CANADA

DEPARTMENT OF MINES

HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER.

MINES BRANCH

JOHN McLEISH, DIRECTOR.

INVESTIGATIONS IN 1920

CERAMICS AND ROAD MATERIALS

(Testing and Research Laboratories)

(a) Testing of brick and fireclays from various Provinces;
(b) Pottery clays;
(c) Clay-working industry—structural materials and clay wares;
(d) Field examination and clay testing;
(e) Practical instructions as to sampling;
(f) Laboratory tests;
(g) Testing under working conditions—

By **Joseph Keele.**

(h) Road material survey along the Gananoque–Napanee section of the Toronto–Montreal highway, Ontario;
(i) Road materials in Nova Scotia—

By **H. Gauthier.**

(Annual Summary Report of the Mines Branch, pp. 55–75)

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1922

No. 578.

CERAMIC DIVISION

Joseph Keele

Chief of Division

OUTLINE OF WORK DONE

The field and laboratory work of the Ceramic Division for the past season consisted in the investigation of raw materials used in the ceramic industries. These include clays, shales, feldspar, quartz, limestone, talc, bauxite, magnesite, etc.

A large number of samples of clays and shales were tested for people in various parts of the Dominion; but as the most of these samples were not very intelligently collected, and the locality from which they came was not very clearly indicated, the results of the tests are not recorded.

In view of the fact that most people do not know how to examine and sample a deposit of clay or shale, it has been deemed advisable to devote a part of this summary report to the giving of definite instructions to unskilled prospectors and others relative to the proper way to select samples from promising deposits. See pp. 67-70.

The proper sampling of deposits, especially those liable to variation at depth, or those containing impurities, is very important.

Certain clays which might be utilized for the manufacture of pottery were tested in the laboratory, and the results given in the following pages. These clays are of low grade, but when prepared are quite plastic and smooth, so that they may be used for the manufacture of ornamental pottery, or for instruction in modelling in schools where training in manual arts is given.

Refractory clays are of rare occurrence in Canada, and no new localities for them were recorded during the past season.

The field work done in 1920 consisted of a continuation of the survey of available structural materials along the St. Lawrence river; the principal part of the time being spent in Soulanges, Vaudreuil, and Beauharnois counties, Quebec, and in Glengarry county, Ontario. Mr. L. H. Cole was also engaged on this work, and a joint report on the resources of the region has been completed.

A short journey was made by the writer in August to the Missinaibi river in northern Ontario, in order to examine certain deposits of high grade sands and clays.

Owing to the difficulty of obtaining qualified assistants, the work accomplished by the Ceramic Division both in the field and laboratory was necessarily limited.

TESTING OF BRICK AND FIRECLAYS FROM THE VARIOUS PROVINCES

BRITISH COLUMBIA

VANCOUVER

Some interesting clays occur on the south side of Burrard inlet, at the east end of Queen street, and two miles west of Barnet. Samples of these were collected by Mr. W. A. Johnston of the Geological Survey, and sent to the Mines Branch to be tested.

These clays are seen outcropping about 20 feet above the level of the railway tracks at this point. A bed of white clay overlies grey shale, and some inferior lignite is associated with the clays.

The white clay is rather crumbly, and short in texture, when wet; it has a high shrinkage, and cracks in drying.

It burns to a buff coloured hard body, but its fire shrinkage is excessive. This clay fuses to a slag at cone 9 (1310 degrees C.), so that it cannot be considered refractory. Owing to its defective drying qualities and high shrinkage, this clay is of little value for the manufacture of burned clay products.

The grey shale when ground and mixed with water has good plasticity and working qualities, but it cracks rather badly in drying. Some test pieces were made up by the dry-press process. One of these fired to cone 9 showed no sign of fusion or softening. It was of a dark buff colour, and the body was hard and dense.

This shale does not begin to soften until a temperature of 1450 degrees C. is reached, so that it has semi-refractory properties. It does not shrink so much as the white clay. A mixture of the two clays was made up in dry-press test pieces, and these burned to a fine buff colour and hard body without cracking, but the shrinkage was too great.

It seems difficult to suggest any use for these clays; but a mixture of them might be used for facing brick in building. The full size dry-press brick might crack, although the small test pieces made up by the dry-press process did not.

Spence Bridge

Brick Clays.—A bank of stratified clay from 50 to 100 feet high occurs in a cutting on the Canadian National railway, on the north side of Thompson river, about half-a-mile west of the station at Spence Bridge. A sample of this clay was collected for testing by Mr. H. S. Spence of the Mines Branch.

It is a light-grey, calcareous silty clay, fairly smooth and plastic when wet, and has good working qualities. It flows smoothly through a round tile die, but while it is all right for the smaller size of tile, the clay may not have tensile strength enough in the wet state to hold its shape when made up into the large sizes.

This clay has fairly good drying qualities, and the shrinkage in drying is about 7 per cent.

It burns to a light red, porous, but strong body, and would make a very fair grade of common building brick.

The clay would not be suitable for the manufacture of vitrified wares, as its softening point is too low.

Okanagan Landing

A sample of clay from this locality was collected by Mr. R. W. Thomson, resident engineer, Kamloops district, and sent to the Mines Branch for testing.

This is a light grey, soft, rather highly calcareous silt. It does not contain much real clay substance, consequently its plasticity is low. This material is so flabby in the wet state that it was difficult to mould it into shape.

It burns to a pale red, porous, and rather weak body. Its only use would be for the manufacture of soft-mud brick for filling or backing walls.

This clay is not so plastic as that from Spence Bridge, and while the clay from Spence Bridge might be used for field drain tile, it would seem impossible to use the Okanagan clay for this purpose.

NORTHERN ONTARIO

Clays and sands on Missinaibi river

Brick Clays.—The greater part of the region along the line of the National Transcontinental railway is underlain by boulder clay; but at certain points stratified clays, almost free from stones, are to be found, and these may be utilized for the manufacture of brick and tile.

The railway station at the crossing of the Missinaibi river is named Mattice. About half-a-mile east of the station, a small stream has cut down through a deposit of stratified clay, as far as the underlying stony clay, a depth of 8 feet. This deposit consists of alternating layers of ash coloured silt and brown plastic clay. In the middle and lower part of the section there are occasional small pockets of coarse gritty rock particles, and individual pebbles are sparingly scattered through the deposit. An average sample of this deposit was collected for testing. The clay was found to have good plasticity and working qualities, so that it could be used for the manufacture of drain tile as well as brick. The drying qualities were not tested, but similar clays in this region were found to crack, if subjected to fast drying. This clay burns to a buff or light cream colour, with a total shrinkage of 6 per cent and forms a hard brick when fired to about 1900 degrees Fahr.

There are a few particles of limestone in this clay, and these are detrimental to the burned brick, owing to their tendency to swell on taking up moisture from the air and spall off portions of the brick or tile.

The upper part of the deposit appears to be more free from pebbles than the lower, so that a good deal of the trouble from limestone could be avoided by working only the upper 4 feet.

The upper part of the deposit is weathered, and the lime leached out for a depth of about 18 inches below the surface. This part is very stiff and plastic, burning to a dense hard red coloured brick.

A more extensive deposit of the stratified clay occurs on the west bank of the Missinaibi river, on Mr. John Christianson's ranch, which is similar in character to that just described.

Fireclays.—A fairly large exposure of fireclay and white sand occurs on the east bank of the Missinaibi, about 4 miles above the mouth of the Wabiskagami river, and 45 miles north of Mattice station.

These materials are of Cretaceous age, and underlie the glacial drift; they outcrop for about half-a-mile along the bank, and at one place are visible to a height of 30 feet above the low water stage of the river.

The clay is of various colours, white, pink, and yellow, but masses of mottled pink and white clay prevail. The greater part of the deposit, however, is quartz sand, generally white in colour, but stained in places to a yellowish or pink colour. The whole deposit is overlain by grey stony glacial clay, and some of this clay is pressed into and mixed with the Cretaceous clay for a depth of several feet. Two small streams which cut through the overlying glacial drift expose the fireclay beds, and form convenient places to examine the deposit.

As the mottled pink and white variety formed the bulk of the mass of clay exposed, a sample of it was collected for testing purposes.

This clay is very plastic, with good working and drying qualities.

When burned to cone 9 (1310 deg. C.), it has a hard light red body, with an absorption of 13 per cent, and a total shrinkage of 10 per cent. It begins to soften at cone 27 (1670 deg. C.), so that it is a No. 3 fireclay, which would make a good commercial grade of fire brick.

This material could also be used for the manufacture of stoneware goods, but as it contains a quantity of quartz particles, it would have to be washed and screened in order to render it smooth enough for this purpose.

