiln. The yard is situated on the bank of the Welland canal, which at the time of the writer's visit was being dredged, and the dredge brought up Erie blue clay, showing that this clay must be at least twenty feet deep at this point.

T. M. Ryan and Company, Niagara Falls, have about three feet of Red-top clay overlying the Erie blue clay as usual. The firm uses both kinds in the manufacture of brick, the Red-top clay being made up into stock brick with a Martin machine; about eight hundred thousand of these brick are made per season. The drying is done by the rack and pallet system, and the burning in two large up-draft permanent walled kilns. The water-smoking is done with wood, and the remainder of the burning with coal. The underlying Erie clay is made up into wire-cut brick; the sun dried clay is pulverized is a Bechtel disintegrator, and the clay is then passed through an American machine turning out end-cut wire-cut brick. This part of the plant is not much used at present, Mr. Ryan giving most of his attention to red stock brick.

Wellington

Bell Brothers; R. Holton; Smith & Colfax, Drew: These three yards situated side by side, are located about one mile and one-half from Drew. The clay is a sandy, mild. blue Erie clay, making white brick. On the surface is a foot to a foot and one-half of Red-top clay, somewhat stronger than the underlying Erie clay. This Red-top clay is made into tile, which are formed in Kells machines, and are burned in down-draft kilns using wood for fuel. Bell Bros. use a round down-draft Cornell kiln, while Smith and Colfax have a rectangular down-draft kiln, which they use for tile. In the manufacture of brick all three use Martin machines. The brick are hacked out to dry, and are burned with wood in open-shed scoved kilns. Each of the yards has an output of about one million and a half brick per year.

All three are very progressive yards, and are making brick for shipment, as the local demand is extremely small.

Wentworth

The Fruitland Brick Company, Fruitland: This yard is situated on the line of the Hamilton, Grimsby and Beamsville electric railway. Red brick are made from Medina red shale, which underlies this part of the country, and has the following composition:—

	Per cent.
Silica	56.90
Alumina	17.40
Ferric oxide	6.64
Lime	3.84
Magnesia	2.65
Soda	.53
Potash	3.51
Sulphur trioxide	.31
Loss by ignition	8.78

The shale is uncovered on the surface and allowed to slake; it is then collected in a scraper, and dumped to a pan-mill, where it is ground; the pulverized shale is then elevated to a hopper which feeds a Baird pug-mill that in turn delivers to a another side-cut machine very similar to the Freeze wire-cut machine, which is also used; it has an automatic side-cut cut-off, so that both classes of brick are made in this yard. The brick from both machines are piled on pallets, and trucked by the Bechtel system to open sheds, and also to a Bechtel Carless dryer. The dried brick are burned in permanent-walled up-draft kilns, and also in one round down-draft

kiln. The water-smoking is done with coke, and the remainder of the burning with soft coal. Here we have an example of the stiff mud process of brick making used on a shale, which is better suited to the manufacture of dry pressed brick.

Hamilton Brick Yards: In the western part of the city of Hamilton there are eleven brick yards, all apparently in a very flourishing condition. They are all situated on a high bench which represents a former stretch of Dundas bay. On the surface is from five to eight feet of good red-burning clay. This is underlaid by great beds of gravel which form the margins of the old beach, probably acting as a dam across the Dundas river, behind which the clay settled. At any rate this bank is part of a long raised beach, which extends from the foot of the mountain across the western part of the city to and beyond what is known as the High Level Bridge, then eastward as a bank along the Grand Trunk Railway between Hamilton and Toronto as far as Burlington. The outline of this beach can be traced very clearly; all the lower part of the beach is composed of fine gravel, cemented to a conglomerate. Above and behind this to the west we find the clay which is used in these brick yards. Below the gravel is the usual Erie blue clay. (See fig. 21.)

On this clay bank eleven yards are manufacturing brick, namely,

The Aberdeen Brick Company; John Hancock; Edward New; Crawford Brothers; M. Oilman; George Mills; Sam Cheesman; Frid Brothers; Thomas Landers; George Webb; George Frid.

All these yards are manufacturing red stock brick and the method in almost all of them is the same. A description of one will suffice for all.

The Aberdeen Brick Company was originally formed by the International Harvester or Deering company to ensure a supply of brick for the construction of their large plant, and finding that there was demand for all the brick that could be turned out in the city of Hamilton, they decided to continue operating the plant. Mr. George Beven is manager. This is the largest brick works in the city of Hamilton, the plant itself covering about two acres. Red brick are made by both the soft-mud and stiff-mud process. The clay is dug, hauled by automatic dump car, and dumped into a disintegrator, feeding a Freeze wire-cut machine; and an automatic side-cut cut-off is used. The brick are then piled on cars and run to a tunnel dryer of the Sheldon & Sheldon type. Some of the brick are dried in a Bechtel open-air dryer. In the soft-mud process, the powdered clay is thoroughly tempered in the pug of a Hercules machine. The brick are dumped on pallets and are dried by the rack and pallet system. The burning of both classes of brick is done in a series of eleven up-draft kilns, some of which are permanent-walled, while others are open-shed scoved kilns. The water-smoking is done with coke, and the balance of the burning with soft coal. This plant runs winter and summer, the clay being protected in winter by a coating of straw and manure spread over the surface. The output for the year is about two and one-half million wire-cut brick, and about eighteen hundred thousand stock brick, making a total output of about four and one-half million.

The remaining ten yards, whose proprietors are enumerated in the list above, are so near alike that it is not necessary to describe each one individually. The method of manufacture is practically the same in all of them, and the output is roughly the same. They all have from five to eight feet of the same strong red clay as is worked in the Aberdeen yard. The clay is carted or hauled in cars and dumped to a pug-mill; the pugged clay is fed to a Martin machine, and in a few cases to a Quaker machine; the brick are then dumped on pallets and dried in a rack and pallet yard. The burning in all these yards is done in up-draft permanent-walled kilns or occasionally in scoved kilns; the water-smoking is done with coke or wood, and the balance of the burning with soft coal. These yards have an output of about one and one-half million, each, per season. Mr. John Hancock's yard is a little larger than the others, as he works two Martin machines and has an output of two and a half million or more per season. Many of these yards are run by electric power, which is got

from Deeew Falls; Mr. Hancock, for example, operates his plant, which includes cars hauled by cable, two pug-mills, and two Martin machines, quite easily by a thirty horse-power electric motor. Even the large Aberdeen works, which contain a great deal of machinery is run by an electric motor. The chief advantage of this is that the plant can be started or stopped in a moment, and when once started the motive power requires practically no attention for the balance of the day. The brick made by all these firms are excellent red stock brick, so much alike in color and quality, that they are handled by one contractor, who contracts the brick for all the buildings in the city using the Hamilton product.

York

In Toronto and its suburbs, including Toronto Junction, Carlton West, Humber Bay and Mimico are many brick yards; in all some thirty, engaged entirely in the manufacture of brick, together with several yards making sewer pipe, paving brick and drain tile, as well as pottery. The output of these thirty yards is something over a hundred million brick per season, and the majority of these are stock brick, only about twenty-two million pressed brick being included. There is but one yard engaged in the manufacture of wire-cut brick, but this is largely due to the nature of the clay used.

The clay found in most of these yards represents an accumulation of re-sorted glacial clay. The accumulation seems to have taken place at some inter-glacial period, because glacial clay is found both above and below it. The clays of the Toronto district have been described by Dr. Coleman in the report of the Bureau of Mines for 1904. The clay is very mild and sandy, the upper part of it burning to a red brick, very dark red in color. Beneath this red-burning clay is a gray colored clay, which is also quite mild from the large percentage of sand which it carries, and this when burned yields a white brick, or as they are locally called, gray brick. Both these clays, while containing a great deal of sand, are remarkably free from boulders and pebbles. This clay is so mild that it is used in all cases in the manufacture of soft mud brick, and it is doubtful whether it is strong enough to be used in the manufacture of wire-cut brick.

The above mentioned yards fall into several groups, as certain localities have been chosen by the brick makers, and several yards are found side by side in such places. These yards will therefore be taken up in groups, as the method of working is practically the same in each group.

Wakefield Brothers, C. Mason, J. W. Lainson, James Lochrie, Edward Wakefeld, J. Brown, Thomas Norton; Carlton West: All these yards are situated a little west of Toronto Junction. The post-office, however, for all of them is Carlton West. The general method of manufacture is the same in all, so that a general description of this group will suffice. The clay is dug separately, that is, the red by itself, and the underlying white-burning clay by itself. As a rule these clays are dug to heaps and allowed to slake, when they are taken by cart or wheel-barrow to the machine. In most cases the Martin machine is used, although Mr. Lainson and Mr. Lochrie use the Hercules machine. The brick in most cases are hacked out in the ordinary way to dry. Mr. Lainson, however, uses the rack and pallet system. The brick in all cases are burned together, that is, both red and white, in ordinary open-shed scoved kilns using wood for fuel. The output of each of these yards varies from one million to three million. Mr. Lochrie has the largest output. The brick made here are of excellent quality, the red brick especially having a splendid color.

Hinde Brothers, Lainson and Son, William Bushell, Titley and Frost, Smith and Crang, Brown Brothers; Carlton West: These six yards are situated in another group close to Toronto Junction station on the Grand Trunk Railway. They are smaller yards, and all have about the same method of manufacture. The six have an output of about one million brick per year, part of which are white and part red.

The clay is dug to a heap and allowed to slake, when it is worked by the Martin machine in the usual way. The brick are dried by the ordinary hacking system, and are burned with wood in open-shed scoved kilns.

Joseph Russell, Queen St. East, Toronto, operates one of the largest yards in Canada. It is entirely given up to the manufacture of stock brick, both red and white Two machines operate all the year round, and five machines for seven months during the year. The output of the yard for a season is about ten million brick. The clay is dug directly from the bank and carted to one of the machines, all of which are of the Martin type. In five of the plants the drying is done by the rack and pallet system or by the hacking system. In the other more permanent plants the brick are dried in the Sheldon & Sheldon dryer and the burning is done in kilns of various kinds, some of which are the ordinary scoved kilns, some case kilns, some rectangular down-

Fig. 61.—Large continuous down-draft kiln in Jos. Russell's yard, Queen street east, Toronto.

drafts, and one large, oval-shaped continuous kiln composed of sixteen chambers, each of which will hold twenty thousand brick; the whole kiln, therefore, being capable of holding 320,000 brick, a complete round of the burning being made in sixteen days. A full description of this style of kiln was given above in the description of the Port Credit brick works. The continuous kiln is burned by coal, while the other kilns used at Mr. Russell's yard are burned with wood. Both red and white brick are made, but the majority are white.

John Price, W. Morley, J. Ashbridge, Bell Brothers, Morley and Ashbridge, T. Sawden, David Wagstaff; Greenwood Avenue, Toronto: These yards form a group on Greenwood Avenue south of the Grand Trunk railway track. The clay worked by them is like that worked by Mr. Russell, mild, sandy clay, the upper part of which burns red, while the lower part burns white or gray. These yards have practically the same method of manufacture, so that a separate description for each is not necessary. The largest yards are operated by John Price and Bell Brothers.

so that a description of one of these will be given. The clay is dug and carted directly to Martin machines, of which Mr. Price has two. The brick are dried by the Sheldon & Sheldon drier, after which they are burned in open-shed scoved kilns with wood. Both red and white brick are made of an excellent quality. The output of Mr. Price's yard is over seven million per season. The output of Bell Bros.' yard is nearly four million, while the remaining yards make from a million and a quarter to two million per season.

J. Logan, A. H. Wagstaff, I. Price, J. E. Webb; Greenwood Avenue, Toronto: These four yards are on Greenwood Avenue, north of the Grand Trunk railway tracks, and are working a very different clay from those south of the railway. They are situated on the top of the banks of a ravine about a hundred feet deep. The clay is dug in the bottom of the ravine from the face of a steep bank on either side.

Fig. 62.—A. H. Wagstaff's yard, Greenwood Ave., Toronto, showing rectangular down-draft kiln and Sheldon dryer.