The chemical composition of the mottled fireclay as determined by Mr. A. Sadler of the Mines Branch is as follows:—

Silica	(SiO_2)	55·17
Alumina	(Al_2O_3)	28·06
Iron	(Fe_2O_3)	5·36
Lime	(CaO)	0.23
Magnesia	(MgO)	0·16
Potash	(K_2O)	0·26
Soda	(Na_2O)	0·03
Water		9·13

A large portion of the deposit on the Missinaibi river consists of coarse grained quartz sand. The sand grains are coated with white, and in some places pink and yellowish clay. A sample of sand collected from this deposit was washed and yielded only 4 per cent of fine white clay, but some portions of the sand contain a larger quantity of clay. The texture of the washed sand is shown by the following screen analysis:—

Retained on 10-mesh screen	8·27	per cent
" 20 " "	19·47	" "
" 35 " "	38·04	" "
" 100 " "	32·44	" "
" 200 " "	1·33	" "
through 200 " "	0·10	" "

The chemical composition of the washed sand is as follows:—

Silica	(SiO_2)	97·72	per cent
Alumina	(Al_2O_3)	0·42	" "
Iron	(Fe_2O_3)	0·32	" "
Lime	(CaO)	0·28	" "
Magnesia	(MgO)	0·21	" "
Loss on ignition		0·12	" "

The grain size or texture of the washed sand is suitable for glass making purposes, but the iron content is a trifle too high for white glass, but would answer for coarse glass products such as bottles, where a water white colour was not essential.

A small portion of the clay and sand along the immediate bank of the river could be obtained without removing much overburden, but farther away from the bank the topping of glacial dirt increases in thickness, and consequently becomes more difficult to remove.

Another deposit of this description occurs on the bank of the Wabiskagami river about 2 miles west of the Missinaibi deposit. The white sands and clays are exposed for a height of 10 feet above low water level, and are overlain by a great thickness of glacial debris. These two occurrences may be a continuous deposit underneath the glacial drift, but it was difficult to prove it by boring with an auger, owing to the presence of numerous stones in the overburden.

QUEBEC

Little Métis. Matane Co.

A large outcrop of grey shale is exposed in the Intercolonial railway cutting between Little Métis and Kemp stations, and an average sample was collected for testing purposes.

This shale, Sample No. 731, was prepared for testing by grinding, so that it would pass a 12-mesh screen. The ground shale was only feebly plastic, and was difficult to mould into shape. It can be dried very quickly, and has very little drying shrinkage.

If this shale was mixed with some plastic surface clay, it could be used for the manufacture of wire-cut building brick, or this mixture would also be suitable for dry-pressed brick.

Equal parts of clay and shale would give a good red brick by either process, similar to those made at Laprairie.

This shale is not suited to the manufacture of vitrified wares, such as paving blocks, as it will not stand up under the temperature necessary for vitrification.

St. Octave. Matane Co.

Two samples of shale from this vicinity were submitted by Mr. Arthur L. Landry, of St. Octave.

One sample of shale was red and the other grey, but both appear to belong to the same rock formation. These shales, when ground, and mixed with water, developed a low plasticity sufficient to allow of them being forced through the die of a brick machine.

They stand fast drying without cracking, and the shrinkage in drying is low.

The red shale burns to a dark or brownish-red colour, and the grey shale to a light brilliant red. The bricks made from these shales are hard and dense when burned to a temperature of 2,000 degrees Fahr. (Cone 03), and are not quite vitrified. These shales will stand a higher temperature without softening, so that they can safely be used for the manufacture of paving blocks or other vitrified clay products.

Both shales begin to soften at Cone 7 (2318° F.), and are not quite fused at Cone 9 (2390° F.), so that they are true vitrifying shales, a type comparatively rare in this region.

These shales could be used for making a fine grade of rough texture face brick for buildings, but for hollow ware or sewer pipe they would require the addition of about 25 per cent of a good plastic clay to enable them to flow through the hollow dies used in shaping these wares.

Petite Romaine, Iberville Tp., Chicoutimi Co.

On the shore of the St. Lawrence river, at this point, there is a thick deposit of light grey clay underlying from 10 to 15 feet of sand, peat, and yellow ochre. The clay is very silty in character and low in plasticity. It burns to a light red colour, and very porous body. This is a low grade clay, but it might be used for the manufacture of a common building brick, by the soft-mud process, if nothing better was available in the district.

Vaudreuil

About two miles east of the village of Vaudreuil, the Canadian Pacific railway line cuts through a high bank of clay.

This locality should be a favourable point for the manufacture of building brick and field drain tile. The clay is well situated for excavating, and is covered with about two feet of yellow sand, which could be used for mixing with the clay or as a brick moulding sand. A small creek flows along the bottom of the bank, from which a permanent supply of water could be obtained. The clay along the bank of the creek is a yellow, sandy variety, with a low shrinkage, and burning to a fine, hard, red coloured body, and is better for brick-making than the clay in the high bank. The clay in the high bank could be used for both drain tile and brick when mixed with the top sand.

There is an abundance of clay in the counties of Vaudreuil and Soulanges, but as it mostly lies in flat plains, it would be difficult to excavate it on account of surface water coming into the pits, but the high bank noted above would not be open to this objection.

A supply of wood for burning the clay wares could be procured during the winter months from the slopes of Rigaud mountain about eight miles distant.

NEW BRUNSWICK

Hebert—Kent Co.

A thin coal seam occurs at this locality, but no mining operations beyond prospecting have been undertaken. Two samples of clay lying above the coal seam were collected and tested. Lab. No. 737, is a hard, grey, non-calcareous shale, overlying the coal seam. This shale has good plasticity when ground and mixed with water, and works well through both a solid and hollow die. The shrinkage on drying is only 3 per cent. The following results were obtained on burned test pieces:—

	% fire shrinkage	% absorption	Colour
Cone 010	0	12	light red
06	0	11	red
03	3	5	dark red
5	fused		

This material would be suitable for the manufacture of either wire-cut or dry-pressed building brick. It would also be a good material to use for the manufacture of hollow building blocks, as the shrinkages both on drying and burning are low, and the burned body is hard and strong. A better hollow ware would probably be obtained by mixing this shale with the upper clay, No. 736. A mixture of equal parts of these clays would produce a good variety of clay products for building purposes.

The material is not a fireclay, neither is it semi-refractory, Lab. No. 736. This is a soft, yellowish clay, which lies above No. 737. It is very plastic when mixed with water, and makes a smooth bar when pressed through a die. The shrinkage of 9 per cent which it undergoes in drying is rather great.

The following results were obtained on burned test pieces:—

	% fire shrinkage	% absorption	Colour
Cone 010..	0	16	light red
06..	3	6	red
03..	8	vitrified	dark red
4..	fused		

This clay would be suitable for the manufacture of building brick or field drain tile. A mixture of this clay with the lower shale No. 737 is recommended for a larger range of products.

Claire Fontaine—Kent County

A purple coloured, weathered shale outcrops on a branch of Little Black river, about three-fourths of a mile above the shore road. This clay is known as "blue paint" in the vicinity.

The sample collected, Lab. No. 739, consisted of hard and soft lumps of purplish coloured clay, which is very plastic when wet, but rather stiff. It is smooth and free from coarse grit, and has good working and drying qualities.

It burns to a light red, rather porous body, at the lower temperatures, but becomes denser and darker in colour when subjected to higher heats, and finally vitrifies at cone 03. This clay is suitable for the manufacture of wire-cut building brick or field drain tile, the only objection to it being the fact that the shrinkages are rather great. As the sample was taken from the softened outcrops it is possible that different results would be obtained from the hard unweathered shale beneath the surface. This material is not a fireclay, but on the contrary is rather easily fusible.

NOVA SCOTIA

There is a growing demand for a more permanent building material than wood in the Maritime Provinces; also for one that will resist the spread of fire in the growing towns and cities. Burned clay products fill these requirements more effectually than any other class of structural material. Many owners of existing brick plants, that use only the surface clays for common brick, are desirous of improving their products, and are looking for shale deposits to use either alone or in a mixture with the surface clay.

Experiments were carried out in the Mines Branch laboratory for Mr. L. H. Shaw at Avonport, on a shale deposit which occurs near his plant. A mixture of equal parts clay and shale were found to be suitable for hollow ware or rough-faced brick, and arrangements are now being made to produce these wares.

Shale deposits in other parts of the province, not previously reported on, were also examined, and the results of the tests are given in the following pages. The red shale on the roadside near the village of Shubenacadie is worth attention, as a mixture of this and the brick clay, at that point, would give good results in this connexion.

Inverness, C.B.