Examining a section of this clay bank, we find that the upper twelve to twenty feet of clay is very like our typical boulder clay throughout the Province, in that it contains many boulders and pebbles of glacial origin. Immediately beneath this clay, however, there is thirty to eighty feet of a stiff blue clay free from stones of all sorts, but containing many small bands of quicksand. This blue clay is exceptionally uniform in character, and is very compact and laminated like a shale or limestone. Immediately below it again we find the stony clay of glacial age, thereby indicating that this intermediate band was laid down in comparatively still water at some inter-glacial period. This blue clay, unlike the blue Erie clay found throughout the Province, burns to a rich red brick of excellent color and strength. In this respect this clay acts like the Leda clay found in the eastern part of the Province, but of course bears no relation to it. This stiff, blue clay is blasted loose by dynamite. It is then loaded into cars and hauled by cable up on to the level ground to the brick plant, which is situated above the ravine. Here the cars dump to a pug-mill, after passing through a pair of rolls

which serve to break up the stiff layered lumps as they blast out with the dynamite. From the pug-mill the clay feeds to a Martin machine, after which the brick are dumped on pallets which are piled on steel cars and are dried by the Sheldon & Sheldon drying tunnels. They are then burned in scoved kilns or in up-draft case kilns, and in some cases in rectangular down-draft kilns, the fuel being wood in all cases.

Mr. Logan makes about three million bricks per year, Mr. Price and Mr. Wagstaff each making a similar amount, while Mr. Webb, who does not use the Sheldon & Sheldon dryer (see fig. 32), does not make quite two million brick per year. All four yards make very excellent hard red brick. The analysis of this inter-glacial clay is given amongst Lacustrine clays above, No. 70, page 8, of this Report.

John Pears, Davisville: This yard is situated at Davisville and is reached by Yonge street. This clay is unlike any of those mentioned before. It is a local collection, variable in nature. In some places it is very sandy and mild, while in other places it is quite strong. Both red-burning and gray-burning clay are found here, red occurring on top of the gray. This is the order as we have seen throughout the whole of the Province. The two classes of clay are dug separately in the fall, and are allowed to freeze and disintegrate during the winter. The clay is then dug and worked in a Martin machine, one machine being kept for white brick and one for red. The brick are then dumped on pallets, forty of which are piled in a rack on a four-wheeled truck which is hauled by a horse to the rack-yard, where the brick are placed in the racks and allowed to dry. In this way 200 brick are taken at one time by one horse and a boy. It requires in addition one man to load the trucks and one man to unload, but as this yard makes twenty-six thousand brick per day, two men with one boy and a horse handle the total output from the machine to the racks, which appears to be about the most economic method yet seen for handling brick in an open yard. The brick when dried are burned in open-shed scoved kilns with wood for fuel. The output of both red and white brick is something over four million per year.

Butwell Brothers, G. Armstrong; Humber Bay, Toronto: These yards are situated at the Humber and work a very mild, sandy clay much like that found at Mr. Russell's yard, or at the yards on Greenwood Avenue. We have here a mild, sandy clay, the upper part of which burns to red brick, while the lower gray colored clay burns to white or gray brick. Both these clays are dug in separate heaps and allowed to slake. They are then wheeled to Martin machines, dried in an open hack yard, and are burned with wood in the ordinary way in open-shed scoved kilns. Butwell Bros. have two yards having an output of something over two million per year. Mr. Armstrong has one machine with an annual output of about 800 thousand.

The Toronto Fire Brick Company, Mimico: This plant was built some years ago for the manufacture of fire brick, when it was thought that by mixing our Ontario clays with certain imported clays a good grade of fire brick could be made. The method, while successful enough, could not be carried on economically, and the plant was closed down. It has been lately acquired by other parties who have formed the Toronto Fire Brick Company, preserving the old name, but engaging in the manufacture of red pressed brick only. The plant was rebuilt and has only recently been started, the first kiln of brick having just been opened before the writer's visit. The brick were found to be of excellent quality, both as regards color and strength. The raw material is the Hudson River shale, which is blasted, after being steam drilled, and hauled by car and cable to a panmill. From this the powdered clay is elevated to a hopper which feeds the dry presses, three of which are used in this plant. The brick are taken directly from the machine to a series of rectangular down-draft kilns, each of which will hold a quarter of a million brick. See fig. 63. When this plant is running perfectly the output will be about a million per month. The addition of this plant to those previously existing will materially increase the output of pressed brick in Ontario. The shale used has the composition of No. 73, page 8, of this report, analyses of shales.

The Don Valley Pressed Brick Company, Toronto: This is one of the oldest and certainly one of the best brick plants in Canada. It is situated in the Don valley, about half a mile northeast of Rosedale. From its earliest start as an ordinary stock brick yard, it has been gradually improved until at present everything in the brick and block line made from clay or shale is manufactured by this company, including pressed brick, both buff and red, the enamelled brick in all colors now so popular as inside linings of buildings, wire-cut brick for inside walls, stock brick both red and white, terra cotta lumber, and fire-proofing of every description and of every shape required in steel structures. Hollow tile and block are also made for flues or drainage purposes.

This company has exposed a section about 125 feet high. Seventy-five feet at the base is shale, and borings show this to extend for four hundred feet deeper. Resting immediately on this shale is about four feet of very strong stony Erie clay. Above

Fig. 63.—Part of a series of rectangular down-draft kilns used by Toronto Fire Brick Co., Mimico.

this are fifteen feet of red sand showing distinct lamination and much stained by iron oxides. Above this sand is three feet of blue clay followed by two feet of very clean rounded, water-worn sand, above which there is eight to ten feet of clean blue clay which burns to red brick. This clay appears in every way to be contemporaneous with that found at Webb's, Price's and the other yards on Greenwood Avenue north of the railway, being quite free from stones and boulders, and exhibiting the thin bands of quicksand. It appears to be at about the same altitude as the Greenwood Avenue clay, and like it, burns to red brick. Above this blue clay is twenty to sixty feet of glacial mixed clay and loam, which is found so widely scattered over the Province.