Red shale outcrops on the main highway near Broad Cove chapel, about four miles north of Inverness. A sample, Lab. No. 738, was collected at this point for testing.

This material, when ground to pass a 12-mesh screen, does not entirely slake when mixed with water, but remains gritty in the wet state, consequently its plasticity is low.

It can be dried rapidly without cracking, and the shrinkage in drying is small.

This shale burns to a hard, dense body of fine red colour, and would make excellent building brick, either by the wire-cut or dry-pressed process.

The temperature at which this shale softens is comparatively low, so that it is doubtful if it could be used for the manufacture of paving brick or other vitrified products.

Truro

Greenish-grey, hard shale outcrops in a bank on the road near North river, about four miles north of Truro, and the same shale forms the east bank of the river in this vicinity. A sample of this shale was collected for testing by Mr. H. Gauthier of the Mines Branch.

The shale, when ground to pass a 16-mesh screen, and mixed with water, develops enough plasticity to enable it to be run through a brick die. Its plasticity, however, is low, and the shale would have to be mixed with some plastic clay before it could be used for making hollow ware.

It burns to a light red, rather porous body, at the lower temperatures, but becomes darker and denser with longer burning.

This shale is not suitable for the manufacture of vitrified wares, as its softening point is too low.

Some thin coal seams have been found at East Mountain in Colchester county, eight miles east of Truro.

A small sample of grey clay shale associated with the coal was sent by Mr. O. R. Harlow, of Truro, to the laboratory in the hope that it might be a fireclay. This clay does not stand a high enough temperature to be classed even as semi-refractory, as it fuses to a slag at the softening point of pyrometric cone 7 (2318 degrees F.), whereas a fireclay is required to stand at least 3000 degrees before softening.

Shubenacadie

Outcrops of gritty red shale occur along the Halifax-Truro highway, near Dewis Siding, just south of the village of Shubenacadie, a sample of which was collected for testing by Mr. Gauthier of the Mines Branch.

This shale, when ground to pass a 16-mesh screen, and mixed with water, develops enough plasticity so that it can be forced into shape through a brick die.

It burns to a strong body of good red colour.

This shale can be used alone either for making wire-cut brick by the plastic process, or for facing brick by the semi-dry pressed process. It would improve the working qualities to add some of the plastic surface clay from the same locality. A mixture of equal parts ground shale and clay would make excellent hollow building blocks, and rough-faced building brick of fine red colours.

This shale is not suitable for the manufacture of vitrified wares. Grey plastic shales occur two miles west of Shubenacadie, on the property of Mr. John McDonald. The shale weathers easily at the surface into a yellowish plastic clay. The thickness of the shale bed is unknown, but it is at least four feet thick when exposed in the field near Mr. McDonald's house. The same shale is also seen on Ryan's brook in this neighbourhood.

This shale is a good deal more plastic than the red shale on the roadside, and does not need the addition of surface clay to make it workable.

It burns to a good red colour and fairly dense body, and could be used either for hollow blocks or wire-cut brick.

There is, however, a large supply of surface clay at Shubenacadie for making brick and tile, so that it would scarcely pay to grind shales to add to it unless for making higher grade products such as rough-face brick or fire proofing, the demand for which class of product is steadily increasing.

MALAGASH. CUMBERLAND COUNTY

Grey shales outcrop along the sea shore just north of the salt mines at Malagash. A sample collected at this point by Mr. L. H. Cole of the Mines Branch was tested in the laboratory.

This shale, when ground to pass a 12-mesh screen and mixed with water, developed a fair plasticity, so that it could be used for making wire-cut brick or possibly for hollow blocks.

Its drying qualities are good and the shrinkage in drying is low, being only four per cent.

This shale burns to a red colour and hard body at a temperature of 1800 degrees. It becomes dark red in colour and vitrified at 1900 degrees.

It is not a fireclay, as it softens at a temperature of 2200 degrees.

It is possible that this shale could be used for the manufacture of vitrified products, such as paving blocks and for floor tile, if ground finely. It could also be used for the manufacture of rough-faced building brick of various shades of red and brown colours.

POTTERY CLAYS

The Summary Report of the Mines Branch for 1919 contained a chapter on tests of pottery clays from various parts of the Dominion. A short description of how pottery of various kinds is made, and the compositions of glazes and enamels with which they are coated, is included in that report. Clays from several additional localities were procured, and tested during the past season, the results of which are given in the following pages.

Surface clays, generally of glacial origin, are the principal materials upon which work was done, as these are the only kind available over the greater part of Canada.

The higher grade of clays such as stoneware clays, fireclays, and kaolin, are comparatively scarce in this country, and are restricted to a few localities. The principal accessible source of stoneware clay is confined to certain areas of southern Saskatchewan,[1] but a small quantity is also found in Nova Scotia.

As the glacial clays will not stand a very high fire, the glaze that is applied to them must be easily fusible, otherwise the ware made from them will distort when fired for the second time after the glaze coat is applied.

Nearly all the surface, or glacial clays, contain more or less grit, and are not smooth enough to be shaped on the potter's wheel, consequently they must undergo preparation which will eliminate the coarse material. This is accomplished either by slaking the clay in water and passing it through a screen, or by drying the clay and pulverizing it, but washing and screening is the method generally employed.

Heavy household pottery, such as butter crocks, mixing bowls, and jardinieres, can be made from the washed glacial clays. The only objection to their use is that the body is porous, and when the glaze becomes accidentally chipped off, a spot which gathers dirt results. The stoneware articles are not open to this objection, as even when the glaze chips, the vitrified body beneath will not absorb water.

1 "The Clay Resources of Southern Saskatchewan," by N. B. Davis, Mines Branch, Ottawa.

The glacial clays cannot be vitrified, because when the vitrification point of these clays is approached, softening and distortion takes place, consequently the temperature at which the ware made from them is burned is kept well below their vitrification temperature.

While household pottery made from surface clays may not be able to compete with those made from stoneware clay, except in a limited way, there is a large demand for glazed ornamental ware, which has a distinctive treatment both in form, colour, and texture, and this demand can be supplied in part by wares made from the common clays.

ONTARIO

Port Dover

The high banks facing Lake Erie at Port Dover, Port Rowan, Port Stanley, and other places, are largely composed of yellowish calcareous clay. Building brick and field drain tile are made from it at certain points, but all the clay in these banks is not suitable for the manufacture of brick or tile, because certain portions of it contain too many pebbles, or stones, or concretions which would be too expensive to remove in making rough clay products; but a great deal of it is practically free from this defect. This clay burns to a buff colour because it contains a large amount of lime in its composition. As long as the lime is in a finely divided condition, no trouble is experienced after the ware is burned, but if particles and pebbles of limestone are present, they are turned into quicklime on burning, and eventually destroy the brick or tile containing them.

A sample of the upper part of the bank at Port Dover was secured from the Erie Clay Products Company, who manufacture tile and building brick at this point. This clay is yellowish in colour, effervesces freely when dilute acid is dropped on it, and appeared to be fairly free from coarse grit. It has good plasticity when wet, and flows smoothly through the die of a tile machine, but when used on the potter's wheel the grit comes to the surface and spoils the shape of the piece of ware. Furthermore, some of the grit consists of particles of limestone, hence for two reasons it is important to screen this clay for use in pottery.

When washed, and screened through a 40-mesh screen, this clay still contains a good deal of fine grit, but it can be used on the wheel if a very fine finish is not required, the trouble from limestone particles is also removed. The washed clay has very good plasticity, and would make a good clay for modelling as well as for throwing on the wheel, but it would require to be screened through a 60-mesh screen for the finest work.

The drying qualities of the washed clay are good as it will stand tolerably fast drying without cracking. Of course thin wares, like pottery, dry out more quickly than brick or tile, but they are just as liable to crack as brick if dried at too fast a rate.

The Port Dover clay burns to a buff colour with a trace of pink when fired to the softening point of pyrometric cone 06, the pink colour being more pronounced if the firing is finished at a lower temperature. The fired body is very strong and tough, but quite porous at this temperature. If fired to a higher temperature, say cone 03, this clay is liable to soften slightly and deform, it also shrinks greatly at the higher heats, and the body becomes quite hard and of a sulphur colour.

When a clear colourless glaze is applied over the burned ware, and the pieces re-fired, they come out of the kiln a rich dark buff tone. The clear glazes, however, have a tendency to craze some time after the piece is fired, but no doubt the crazing could be stopped by altering the composition of the glaze to suit the clay.

When tin oxide is mixed with the glaze, it becomes opaque, and is called an enamel. The tin enamels gave the best results on this clay; blues and greens being especially good. By adding iron oxide to the clear glaze, a brown colour can be obtained, which does not craze so readily.

The clay might be used for the manufacture of heavy household ware, such as mixing bowls, bean pots, and jardinieres, but the expense of preparing the clay, by washing and screening off the coarse material it contains, may be prohibitive in making goods on which there is only a small margin of profit.

Several pieces of pottery made on the wheel and glazed in different colours at the laboratory of the Mines Branch, were very attractive as flower vases, or ornamental pottery.

Brantford

Deposits of glacial clay are fairly abundant in the vicinity of Brantford. Probably the thickest and most extensive stratified stoneless clay deposit in western Ontario, except on the shores of the Great Lakes, occurs along the bank of Grand river, near Cainsville, about three miles from Brantford. The old brickyard at Mohawk Park, at the east end of Colborne street, worked a bank of stratified clay and silt, but this material would not be suitable for pottery making, as it is not plastic enough.

The old brickyard, worked by Mr. W. H. Freeborn, had a red burning clay on the surface to a depth of two or three feet, and below this is a stiff brownish laminated clay which has good plasticity and burns to a hard buff body.

A similar clay is found in the pits of the Ideal Brick and Tile Company, on Stanley street, and a sample of the clay was procured for testing purposes.

This clay contains so many gritty particles that it cannot be used for making pottery on the wheel as it comes from the pit, but must be prepared by washing and screening. It is not so coarse in texture as the Port Dover clay, so that passing through a screen of 40 meshes to the inch will eliminate enough of the grit to make a very smooth and highly plastic modelling clay. The washed clay has good tensile strength and toughness, so that it can be thrown on the wheel to make any desired shape. It would also serve as a modelling clay for school use, as built pottery forms either square or round, and tiles can be made from it.

The opaque enamels which have tin oxide in their composition seem to work well on this clay, but the clear glazes have a tendency to craze. The burned colour of the body before glazing varies from a pink to a light buff according to the heats used.

Essex County

The clay used for the manufacture of brick and tile in Essex county occurs as a thin sheet on the surface of certain areas. It is seldom more than about 2 feet thick, and in some places even less, and rarely reaches to a depth of three feet below the surface. The top clay is free from lime and of a brownish colour, the clay below this is a grey stony material which is absolutely useless for the manufacture of clay products. The top clay burns to a good strong body and a fine red colour, in fact, the burned ware has the most glorious red colour that we know of among all the red clay products in Canada.

The clay as it comes from the pits contains a good deal of coarse and fine gritty particles, which must be removed by washing and screening before it can be used for modelling, or for wheel work; furthermore, it is necessary to use a screen of 60 mesh to an inch in order to make it workable for a smooth finish. This screened clay is very plastic, and has good tensile strength, so that it can be turned into any shape on the wheel, or used for modelling. Ornamental pottery made from this clay need only be glazed on the inside, the outside can rely on the fine burned red colour without the addition of glazes, or enamels, but the whole body can be glazed if desired.

Renfrew County

There is a great quantity of stoneless plastic clay of marine origin along the Ottawa and St. Lawrence rivers. It is a dark grey sticky clay, hard to dry, and has a high shrinkage. It is an unsatisfactory material to use for pottery, although a quantity of flower pots were produced from it in a small plant, but as a general rule this clay is a failure as far as pottery is concerned. This clay burns to a red colour, but at a few points there is a bed of buff burning clay below the red. Most of the buff burning underclays are very silty and only feebly plastic, but at Renfrew the underclay has very good plasticity, and better working qualities than any of the red upper clays—which is a very unusual occurrence.

A sample of the underclay was collected from the old brickyard site in the valley of Smith's creek. This clay was formerly used in the manufacture of field drain tile, it is fairly smooth, and appears to be free from coarse grit. It cannot be used, however, direct from the bank as a wheel clay, because it contains certain layers which do not slake in water, but remain in small lumps, hence it is necessary to either pulverize the dry clay very finely, or else wash and screen the clay. The washed clay is very smooth and makes an excellent clay for modelling, hence is recommended for use in schools.

SASKATCHEWAN

Estevan

The Estevan Coal and Brick Company use two different kinds of material from their mine for brickmaking, an upper clay which burns to a buff colour, and a dark grey clay which occurs below the coal seam, for making red dry-press brick.

The dark clay under the coal cracks in drying when made up into brick shapes by the plastic process, consequently it has to be used by the dry-pressed method. The lowest part of the dark clay, however, if it is used separately, is not so liable to crack in drying, as it is not so fat and pasty when wet as the upper part.

The lowest clay, however, contains a good deal of grit, but this can be removed by washing it through a 30-mesh screen. A very fine working, smooth clay is thus obtained, which is suitable for use on the wheel. None of the smaller pieces turned on the wheel cracked in drying, but some large wide pieces, like bowls, cracked across the bottom while drying. This clay burns to a very hard, dense light red coloured body, on which the glazes, either clear or opaque, did not craze.

The top material over the coal is a yellowish calcareous clay, containing a great quantity of rock particles. When washed through a 40-mesh screen it makes a clay of good consistency and working qualities for the wheel. The drying qualities appear to be good, as none of the wheel pieces showed any indication of cracking. This clay burns to a buff colour, but the burned body shows numerous small specks of a reddish colour. Clear and opaque glazes cover well on this body without crazing.

A mixture of equal parts of the clays appears to give better results than either of them used alone, because the defects of one clay are compensated by the good qualities in the other. For example, the buff clay has too porous a burned body, but it is easy to dry. The grey clay is difficult to dry, but its burned body is very dense. Furthermore, the mixture of clays forms the best body on which to apply glazes.

The mixture of clay is recommended for use in teaching modelling in the public schools of the district.

The Estevan clays may also be used in combination with the white stoneware clays found in other parts of southern Saskatchewan, in order to produce different bodies and glaze effects at lower temperature than those which the white clay alone will produce.

CLAY-WORKING INDUSTRY

Structural Materials

The clay-working industry in Canada is engaged mostly in the production of structural materials, such as brick and hollow building blocks and drain tile for agricultural purposes. These are made from the surface clays of glacial origin which are so widespread over all the country; but at a few points shales from the older rock formation are the raw materials used. Vitrified structural wares, such as sewer pipes, are made to a limited extent, but no paving brick are produced, mainly for lack of the proper kind of vitrifying shales employed in their manufacture. Four plants are engaged in the manufacture of heavy household pottery and stoneware goods such as crocks and jars. Two of these plants import their clays from the United States. White vitrified floor tile are made at one point and sanitary ware and electric porcelain at two others. All the industries making white bodies import their raw materials both from England and the United States.

The industry as a whole is on a sound economic basis as it keeps pace with the demands of the country. When the capacity for consumption in the home market increases, the industry will, no doubt, expand to meet the needs.

The following table shows the value of the principal classes of clay products manufactured in Canada for the year 1919:—

Brick	$3,154,381
Hollow blocks, or fireproofing	396,084
Sewer pipe	1,074,146
Field drain tile	616,510
Stoneware pottery	185,474

Special Clay Wares

Some of the existing plants throughout Canada, engaged in the manufacture of brick and drain tile, might take up with advantage the making of a more specialized and profitable line of wares wherever they have a suitable clay or shale. There is a large and growing demand for the ordinary red floor tile used in corridors, kitchens, hospitals, and other places, which may easily be made from some of the red brick shales by simply grinding them finely. While these shales may not be suitable for tiles for outdoor use, on account of their porosity, they will give good wear on indoor positions. Roofing tile, and tile for lining digesters in the pulp mills, are other profitable lines for the manufacturers, but the latter would have to be salt glazed.

Porous clay wares, such as iceless refrigerators and water coolers, would have a large sale if any one undertook their manufacture. Vessels of this kind owe their cooling properties to their ability to soak up a large quantity of water, and the evaporation of this water as it comes to the surface keeps the contents cool. The Medalta Pottery Company at Medicine Hat, Alberta, is the only firm in Canada which makes this class of ware. This firm makes a porous water jug especially designed for keeping water cool, for workers in the fields during the hot weather.

White Table Ware

No table ware, such as white earthenware, semi-porcelain, or china, is produced in this country, the reason probably being due to a dearth of the proper kind of raw material used in their production, and the market not being large enough.

The commoner kinds of table ware have hitherto been made so cheaply and so well in European countries, that it was impossible for a firm in Canada to compete with them. In recent years, however, the prices for these goods have increased fourfold or even more, so that there is a much better opportunity for manufacturing in Canada, at a reasonable profit.

The manufacture of staple lines would be the safest kind of business to undertake at the start. These include: (1) plain white, or, as it is sometimes called, white granite ware; (2) gilt wares, light and heavy, these being simply decorated over the glaze with a gold line, or with a stamped device in gold, the commonest on the market being the clover leaf, but the Canadian manufacturer should stamp his ware with a gold maple leaf or a beaver; (3) ware decorated with a transfer pattern in one colour, generally called printed ware; (4) water jugs, either plain white, or decorated with gilt band, or printed decoration.