The finding of this thick layer of blue clay, underlaid and also overlaid by the typical glacial clay carrying boulders and pebbles, shows it to be an inter-glacial accumulation laid down in comparatively still water. The section of shales, sand and clays found at the Don Valley Brick Works is the most interesting one seen in the Province, as all the relations are so well exposed.

All the clays mentioned above are worked by the company into one class or other of clay product. The top boulder clay and loam is worked by itself in a wire-cut plant for the manufacture of inside brick. Of this class of goods the company made eight million and a half last year. This clay is also made up into porous brick, or what is known as terra-cotta lumber. These are large hollow blocks of any desired shape, made so that nails, screws, etc., may be driven into them. The demand for these is becoming quite great, and 600 thousand blocks of various shapes were made by this company last year. They are usually one foot square and two or three or more inches in thickness, as required.

The red-burning clay, as well as the gray-burning clay, is made into stock brick. This clay is dug and sent in cars from the upper part of the hill to the valley where the cars are dumped on automatic tipples, to a large granulator, or pug-mill. From this the clay feeds to conical rolls. The empty car is hauled to the top of the hill by the descending loaded car, a brake being all that is necessary to govern the speed. The brick are made in a Hercules machine, are dried by a system of Sheldon & Sheldon dryers, and are burned in a continuous kiln.

The wire-cut brick, which are made from the gray, or upper Erie clay, which is dug by steam shovel, are made at the rate of 80 thousand per day in a Chambers automatic wire-cut machine. The bricks are piled on cars and dried in a Sheldon & Sheldon dryer, and are burned, like the stock-brick, in a continuous down-draft kiln. In the manufacture of fire-proofing, the Erie clay, after being thoroughly ground to crush any pebbles, etc., which it may contain, is mixed with a certain percentage of sawdust. It is then forced through a tile machine with a die of the required size. The blocks are piled on cars and are dried in a Sheldon & Sheldon dryer, after which they are burned in a down-draft kiln, when the sawdust burns out, leaving the blocks quite porous. This has two advantages: in the first place, the blocks are left so porous that they are light and therefore fit for ceilings, arches, walls, etc., with the minimum of weight; and again, being porous, nails, screws, etc., can be driven into them about as readily as into lumber.

The shales underlying the clay are worked into pressed brick; both buff and red colored. The shale is blasted out as usual. It is drawn up by car and cable and dumped to a panmill, where it is thoroughly ground. It is then fed to three presses. The bricks are taken directly from this to a series of six rectangular down-draft kilns. The output of red pressed brick for last year was three and a half million, and of buff pressed brick about two million. The burning in all these kilns is done with coal. In addition to the six down-draft kilns, this company has two large continuous down-draft kilns, one of which holds 400 thousand brick, the other one and a quarter million brick. These are charged and burned in the usual way and need no description here.

For the manufacture of enamelled brick this company has the only plant at present in the Province. The pressed brick, whether red or buff as required, are dipped on face in a glaze, after which they are dried. This dipping is repeated several times, and when a sufficient coat is deposited the brick are burned in a special kiln. This is a muffle kiln heated by coal, but the brick are not exposed to direct heat. Glazed brick of all colors are now made by this company. The output for last year of all classes of enamelled brick was 120 thousand.

Paving Brick

The Ontario Paving Brick Company, Limited, Toronto Junction: Having now dealt with the manufacture of building brick in yards representing all parts of the Province, we will turn our attention to some of the other product, manufactured from our Ontario clays. That most nearly associated with brick is paving brick, whose chief quality is hardness and resistance to wear. Its manufacture is made possible

Fig. 64.—General view Ontario Paving Brick Company's plant, showing stock of paving brick and Sheldon dryer.

Fig. 65.—Rectangular down-draft kilns for burning paving brick ; Ontario Paving Brick Company.

by finding a clay which, in addition to burning hard, can be vitrified by a little higher temperature without causing the whole mass to become viscous and lose its shape. There is only one such plant in the Province of Ontario. Vitrified paving brick differ from building brick in shape and hardness. They are made 4x4x9 inches, with rounded edges so as to prevent chipping and when laid in a pavement outlast any other material for paving. The chief objection, however, to them is that they are noisy. The size of brick mentioned above is somewhat greater than usual. The increase in size is for the purpose of making the brick less noisy by a reduction in the number of joints per square yard of pavement, for it is the rattle of the joints which causes the noise.

This company has a very successful plant situated at Toronto Junction. They are engaged in the manufacture of vitrified paving brick, sidewalk brick, sewer brick, also red and gray building brick. The raw material used is a mixture of Hudson River shale with the Red-top clay, about one-seventh of the latter being added. The shale is hauled to a store shed during the winter and allowed to dry. It is then ground in two pan mills, the ground material being elevated to a hopper from which it is fed to a large pug-mill. This in turn feeds an auger stiff-mud machine, which turns out the bricks like an ordinary wire-cut machine. The brick are then re-pressed in a machine which shapes them perfectly and rounds the edges and corners. The re-pressed brick are then piled on steel cars and run into tunnel dryers for forty-eight hours. By this time they are thoroughly dry, when the cars are run out in the opposite end of the tunnels to a series of five rectangular down-draft kilns. The water-smoking is done with wood as usual, and the balance of the burning with soft coal. The brick are burned for about four days after water-smoking, when the temperature is raised sufficiently to vitrify them without causing the whole mass to fuse. The interior of the kiln is fire-brick. The open floor is composed of a specially large fire-brick block. The output of paving brick from this company is about five million per year. Pavements laid from these brick may be seen in Toronto between the car tracks of the Toronto street railway, and on the following streets: Simcoe, Pearl, Lombard, Henry, Duncan, Concord, also at the Union Stock yards, and at other places. Many of these have been down for fourteen years and are still in good condition. The company is also engaged in the manufacture of building brick both red and white, and its output of these brick is about four million per year. The brick are made in two Doig machines, are dried by the rack and pallet system and burned with wood in four large kilns, two of which are permanent up-draft kilns and two open-shed scoved kilns.

A series of analyses of the Hudson River shale used by this company in the manufacture of paving brick shows a very interesting variation, which corresponds very closely with the variation in an Erie clay bank in any part of the Province. This variation has been described above, namely, the removal of lime constituents from the upper part of the bank by ordinary surface weathering. These analyses from two different shale pits are given below, and it will be noticed how completely the lime has been removed from the upper parts of the formation. This corresponds entirely with the same change that has taken place in the Erie clay banks throughout the Province.

SHALE PIT No. 1.

	Alumina. Per cent.	Silica. Per cent.	Lime. Per cent.	Magnesia. Per cent.	Iron. Per cent.	Alkali. Per cent.	Loss. Per cent.
Top Shale	16.49	63.60	.99	2.40	5.27	2.34	8.71
Mid. Shale	12.11	62.56	6.39	.73	9.45	1.56	12.50
Base Shale	14.77	41.63	19 71	2.71	4.60	1.28	15.33

SHALE PIT No. 2.

Top Shale	18.62	60.01	.10	.20	10.15	6.70	11.45
Mid. Shale	18.42	59.24	3.32	3.30	8.37	1.60	9.46
Base Shale	14.77	51 82	16.30	5.83	3.16	1.36	17.74

Portland Cement

Next to brick, the most important industry in Ontario, using clay as raw material, is the Portland cement industry. An account of the origin and development of this industry, and its rapid growth since its establishment in 1891, was given in the Report of the Bureau of Mines for 1903, and a fuller review in the Report for 1905, so that no attempt will be made here to describe the industry in detail. Reference will simply

Fig. 66.—Goderich Cement Brick Co's plant, Goderich.

be made to the classes of clay used in the manufacture of this important product. All the clays mentioned above, with the exception of the Saugeen clay, are used in some one plant or other in the Province. The Red-top clay is used by the National Portland Cement Company at Durham, Ontario. The clay is dug at Stratford, and hauled

Fig. 67.—Digging Red-Top clay, which is shipped by rail from Stratford to Durham for the manufacture of cement by the National Portland Cement Co.

by Grand Trunk railway to Durham. Its composition is shown by analysis No. 4, page 17, of this report.

The Erie blue clay is used in some of the plants. In most cases it is dug close to the works, and usually below the marl beds, but in some instances it is also brought some distance, for example, the Bl[illegible] Lake Cement Company, operating near Paris, bring their clay from Harrisbu[illegible]he Grand Trunk railway. This clay is one phase

of the Erie blue clay. In most other cases the blue clay is dug from beneath the marl, close to the company's plant. In the case of the Canadian Portland Cement Company, located at Strathcona, the marl is brought to the clay, the marl being dug at Marlbank. This was the old plant belonging to this company, but it is about to be abandoned in favour of the Marlbank works, where the marl and clay are dug together. The International Portland Cement Company, of Ottawa, use limestone with Leda clay, which is dug there from a bank about 25 feet deep. This is an excellent clay, having composition of Nos. 62, 63, page 31, of this report. An idea of the importance of clay in cement manufacture, can be gathered from the fact that the statistics for 1905 show that 1,254,360 barrels cement were manufactured, having a value of $1,783,451.

Tile Making

Another industry of considerable importance is that of tile making. Ordinary unglazed drain tile are made, or can be made, in almost every brick yard in the Province, while glazed sewer pipe are made by only three concerns. Drain tile are made from all classes of clay mentioned above, but the stronger clay is preferred. The clays are worked in any of the machines suited to the manufacture of stiff-mud brick, as described above, the form of the die being all that requires changing. Dies making from two-and-a-half to ten-inch tile are in common use, and in some cases, where special orders are received, these ordinary tile are made as large as eighteen inches in diameter. The tile are usually fourteen inches long, and about a half to three-quarters of an inch in thickness. As mentioned above, the stronger clays are preferable for tile making, as they are tougher and can, therefore, be worked stiffer, which is an advantage, since a softer tile will not retain its shape while drying. Freshly made tile should be stood on end for the first twenty-four hours, to prevent flattening. Moreover, they should not be exposed to the wind or sun, as the strong clay will usually crack if dried too quickly. (See fig. 70.) In burning tile they can be so nested, that is, set one within another, as to give a kiln great capacity. Most of the tile in the country are made from Erie blue clay, and burned creamy white. This clay often contains small pebbles of limestone, and the clay itself is highly calcareous. Both these ingredients are objectionable, as the small pieces of limestone, when burned to lime, as they are in the burning of the tile, cause the latter to burst, and even the presence of so much lime finely scattered through the clay, seems to cause the tile to scale. These defects can be almost entirely overcome by the addition of a half a shovelful of common salt, to the last two or three fires before the kiln is cooled. This addition of salt will not glaze the tile, as the temperature at which ordinary drain tile are made is not sufficiently high for glazing.

Sewer Pipe

The Toronto and Hamilton Sewer Pipe Company: In the manufacture of sewer pipe Medina shale is used with the composition shown in No. 23, under shales of Ontario, page 8, of this report. It is blasted out, and brought by Grand Trunk railway to Hamilton from Waterdown, a distance of four miles. Three cars of shale per day are used. The shale is ground in a panmill, and elevated to a hopper, which feeds the tile machine. The manufactured tile are stood in a drying room on end, till they dry sufficiently to be handled. They are then shifted to a hotter drying room, above the kilns, seven in number. These are round down-draft kilns, lined with fire brick. When the tile are well dried, they are stood on end in the kilns, and, after drying, require only forty-five hours to burn, including the glazing, which is done towards the end of the process. When the tile are thoroughly burned, and are raised to such a heat that they are just fusing, as shown by test pieces which can be lifted out by a poker, common salt is thrown in to each fire, and a good hot fire kept up. The salt fuses and is carried into the kiln, where it meets the tile, which are also just at the fusing temperature, and a splendid glaze is the result. After this, the tile are allowed to cool gradually, for about three days, when the kilns are emptied. Even then they are as hot as the men can handle. This company manufactures all classes

of sewer pipe, elbows, T's, etc. All the curved forms are made in plaster of Paris moulds, the clay being fashioned by hand, and all joints, etc., are carefully made by hand moulding. The company shipped four hundred cars of glazed tile of all descriptions last year, in addition to all local sales.