There is an enormous quantity of these goods sold in Canada, and any manufacturer producing them at say 20 per cent less than the imported wares would be assured of the greater part, if not all, of the business.

Raw Materials.—A mixture of four different kinds of raw materials is used in making the above wares, these being: china-clay, ball clay, flint, and feldspar. In addition to these, a supply of fireclay is necessary for making the saggers or containers in which the ware is burned.

The present supply of china-clay in Canada is limited to one deposit, that of the Canadian China Clay Company, of Huberdeau, Quebec. This deposit is being developed by new mining methods, and a larger output of clay is promised than was formerly available. So far, no ball clay has been discovered within reach of transport in Canada. Certain of the white sandstones in eastern Canada, when pulverized, can be used for the flint in pottery.

There is a plentiful supply of high grade feldspar for pottery bodies and glazes in eastern Canada. Any firm doing a large amount of business in white earthenware could purchase the crude feldspar and quartz from the mines, and do their own grinding.

Fuel.—As it requires six tons of coal to produce one ton of white table ware, the fuel question would have to be studied closely, and particular attention paid to design of kilns and methods of fuel saving. Putting the coal through a gas producer and using the gas for fuel in a tunnel kiln seems to be the practice that is approved by most ceramic engineers.

Location.—The location for a plant making white table ware depends on various factors. Of these the assembling of raw materials, the cheapest place to deliver coal, the transportation facilities for assembling and distribution, and the labour supply, are the principal things to be taken into consideration.

Points on the St. Lawrence river up to Montreal have the advantage of ocean freight delivery of supplies of English china-clay and ball clay without re-handling, as well as access to the Nova Scotia coal fields. Points on Lake Erie, such as Port Stanley or Port Colborne, are well situated for receiving supplies of coal and fireclay from the United States, and points on the Welland canal have similar advantages for assembling raw materials and distributing finished products.

FIELD EXAMINATION AND TESTING OF CLAYS

The testing of any clay or shale for commercial purposes begins with an examination of the deposit in the field. A clay deposit should be conveniently situated with regard to transportation, and in a body large enough to keep a plant going for a considerable time, free from harmful impurities, and be easily worked. There are many important questions to be considered, however, in a preliminary inquiry, for example:—

1. Can drainage be provided as excavation or mining proceeds since it is necessary to keep the workings dry?
2. Is the water supply for all purposes adequate, and of good quality?
3. If sand is required for mixing, or moulding, can it be obtained cheaply?

4. Consideration of the fuel supply.
5. Are conditions in the locality favourable for labour?
6. Can breakages of machinery be repaired quickly?
7. Can the kiln foundations be kept dry?
8. Would further prospecting probably reveal a more desirable deposit?

Some idea of the extent of a clay deposit may be gathered in a preliminary way from outcroppings either in ploughed fields or hillsides or ridges and along the banks of streams or dry gullies. Springs issuing from hillsides sometimes furnish a clue to the upper level of a bed of clay, as the surface water cannot seep down through it. Wells and foundations excavated for buildings are useful guides; but railway cuttings often furnish the best information, especially when they are freshly made. As soft clays in a steep bank are liable to be concealed by slide material which has washed down over them, it is often necessary to cut a deep trench up the slope from top to bottom of the deposit, before the true character of the beds is seen. Some banks contain several different grades of clay, some of which may be worthless, and so situated as to render the good clay unworkable.

In addition to the information gained from outcrops it will be necessary to make several borings in order to get at the extent of the deposit and its variations. Borings can be made quickly and cheaply in surface clay deposits, with a 2-inch auger, coupled to short lengths of pipe, and fitted to a cross head. The auger is screwed into the clay for about 6 inches, then withdrawn with a straight pull, and the clay which clings to the auger removed. As the boring proceeds, extra lengths of pipe are added. The clay stripped from the auger is laid out in the proper order, on boards or on the grass, from which small samples can be selected at any depth up to 30 feet, or more if desired.

The clay deposit may be covered with a varying thickness of either gravel or stony clay which cannot be used for any purpose. In most cases it will not pay to strip this overburden if it is very thick, but the higher grades of clay, like stoneware and fireclays, can have an overburden of one foot removed for every foot of clay obtained. If the overburden is composed of sand, much of it may be used for mixing with the clay, especially if it should be a fat clay, with high shrinkage. An otherwise useless overburden may sometimes be used for filling or levelling up ground on which it is proposed to erect the plant; or it may be removed cheaply by hydraulicing, if a sufficient head of water is available. An overburden which contains pebbles, especially pebbles of limestones, should be removed completely, and kept well back from the face of the bank which is being worked, so that there will be no danger of the pebbles rolling into the material that is being worked for the manufacture of clay products.

Shale deposits are often exposed in fairly steep banks, either in an escarpment or on stream banks, or in a railway cutting. From exposures of this kind a good idea of their probable value may often be formed. If the outcrops on the property to be examined are not exposed to any appreciable depth, it will be necessary to sink some shafts before any sampling can be done or any decision formed regarding its economic value.

Several of the soft shale deposits in the plains region of western Canada can be examined as easily as surface clays from boring with an auger; but the shales in the east are all too hard for this method of sampling.

The shale formations in eastern Canada are generally uniform in character over very large areas, but those in the west are often extremely variable, so that they require great care in sampling and examination.

Impurities in clay or shale are of two kinds, those which are visible to the naked eye, and those which are not. The field examination detects the first kind, and the laboratory tests should reveal the second kind. Pebbles are probably the most serious visible impurities in surface clays. They may occur sparsely scattered throughout the clay or they may be in the form of gravel streaks, pockets, or regular layers. If the pebbles are mostly of limestone, the deposit is practically hopeless. Some manufacturers in search of material will not consider a deposit if they find it contains even a few scattered pebbles. Beds of calcareous clay are found, in many instances, to contain layers of concretions, but to be otherwise free from pebbles. Concretions are hard, rounded, elongated, or fantastically shaped nodules, known as "clay dogs" by men working at the clay banks. Concretions will destroy burned brick more effectively than any other form of lime, and should be rigorously excluded from the brick mixture. This may be done if the concretions occur in layers, but if they are scattered through the mass there is no hope for the deposit. Layers or pockets of sand, if not in too large a quantity, are sometimes beneficial in a surface clay, especially if it is of a highly plastic nature. Brickmakers like a clay bank to work itself, meaning one that carries the right proportion of sand to clay, but a clay deposit that is too sandy is undesirable because the product made from it is liable to be weak and porous. Although a shale deposit may consist largely of beds of true shale, it is possible that it may also contain so many layers of sandstone or limestone as to be of doubtful economic value. If the stone bands or layers are thick enough they may be sold for building stone, if a convenient market exists for them. Ironstone concretion, and lumps of iron pyrite, are among the serious impurities in shales and clays. They sometimes occur of such large size that they may be discarded in mining. Gypsum or lime sulphate is a frequent impurity in the soft shales of western Canada. It generally occurs in small, glistening particles disseminated through the shale; or it may be in large crystals or rosettes. It generally follows in the west that clays carrying gypsum are hard to dry without cracking.

It is generally impossible to foretell much about the value of a clay or shale by simply inspecting the deposit in the field. An experienced clay worker, however, can gather some information for his guidance in the selection of material. The feel of the moistened clay when kneaded in the hands indicates its degree of plasticity and its probable working qualities. A shale may be distinguished from a slate by grinding a little with a hammer and moistening it. The moistened shale dust will have more or less plasticity; but a slate will have none. Any clay or shale that carries more than about 7 per cent of lime will probably be useless for the manufacture of vitrified wares, such as paving brick or sewer pipe. If a few drops of diluted hydrochloric acid will produce strong effervescence in a clay it may be discarded as unsuited for this purpose.

Many clays will crack in drying. These can be easily detected by kneading up some of it with water to the proper consistency, shaping it into a rough brick or cube, and setting it to dry. Others will not show cracking for several hours. If the clay dries intact, then make another brick by hand and set it over a boiler or in an oven at a temperature of about 150 degrees F., and observe the results. A clay must be able to stand a certain amount of abuse in drying in order to give a large output of finished products.

PRACTICAL INSTRUCTIONS AS TO SAMPLING

Many people send a few ounces of clay to a testing laboratory and expect to be told all about its properties and uses. It is not possible, however, to make any definite statements unless at least two pounds of clay are submitted, and then the results of tests on a sample of this size should, in many cases, be only preliminary to testing a larger sized sample.