The Dominion Sewer Pipe Company, Swansea: This company, like the Toronto and Hamilton Sewer Pipe Company, gets its shale from Waterdown. This is the Medina shale, and three cars per day are brought to the works. This shale is ground in a wet-pan mill, which thoroughly pulverizes the clay, and at the same time tempers it to a good stiff mud. It is then carried by elevator to the top of the plant, where it feeds a large tile machine, making tile of all sizes from four to twenty-four inches in diameter. T's, elbows, reducers and expansion joints and all other classes of sewer pipe are made. These, of course, are moulded by hand in plaster of Paris casts, as described above in the Hamilton Sewer Pipe works. They, as well as the tile, are

Fig. 68.—Dominion Sewer Pipe Coy's plant, Swansea; showing low down-draft kilns.

dried over a lattice floor by steam heat, and when dried are set in a series of six round down-draft kilns. When the tile are thoroughly burned, a salt glaze is put on as usual, after which they are allowed to cool gradually and are then ready for shipping. This is a new company which has not been in operation for a year as yet, so that their output is not known; but they report a very brisk demand for all classes of articles which they are manufacturing.

The Ontario Sewer Pipe Company, Mimico: This company, which is situated alongside the Grand Trunk railway tracks near Mimico, is also engaged in the manufacture of sewer pipe and all varieties of glazed pipe. They, like the others, get their clay shale at Waterdown, bringing it thirty miles by railroad. Their plant is in every way like the Dominion Sewer Pipe Company, so that a description of it will not be necessary. Their output is about equal to that of the Toronto and Hamilton Sewer Pipe Company.

The production of sewer pipe is expanding rapidly in Ontario. In 1900 the value was only $130,635, while in 1905 it was $225,835.

Pottery

The only other clay products of much interest in Ontario are pottery and terra-cotta. The pottery industry a few years ago was of great importance in Ontario, and almost every town had its local pottery. The manufacture of the better classes of pottery, stoneware, etc., in the southern parts of the States, where a better class of clays, much purer than the glacial clays found in Ontario, is to be found, has seriously interfered with the use of the Ontario clays, which are suitable only for the manufacture of common pottery. The result has been that nine-tenths of the potteries of Ontario have been forced to close, and those which remain are running on a very small scale. Pottery is made, however, from both the Red-top clay and the Erie blue clay; the first, turning out red pottery, suitable for flower-pots, etc., the second, a better pottery suitable for domestic purposes, such as churns, crocks, jugs of all sorts, and other common stoneware. The clay in all cases is well washed, and then worked by hand into the desired articles. Most of the white ware is glazed, the glaze varying to suit the requirement.

Fig. 69.—Ontario Sewer Pipe Co's plant, Mimico, showing down-draft kilns used for sewer pipe.

As stated above, very few of the potteries formerly in operation in Ontario now exist. Most of them have been closed up; a few, however, are still engaged in the manufacture of flower-pots, butter crocks, churns, and jugs of various kinds, including vinegar and syrup jugs. The flower-pots, both red and white, are unglazed, while the other classes of pottery are glazed in various ways from clear transparent glazes through mixed glazes to deep brown and almost black. Among the potteries operating in Ontario the following may be mentioned:—J. Taylor, Port Hope, Durham county; Horning & Brownscombe, Owen Sound, Grey county; F. Burgarde & Son, Egmondville, Huron county; S. R. Burns, Bolton, Peel county; J. & G. Cranston, Hamilton, Wentworth county; S. P. Foster, Hamilton, Wentworth county: Wm Stonehouse, Carlton West, York county; Joseph Davis, Davisville, York county.

The method of manufacture, the output and the varieties of goods made in all these works are about the same, so that a general description will be given for them. Both the Erie and Red-top clay are used in the manufacture of pottery. The Erie burns to a white color, while the Red-top burns to red. These clays are usually dug and

Fig. 70.—Strong clay left by potter to dry. Note shrinkage of clay on drying; hence necessity for adding sand to strong clay in brick-making to prevent cracking when drying.

re-washed so as to remove all sand, gravel, or other impurities. The washed clay is run into settling tanks and allowed to dry, or it is taken wet and is thoroughly beaten to remove all air from the interspaces in the clay, or, as the potters say, to beat the

Fig. 71.—Huron Pottery, F. Burgarde and Son, Egmondville.

wind out of it. After this, the clay is either moulded by hand for certain of the forms, or is pressed into moulds for other forms. The articles are then slowly dried to prevent cracking, and when thoroughly dry are ready for the kilns if they are to be unglazed.

If glazed ware is required, the thoroughly dried articles are dipped into the required glaze several times until a sufficient coat has adhered. They are then placed in the kiln where they are slowly heated for three or four hours, after which they are fired up to a high temperature, about the same as for brick, that is, from 1700 to 2100 degrees Fahrenheit. The kilns are heated by wood or coal or coke, but the ware is not exposed to direct heat, that is, the fires do not lead through the ware. The inner lining of the kilns is built of fire-brick. The output varies with the demand, so that no definite list can be given. Some of the potteries have now gone into the manufacture of drain tile, since the demand for pottery is not brisk.

R. Campbell and Sons, Hamilton: This pottery deserves special mention, because it is one of the largest doing business in the Province. The business, however, has been largely increased by using foreign clays. A great deal of this comes from the United States.

The firm manufactures many varieties of pottery and stoneware. Tea-pots, coffee-pots, stove mouldings, stove linings, and all classes of ordinary stoneware, such as crocks, cuspidors, etc., including stone mugs, jugs and water-tanks, with many other varieties of products, are made by this firm. Most of the clay used is imported from the different parts of the United States, as these clays will stand much higher temperatures than the clays found in Ontario, and, therefore, a better class of stoneware and crockery can be made from them. The articles are all made in moulds, very little hand work being used in this factory. In many cases the clay forms are turned out as on a turning-lathe. The goods are all glazed, and after glazing are placed in jackets, which prevent one piece from touching another, while the jackets themselves can be stacked in the kiln and used over and over. This is the largest pottery doing business in Ontario at present, and it is the superiority of these clays which has enabled the manufacturers in the United States to replace the Canadian manufacturers in this line.

Terra-Cotta

Another industry closely allied to pottery-making is terra-cotta making. This branch of clay manufacture is not as flourishing in Ontario of late years as it was formerly. Since the burning of the Rathbun Company's terra-cotta plant at Deseronto, there has been little done in this line in Ontario. A few buildings have been erected, using Ontario terra-cotta, made by companies manufacturing pressed brick. Chief among these companies is the Toronto Pressed Brick Company, of Milton, Ontario; and also the Milton Pressed Brick Company, of Milton. The raw material used here is the red Medina shale, which is also employed in the manufacture of pressed brick. The shale is blasted, and pulverized by a panmill, after which it is wetted and thoroughly worked to expel all the air from between the particles, *i. e.*, the clay is worked. and beaten, till it becomes very close in grain. Plaster of Paris moulds are made from the drawings of the articles required; from these moulds plaster of Paris casts are made and these in turn are covered by the compact clay. The plaster of Paris is then removed, and the clay model is thoroughly dried, after which it is burned in the usual way. Most of the terra-cotta used in Ontario recently has been imported from the United States, where it has been claimed that the clay is much purer, but since these companies in Ontario have been using the ground shales, the quality of red terra-cotta could not well be improved. The largest manufacturer of terra-cotta is Mr. Lewis, who operates the Toronto Pressed Brick works at Milton, and splendid examples of his work may be seen at the Macdonald Institute building recently erected at Guelph, Ontario. For any of the other colors of terra-cotta goods, for example, the buff, cream, white. etc., suitable clays have not yet been found in the Province, but for those requiring red terra-cotta, that manufactured from our Medina shale could scarcely be improved on.

INDEX

FINIS

PROVINCE OF ON

MAP NO 28

TOWNSHIPS

MAISONVILLE, GRE

DISTRICT OF TIMI

To accompany Report by A.G. Burrows and P.E. Hopkins
Hon. W. H. Hearst, Minister

Scale—1:47520 or ¾

LEGEND

Glacial and Recent

Stratified clay and sand, boulder clay, gravel.

PRE-CAMBRIAN

Diabase dikes.

INTRUSIVE CONTACT

Cobalt Series

Conglomerate, quartzite, slate-like greywacké.

GREAT UNCONFORMITY

Post-Timiskaming Intrusives

Red and grey feldspar porphyry.

Reddish hornblende syenite with some granite in places.

Granite and syenite.

IGNEOUS CONTACT

Timiskaming Series

Quartzite, greywacké, conglomerate and schistose derivatives.

UNCONFORMITY.

INCE OF ONTARIO

DEPARTMENT OF MINES

MAP No 23 h.

VNSHIPS OF

E, GRENFELL AND EBY

T OF TIMISKAMING

P.E. Hopkins in Part II., Volume 23, Report of Bureau of Mines, 1914.
Wilfrid G. Miller, Provincial Geologist

7920 or ⅛ Mile - 1 Inch

Miles

Kilometres

NOTES

The townships of Maisonville, Grenfell and Eby lie immediately to the west of the Kirkland Lake-Swastika gold area in latitude 48° 10'. The height-of-land between the Hudson Bay and St. Lawrence waters passes through the township of Maisonville at mileage 177½ on the Timiskaming & Northern Ontario Railway. At the height-of-land the railway is 1086 feet above mean sea level. In 1901 Mr. W. J. Wilson, of the Geological Survey of Canada, while examining the Abitibi region, made a reconnaissance survey of the White Clay and Blanche rivers to Round lake. In 1902 Mr. L. L. Bolton, for the Bureau of Mines, Ontario, gave a description of the natural features of Eby township, and a description of the geology of the water routes in an area, part of which is now included in the townships of Grenfell and Maisonville.

The topography is very similar to other portions of the northern Ontario peneplain. Rocky ridges with sparse timber are separated by spruce flats and muskegs, while here and there are sand plains or rolling sand ridges. From the higher ridges in the northeast part of Grenfell township, Mount Chiminies, on the boundary between Ontario and Quebec, can be seen at a distance of about 36 miles.

A great part of the township of Maisonville has been burned over in recent years. The timber is of the average character, consisting of spruce, jack pine, poplar, birch and cedar, with a few groves of red and white pine near Swan Lake.

Geology.

A description of the geology of the Kirkland Lake-Swastika area is applicable to this area.

Keewatin.—The rocks of the Keewatin system, which are most widely distributed, consist largely of basic types of volcanic origin, basalt and andesite, that frequently show an ellipsoidal structure, and the schistose derivatives of these rocks. A basalt from the south half of lot 12, con. III, Maisonville, gave on analysis 50.42% of silica. Amygdaloidal basalt occurs in parts of the area, and some gold-bearing veins on Wolf lake are in this rock. Andesite is prominent in Maisonville and Grenfell. An andesite from lot 9, con. II, Maisonville, has the following analysis: silica, 61.79; alumina, 18.15; ferrous oxid, 3.39; ferric oxide, 2.10; lime, 7.89; magnesia, 1.97; potash, 0.46; soda, 3.90; water, 1.06. Narrow bands of iron formation, consisting of magnetite and silica, occur in Eby and Maisonville townships. On the north shore of Wewegimek lake the formation is much contorted and broken up, probably due to the granite intrusion to the east. The formation in the north part of lot 7, con. III, Maisonville, is also much disturbed, and secondary pyrite and pyrrhotite with some copper pyrites have been deposited.

There is a great volume of diabase which occurs with the Keewatin. Some of this diabase is fairly fresh-looking, but generally it is much more altered than the Nipissing diabase.

Temiskaming Series.—This series of sedimentary rocks is well exposed to the south of Kenogami station, where it occurs in beds which are highly tilted. These rocks have been traced to the westward as far as Kenogami lake.

Post-Temiskaming Intrusives.—In this group are included lamprophyre, feldspar-porphyry, syenite and granite. A wide augite lamprophyre dike intrudes the Temiskaming conglomerate to the south of Kenogami station. On lot 4, con. V, Maisonville, a lamprophyre contains fragments of granite, syenite and greenstone, forming a pseudo-conglomerate. The matrix, however, is igneous. This peculiar occurrence of lamprophyre has been observed near Kirkland lake and at Cobalt.