Since few clay or shale deposits are uniform in character throughout their entire thickness, the selection of samples for testing purposes is a matter of some importance.

If the deposit appears to be uniform, then the sample should represent an average of the depth of the face it is proposed to work. The average sample should be supplemented by two or three other samples taken from different depths, as appearances are frequently misleading in clay investigation. Many persons pick a small sample of clay from the surface of a deposit and send it to be tested. The results of tests from this kind of sampling are generally useless. The body of material, when opened up for working, may given entirely different results from the thin veneer of weathered clay overlying it. In a locality where industries have been located for a long time, working satisfactorily on a material which occurs widespread, and uniform in character, the necessary information may be obtained merely by inspection of a suitable site in the vicinity of the older plants. This proceeding is often, but not always, safe where the manufacture of common brick only is concerned. Where any of the highest class of clay products are to be made, the cheapest method is to take every possible precaution at the outset of the enterprise.

LABORATORY TESTS

The visible impurities in a clay, which may produce defects in the process of manufacture or in the appearance of the finished ware, can be detected only by working up and burning test pieces made from the clay.

A good deal of time and money has been expended on the chemical analysis of clay, and many chemists have been rash enough to state in reports the kind of wares a clay will make, based upon the results of their chemical analysis alone. There may be special instances, as in the case of some high grade clays, where the chemical analysis is of value; but it is worthless for the general group of clays or shales used in the manufacture of structural ware.

What the clay worker desires to know about a clay or shale is:—

1. Its plasticity and working qualities.
2. The rate of drying.
3. The exact drying and burning shrinkages.
4. The commercial limit of burning.
5. The porosity and absorption of the burned wares.
6. The actual difficulties encountered in burning, such as cracking, warping, or swelling, and scumming or whitewash.

Many of the important clay-working plants in the United States and England, especially those making a variety of wares, have an experimental laboratory, with small kilns for burning trials, in charge of a competent ceramist. These firms test a large number of clay samples which are sent to them from outside sources. Three or four of the State universities give courses in ceramic engineering and have fully equipped clay-testing laboratories. A certain amount of commercial work is done, for which fixed charges are made, according to the scope of the investigation. The tests are conducted by experienced men, whose reports are reliable, and extremely valuable to the person or company about to start a clay-working industry.

Most of the manufacturers of clay-working machinery have a clay-testing department on their premises. These people invite prospective customers for machinery to send samples of their clay and have it worked up into specimens of ware. They generally make the tests free of charge. The specimens of burned wares sent back by the machinery companies to their prospective customers are generally perfect in every respect. These samples should be regarded as a standard to be ultimately attained, however seldom reached, in the everyday world of clay-working.

TESTING UNDER WORKING CONDITIONS

If a company or individual wishes to establish an important clay-working industry at a certain place, to make a certain class of wares, a reasonable way to proceed in the test of their clay—provided the field examination was satisfactory—is as follows:—

Take an average sample of, say 50 pounds, from top to bottom of the workable depth of the deposit, if it is uniform in appearance, or as many samples as there are different beds. Have a complete set of laboratory tests made from the samples. If the laboratory tests prove satisfactory, then make arrangements with some firm, outside the zone of competition, who are making wares similar to those required, to put a large quantity of clay through their process and to burn it in their kilns. It is important to have an experienced man do the sampling and accompany the clay to its destination, so that he may observe the behaviour of the material in the various stages of manufacture.

The proper location of the deposit and the assurance of the suitability of the clay for the purpose for which it is to be used are absolutely essential to begin with.

The plan of the buildings, the design of the kilns or driers, and the selection of the best types of clay-working machinery, should be done by a competent ceramic engineer.

It is impossible to provide against all the troubles which may arise in new localities when dealing with a new material; but the chances for the occurrence of trouble can be materially lessened by proper precaution.

The business of manufacturing clay products is a desirable one in many respects. It gives healthy employment and produces articles of great use to a community. It is a fairly profitable business when brains and technical skill, as well as capital, are invested in it, varying nowise in this respect from any other complex, producing business. It is just as easy, however, for the unwary novice to lose his money in a homely looking clay-working plant as it frequently is in the more spectacular operations of metal mining.

ROAD MATERIALS DIVISION

H. Gauthier

The activities of the Road Materials Division have been curtailed to a certain extent during the present year on account of the resignation of Dr. K. A. Clark as chief of the division. However, investigations on road materials were carried on in Ontario and in Nova Scotia by the two remaining engineers, R. H. Picher and the writer—who worked together.

The first part of the summer was spent between Gananoque and Napanee in Ontario, with headquarters at Kingston. During the balance of the field season investigations were started in Nova Scotia, along the Halifax-Windsor, Halifax-Truro-New Glasgow routes, and in the Annapolis valley.

Since 1914, investigational work on road materials has been undertaken in every province of the Dominion, except the Maritime Provinces. In Ontario and Quebec this work has taken the form of material surveys along some of the routes of proposed main provincial highways. All available supplies of materials were then examined, mapped, and such sampling done for subsequent laboratory study as was necessary to determine the quality of such material, and to enable discrimination to be made between good and poor deposits. In the western provinces, road material investigations have been more in the direction of trying to determine how use can be best made of such materials as exist, in order to get serviceable results in road building.

By means of these surveys the staff of the division was afforded an opportunity of becoming familiar with the local conditions and problems connected with road building in the various provinces. Considerable information on the relative road-making qualities of a wide variety of materials has been gathered, which will be valuable to the highway engineers and contractors of the country.

In compliance with a special request from the Highway Board of Nova Scotia, it was found advisable to extend the field of work to that province. Consequently, some time was spent there, with the object of finding out in just what way the Road Materials Division could function best in gathering information wanted by the Highway Department and engineers.

A final report on the available supply of road material along the Gananoque-Napanee section of the Ontario provincial highway is under preparation. The investigational work in Nova Scotia has not advanced sufficiently for formal report.

A brief summary of the work accomplished in Ontario and in Nova Scotia follows:—

ROAD MATERIAL SURVEY ALONG THE GANANOQUE-NAPANEE SECTION OF THE TORONTO-MONTREAL HIGHWAY, ONTARIO

The road material survey for the Toronto-Montreal highway was started in 1914, and continued during the summers of 1916, 1917, and 1919. Reports have been published,[1] or written and will be published,[2] dealing with the various sections of this proposed provincial main highway. That stretch of the route from a point seven miles west of Gananoque to Napanee remained to be surveyed, and the aim of the field work undertaken during last summer was the completion of this survey.

The entire strip of land extending from the St. Lawrence river to from 4 to 7 miles inland was traversed. This includes the southwestern part of Pittsburgh town-

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[1] Road Material Survey in 1914, by L. Reinecke, Memoir 85, Geol. Surv.
Report on Road Materials along the St. Lawrence river, from the Quebec boundary line to Cardinal, Ont., by R. H. Picher, Bulletin 32, Mines Branch.

[2] Reports dealing with the sections Cardinal-Gananoque and Napanee-Port Hope.

ship, and the southern part of Kingston township in Frontenac county, and nearly all of Ernestown township, and the eastern portion of North Fredericksburgh township in Lennox and Addington counties.

The work consisted in the examining, locating, and mapping of all deposits of bed-rock, and in sampling the more important sources of supply for laboratory examination.

Throughout this district the route followed by the proposed highway is the Front or river road from Gananoque westward to Kingston, and from there the York road through Cataraqui, Westbrook, Odessa, and Fellows to Napanee.

The alignment of the highway is pretty straight all the way, with no right-angled turn, and only a few steep grades at Barriefield, Cataraqui, and Westbrook. The distance from where this survey was started, to Napanee, is 30 miles. For nearly all of that distance occurrences of bed-rock close to the highway are common, and constitute a plentiful supply of road stone for its construction and maintenance. The area surveyed is underlain by Palæozoic sediments of the Black River and Trenton formations, composed of limestone and shales. Igneous rocks of Pre-Cambrian age also occasionally occur, but only through the eastern part of the examined area. These rocks, which are in intrusive contact with the Black River limestones, are in chronological order, beginning at the oldest: Grenville gneisses and quartzites, Laurentian gneisses, and Algoman granite.

The more important occurrences of granite are located at Barriefield and Kingston Mills. The gneisses are found in scattered outcrops along the St. Lawrence river, between Barriefield and Gananoque. Their occurrence becomes more and more common, eastward through the area surveyed in 1919.

The boss-like occurrence of granite at the Kingston Mills locks on the Rideau canal covers an area of over half a mile square, and rises to approximately 75 feet above its lowest point. On either side of a deep gorge cut by the Cataraqui river at the locks, and along the edges of the outcrops close to the roads, are excellent exposures, with plenty of good faces for quarrying.