A boss of medium-grained hornblende granite occurs in southwest Eby. A reddish syenite outcrops in the east part of Eby,

(Kirkland Lake and Swastika Gold Areas.)

Granite and syenite.

INTRUSIVE CONTACT

Timiskaming Series

Quartzite, greywacke, conglomerate and subsidiary formations.

UNCONFORMITY.

Keewatin

Greenstones (basalt, andesite, etc.), diabase and iron formation.

SIGNS

- Hill
- Swamp
- Trail or Portage
- Road
- 1611' Elevation in feet above sea level
- Building
- I.F. Iron Formation
- Prospect Pit

SOURCES OF INFORMATION

Township and mining location plans from Surveys Branch, Department of Lands, Forests and Mines, Ontario.

Map of Swastika Gold Area, accompanying report by E. L. Bruce, Twenty-first Report of Bureau of Mines, Ontario, 1912.

Lake elevations from Timiskaming and Northern Ontario Railway surveys, also hand level determinations.

Geology of Eby by R. M. Smith and R. W. Young; Malcombe and Grenfell by R. M. Smith, R. W. Young, P. E. Hopkins and A. G. Burrows.

Drawn for photo-lithography by W. J. Bell.

This sheet forms Map No. 23a (Kirkland Lake and Swastika Gold Areas)

Temiskaming Series.—This series of sedimentary rocks is well exposed to the south of Kenogami station, where it occurs in beds which are highly tilted. These rocks have been traced to the westward as far as Kenogami lake.

Post-Temiskaming Intrusives.—In this group are included lamprophyre, feldspar-porphyry, syenite and granite. A wide sapite lamprophyre dike intrudes the Temiskaming conglomerate to the south of Kenogami station. On lot 4, con. V, Maisonville, a lamprophyre contains fragments of granite, syenite and greenstone, forming a pseudo-conglomerate. The matrix, however, is igneous. This peculiar occurrence of lamprophyre has been observed near Kirkland lake and at Cobalt.

A boss of medium-grained hornblende granite occurs in southwest Bby. A reddish syenite outcrops in the east part of Bby, being part of the large area of syenite in Otto township. The syenite is consistently gneissoid near the contact with the Keewatin. In the vicinity of Wiman lake there is a red hornblende granite which changes to a syenite further north. A much smaller mass of quartz-hornblende syenite can be seen in the north central part of Maisonville.

Quartz-feldspar porphyry dikes occur near the syenite and may be apophyses from the syenite. The syenite contains numerous veinlets of white quartz.

Feldspar-Porphyry.—Dikes of red and grey porphyry up to 100 feet in width are found in the Keewatin. Under the microscope the rock shows phenocrysts of acid plagioclase, with a few of quartz and occasionally hornblende. The groundmass is usually fine-grained, consisting of feldspar, quartz, etc. These dikes frequently contain white quartz and carbonate veinlets similar to the dikes around Kirkland lake. Quartz veinlets containing visible gold intersect the feldspar porphyry on lot 5, con. V, Maisonville.

Cobalt Series.—This series contains the latest sedimentary rocks of the area occurring as remnants which have escaped erosion. Rocks of this series were observed just northwest of Kenogami station, and have been traced westward to Kenogami lake. A section, showing conglomerate, greywacke-slate, quartzite and upper-conglomerate, is to be seen in a hill 100 feet high overlooking the railway on the west shore of lower Twin lake. The conglomerate at Kenogami station lies directly on stilpnoidal greenstone. On the east shore of Kenogami lake there is a local unconformity in the Cobalt series. Fragments of the slate-like greywacke of a lower formation are enclosed in a conglomerate overlying the greywacke.

Diabase.—Narrow dikes of fresh diabase intrude all the above mentioned rocks.

Economic Geology.

Gold.—Numerous small quartz veins, some of which are auriferous, occur in this area in rocks which are older than the Cobalt series, while most of the veins are in the Keewatin greenstone. Visible gold was noted at two locations in Maisonville township, and has also been reported in a number of veins which have been prospected along the railway to the north of Swastika. A number of samples of vein material were taken for assay and low values in gold were usually obtained. A number of pits and shafts have been sunk in previous years, but in 1913 very little work was being done.

The Dane Copper Mining Company was prospecting lot 5, con. V, Maisonville, to the east of Wolf lake, and had exposed (in the amygdaloidal basalt) three parallel quartz and calcite gold-bearing veins which strike northwest and southeast. A shaft being sunk on one of the veins has reached a depth of 30 feet. On the same lot to the southeast, quartz veins in reddish feldspar-porphyry had been stripped for 400 feet. The porphyry has been greatly broken up and there is a breccia structure to the veins. Some visible gold was observed at several points.

In September, 1913, a narrow quartz vein, averaging less than six inches in width, was discovered on lot 6, con. V, Maisonville, just south of Kapakita creek. There are a number of showings of gold along the strike of the vein which has been stripped for 150 feet. The wall rock is greenstone, which is quite massive, with little evidence of alteration along the walls of the vein.

Lead and Zinc.—Narrow calcite veins, carrying some galena and sphalerite, occur in the greenstone on the west shore of Weweigamak lake. To the south of Wolf lake are several quartz-calcite veins carrying similar minerals. One of these veins on claim H.R. 800 (Dan Smith claim) has been trenched for 200 feet, showing a width in places of 14 inches. A shaft has been sunk 30 feet and several tons of lead-zinc ore have been piled up. The vein consists of quartz along the wall with a central filling of calcite, galena and sphalerite.

Pyrites.—On lot 7, con. III, Maisonville, is an iron formation band which has been greatly fractured and impregnated with pyrite, pyrrhotite and a little chalcopyrite. A sample of pyrrhotite gave a trace of nickel on analysis. The rocks are much rusted, and the quantity of iron pyrites suggests that this locality is worthy of prospecting for the mineral, which is used in the manufacture of sulphuric acid.