The general character of the granite, which is largely composed of feldspar (orthoclase), is reddish to pink, medium to coarse grained, and fairly massive.

At Barriefield, the granite occurs in the form of a dike cutting through the gneiss. The rock is bright red with bluish dots, medium to coarse grained. It was formerly quarried for monumental and building stone.

Throughout the entire area surveyed, outcrops of limestone are plentiful. Limestone of the Black River formation is especially well developed in the vicinity of Kingston. It has been quarried for many years there, and so largely used in the city buildings that Kingston is known as the "Limestone City."

This formation forms a prominent flat-topped hill at Barriefield, and the beds are exposed to a depth reaching 50 feet in places on the margin of bluffs on either side of the Cataraqui river, north of Kingston. In many instances the stone has been quarried for road materials, and openings with good exposures are found at short intervals between Kingston and Kingston Mills, and east of Barriefield along the Front and the Middle roads. West of Kingston, the more important occurrences of Black River limestone are north of Portsmouth, northwest of Cataraqui, and along the lake shore west of Collins Bay.

The character of the stone is of three main types. In ascending order they are: a greenish, sandy limestone, and shales, irregularly bedded, and uneven; a dove-blue to brownish-grey, dense, almost lithographic limestone, with, in places, numerous fine crystals of calcite scattered through its matrix; and a fossiliferous, dark grey, fine to coarse grained limestone. The greater part of the stone seen in the exposures is of the dense-textured type. It generally occurs in well defined and flat lying beds, and is, as a rule, fresh.

In the western half of the district surveyed, and especially to the east and north-east of Napanee, the occurring limestone resembles that of the Trenton formation near Ottawa and Montreal. There is very little noticeable variation in the character of the limestone along the route of the proposed highway from Westbrook to Napanee. The general character of the stone is thin bedded, laminated, dark coloured, uneven and highly fossiliferous limestone, with thin, black, shaly partings. At Napanee the limestone is somewhat different. It includes irregular layers of dense stone like that near Kingston, interbanded with a coarse and more crystalline variety. Some of the stone presents cavities lined up with crystals of calcite.

A large number of outcrops lie within hauling distance of the highway. In that section the more important deposits are located at Westbrook, northeast of Odessa, at Morven, and near Napanee.

There are several quarries from which stone has been obtained from time to time for local road work. In most cases more stone may be had without trouble.

Forty samples, including granite, Black River, and Trenton limestones of the various types, were collected and tested. The tests ordinarily made in examining stone to be used as road material are the following: abrasion, toughness, hardness, cementing, specific gravity, and water absorption.[1] To make these tests, the sample must consist of sixty pieces of rock, of chunky shape, i.e., not flat or splintery, approximating in size and general shape to a 2-inch cube, and also a block of stone, free from fractures and checks, rectangular in shape and at least 4 inches by 4 inches by 6 inches in dimensions.

In the final report the road-making qualities, and the comparative value of the various classes of rock sampled and tested, will be discussed. In the discussion, conclusions will be based on the results of laboratory tests, and on service conditions as revealed by the inspection of roads on which they have been used. The report will also contain a detailed description of each deposit of bed-rock occurring in the area traversed, from which road stone could be obtained. The outcrop areas which were mapped and examined number over fifty.

ROAD MATERIALS IN NOVA SCOTIA

Since 1917, in the province of Nova Scotia, every mile of highway has been under the control of the Nova Scotia Highway Board.

This Board has a large highway programme, partly mapped, but is finding it difficult to secure proper surfacing material. In some parts of the province, they have no difficulty in this respect, but in many places there appears to be no suitable material, or at least they have been unable to find such.

Investigations have been carried on in the western provinces in connexion with sand and clay roads, in order to determine how best to use such road materials as exist in order to get satisfactory results. This same problem presents itself in certain parts of Nova Scotia where the country is devoid of rock or gravel.

The main object of the work started in Nova Scotia was to observe conditions and try to determine a plan of work which the Road Materials Division could carry out, and which would best aid the Provincial Highway Department to get a better understanding of the road building materials at their disposal, in their relation to the various road building conditions that have to be met.

Thanks are due to Mr. J. W. Roland, ex-chief engineer of the Provincial Road Board, for his co-operation in the matter of going over the situation, and in doing all in his power to aid in getting a programme of work planned along the most useful lines possible.

Nova Scotia, with 18,000 miles of highways, has an excessive mileage of roads, considering its area, population, and the revenues for their betterment.[2] The pro-

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[1] Explanation of these tests and general limiting values for broken stone to be used in various types of road construction are given in the Mines Branch Summary Report for 1918, page 170.

[2] Report of the Provincial Highway Board of Nova Scotia, 1918, p.5.

posed main highways aggregate some 2,000 miles in length. These main trunk roads, after improvement, would be an asset of undoubted value to the province, and would open up to tourist travel portions of Nova Scotia of great scenic beauty.

The object of the Road Materials Division, in the past, has been to confine itself as much as possible to work upon the main interprovincial highways. So far as Nova Scotia is concerned, the main interprovincial road is that connecting St. John —the commercial metropolis of New Brunswick—with Halifax, the capital of Nova Scotia. Beginning at the boundary between New Brunswick and Nova Scotia, the route followed is via Amherst and Truro, a distance of about 75 miles. From Truro to Halifax—a distance of 62 miles—the route will be through Stewiacke, Shubenacadie, Waverly, and Bedford, the total distance from the boundary line to Halifax being about 137 miles. The route Halifax-Digby via Windsor and the Annapolis valley also connects Halifax with St. John, N.B., and is one of the more important provincial routes. The distance from Halifax to Digby is 154 miles. There are good boat connexions between Digby and St. John, across the Bay of Fundy, which is 48 miles wide there. This route is one of the alternative routes from Halifax to Yarmouth. The latter city is 67 miles from Digby, the total distance from Halifax to Yarmouth being 221 miles. The south shore route, via Chester, Bridgewater, Liverpool, and Lockeport, is 230 miles long, and part of it is through unsettled and wild country.

The improvement, even of existing main highways through the province, is still in its infancy. While only a small mileage of these has been surfaced with gravel, yet it is a fact that a big improvement has been made throughout every section of the province. On a great part of the routes above mentioned, culverts and bridges of a permanent nature have been built, and stretches of improved gravel roads or water bound macadam have been built in the more thickly populated centres. The greater part of the work being done, however, is of a preliminary nature, and consists in grading, ditching, and preparing the subgrade for future surfacing.

Along certain sections of these routes there are plenty of occurrences of bedrock outcrops from which good road surfacing material is available; along other sections the country is thickly drift covered, but gravel deposits are encountered at intervals. There are areas, however, varying in extent, where no suitable material can be found, or where the only occurring road building material is either clay or sand.

The work started last summer by the Road Materials Division consisted, mainly, in the study of the local conditions, and in the gathering of the more pressing information needed by the highway engineers. Some of the proposed main roads were visited, and the soil conditions and character of the available road materials examined, in order that systematic work could be planned for the future. The routes along which the inspections were made are the Halifax-Truro-New Glasgow highway, the Halifax-Yarmouth highways, via Windsor, the Annapolis Valley and Digby, and via the south shore. Some time was also spent in extending an investigation, having as objective the locating of some suitable material within hauling distance of the highway, between Windsor and Hantsport, and over an area northwest of Kentville, where no suitable material has yet been found.

Many samples of rock, gravel and soil were collected, and sent to the laboratory at Ottawa for examination during the winter.

APPENDIX

Preliminary Report on the investigation of the manufacture of peat fuel, conducted by the Joint Peat Committee of the Federal Government and the Government of Ontario up to December 31, 1920; together with a statement of plans and outline of work to be done during the year 1921.

B. F. Haanel

Secretary to the Committee

It has been stated on many occasions that the investigation being conducted by the Peat Committee is concerned with the determination of the feasibility of manufacturing peat fuel on a commercial basis in Canada, under present day conditions; but since confusion appears to exist with regard to the activities of the Peat Committee, which has given rise to impatience on the part of the public regarding the results so far obtained, the committee deems it desirable to restate certain facts.

The possibility of utilizing the enormous sources of heat energy lying dormant in the peat bogs of Ontario was investigated some twelve years ago by the Mines Branch of the Department of Mines of the Federal Government, and at the conclusion of this investigation it was stated that peat fuel, under conditions existing then, could be manufactured commercially on a small scale to compete with coal, for certain purposes. The conditions referred to were cheap labour and plant cost, consequently it was possible to employ a type of machine which was being operated in large numbers in Sweden, Russia, and other European countries.

The conditions in Canada for manufacturing peat fuel were so similar to those existing in Sweden that the technical officers in charge did not consider that experimentation would be necessary. A small plant of thirty tons capacity, complete in every respect, was, therefore, imported from Sweden, and erected on the Alfred bog, which had previously been prepared for manufacturing operations. It was intended, moreover, that this installation should serve as a demonstration plant, to show those interested in the manufacture of peat fuel how to manufacture the peat content of a bog into a fuel, by the only economic process known to exist at that time. In other words, it was to serve the same purpose regarding the development of our peat bogs as experimental farms scattered throughout the Dominion of Canada serve the purposes of the farmer. The manufacture of peat fuel was demonstrated during two seasons, at the conclusion of which time it was decided to dispense with the plant and bog, and sell the same to private parties; inasmuch as the main objective of the Government's practical demonstration of economic peat manufacture had been accomplished.

In the final report of the work done at the Alfred bog under Government auspices, it was stated that, in order to manufacture peat fuel on a large commercial scale, it would be desirable to reduce manual labour to a minimum, and to introduce labour-saving devices wherever possible. As a result of this recommendation, private parties did attempt to introduce mechanical labour-saving devices in the shape of a new type of Anrep machine, which was installed on the bog, prior to the war. Experimentation with this machine, however, was cut short owing to the difficulty of obtaining financial assistance, after the declaration of hostilities; and no work was consequently done to develop the peat resources of Ontario and other parts of Canada until the Ontario and Dominion Governments decided to appoint a joint committee to investigate the feasibility of manufacturing peat fuel. This committee was appointed in 1918, and shortly after its appointment organized and made preparations to conduct an investigation.

It should be stated here, that the Ontario and Federal Governments, independently, decided almost simultaneously to investigate the possibility of utilizing the peat resources of Canada, for fuel purposes, a decision which was largely influenced by the precarious fuel situation then existing. The Ontario Government decided to erect a peat plant of the Anrep type; while the Federal Government made plans to construct and erect, at Alfred, a peat machine of the Moore type. Since there was doubt in the minds of the Committee regarding the value of the two types of machine for the commercial manufacture of peat fuel, it was decided to thoroughly test the two types in order to ascertain which type of machine would be the best suited to Canadian bogs, or to determine the best features of each type.

The design of the Anrep machine was very considerably altered, and several innovations introduced in order to eliminate the large amount of time lost in altering the position of the main part of the machine, namely, the excavator element, on the field, and to otherwise increase its efficiency. The principal improvement was the mounting of the machine on caterpillar aprons. This obviated the necessity of moving the machine on specially laid tracks, and also permitted a greater degree of flexibility. The main parts of both machines were, so far as possible, made identical, so that if one type was found to be inferior to the other, it could be altered, at little expense, to conform to the best type. The mounting of the machines on caterpillar aprons was a new departure in the construction of peat machines; necessitating not only an original and entirely new design in the caterpillars themselves, but also alterations in the design of other parts of the machine. Consequently, a large amount of experimentation and alteration had to be done before the caterpillar elements could be pronounced satisfactory. The design of other parts of the two machines was also materially improved; notably the excavating buckets, and a considerable amount of work was required to make these satisfactory in every respect. The major portion of the required alterations was made during the season of 1919, and both machines were given a thorough mechanical test during that season. An attempt was made to give both plants a commercial demonstration during the season of 1920, but it was found impossible to operate them to full capacity and to take advantage of the full working season.

The Anrep system it may be pointed out, consists of two main elements, (1) the excavating element, which operates as a unit by itself; and (2) the distribution and spreading system or element. The spreading system employed with the Anrep peat machine, and which is always considered an inseparable and most important part of the Anrep method of manufacturing peat fuel, consists of a rectangular track layout, with rounded corners around which cars, operated by a cable way, actuated from the power plant situated on the excavator element, which delivers the pulped peat to a spreader, and which is operated at right angles to the line of travel of the excavating element. With this system, nine men are required to load cars and spread the peat on the field, and in addition to these very high labour costs, a serious loss of time is also occasioned in moving the tracks, an operation which must be performed at stated intervals—depending on the forward motion of the excavating element. The capacity was also reduced owing to the difficulty encountered in delivering a continuous supply of cars to the spreader.

The principal innovations in the Moore system are, (1) the unique device employed for delivering the pulped peat to the spreader and laying it on the field; and (2) the method of excavating the raw peat. The former is accomplished by delivering the pulped peat from the macerator continuously onto a belt conveyer which is supported on a bridge work some 160 feet long, which is attached to the main peat machine at right angles to its direction of travel. The delivery and spreading of peat is, therefore, continuous and automatic, but unlike the Anrep system, the peat is spread parallel to the direction of travel. With the Anrep system the peat is spread at right angles to the direction of travel of the excavating element. As a result, the Moore system requires a much greater length of working face than the Anrep system, in order to lay its full season's production on the field, but the number of men required to operate it to full capacity is very much less than the full complement of men required to operate the Anrep system.

OPERATION OF PLANTS DURING THE SEASON 1920

Both plants were operated during the entire season, although not continuously, the Anrep plant being operated on that portion of the field which had been prepared several years, and which, consequently, was in the best of condition for manufacturing peat fuel to advantage. The Moore plant, on the other hand, was operated on that portion of the bog lying adjacent to the C.P.R. tracks which had not been drained, and was, therefore, inferior to the other portion of the field. This handicapped the Moore machine very seriously; but it was the desire of the Peat Committee to give the Anrep unit every possible advantage in order to prove its value, since it was of standard design as regards the principles employed in excavating and spreading, and it was contemplated that the Moore machine would require a great many alterations before it could be put in working order. Notwithstanding the great handicaps under which the Moore plant operated, it became manifest early in the operations that this plant would not have to be seriously altered in order to put it into good working shape.

Fuel manufactured.—Between 5,000 and 6,000 tons of standard peat fuel were produced during the season of 1920, the major portion of which was sold to householders in Ottawa, Peterborough, and other towns, and a certain portion sold for commercial purposes.

RESULTS OF INVESTIGATION UP TO DATE

Although it is not possible for the Peat Committee to state that peat fuel can or cannot be manufactured on an economical commercial basis, as a result of the investigation so far conducted, the Peat Committee can definitely state:—

1. That the Anrep plant, as it stands, is in no sense commercial.
2. That the Moore plant under certain conditions can be employed commercially for the manufacture of peat fuel.
3. That the Anrep excavating element is the superior of the two, and the logical one to employ; while
4. The Moore spreading system is far more efficient, and is the logical spreading system to employ.

The main difficulty with the Anrep machine is the high cost of labour involved in the spreading system, and the large amount of time lost in changing tracks and in delivering a continuous supply of peat to the field, resulting in reduced capacity. The main difficulty with the Moore system is the excessively long working face which is required, an inherent difficulty which prevents this type of machine from being employed intensively on a bog of average dimensions.

In order to manufacture peat fuel on a large commercial scale during the comparatively short working season it is absolutely essential that the bog be worked intensively, that is to say, the largest number of units must be employed. This can only be accomplished by employing an excavator of the Anrep type combined with a spreading system of the Moore type, and, moreover, it is essential that all the manufacturing units be driven by electric motors supplied with current generated in a central station, which will effect a further reduction in costs.

RECOMMENDATIONS OF THE PEAT COMMITTEE

On the strength of the concrete results which the Peat Committee now have on hand, and after very careful consideration of these results, they recommend that the Anrep excavating element, which requires no alteration, and which is in as perfect condition as it is possible to put it, be combined with the Moore spreading system. This spreading system, in order to meet the requirements of the Anrep machine, will have to be specially designed, inasmuch as the bridge work necessary to support the belt conveyer, will be some 850 feet long, it will move at right angles to the direction of travel of the excavator, and lay peat in 800 feet rows. The designs for this new spreading system have already been thoroughly worked out, and are sufficiently complete to be placed in the workshop for fabrication. With this new element, the Anrep excavator can be operated at full capacity throughout the working hours, and deliver pulped peat continuously to the field spreader, which will lay down peat in a direction parallel to the belt conveyer. While no attempt will be made to describe this transportation system, in detail, it is necessary to point out that the design of the new system required a large amount of work and expert advice, and in order to reduce chances of failure to as great a degree as possible, the Peat Committee enlisted the expert opinion of engineers and companies who had experience in belt conveying systems used for various purposes.

It is also the intention of the Peat Committee to operate the Moore plant as it stands, continuously throughout the season of 1921, on a strictly business basis, with the minimum complement of men, and without the attention of the expert engineering staff. This plant, thus operated, will serve as a demonstration to those interested in the manufacture of peat fuel, and will also enable exact figures as to cost of manufacturing, harvesting, etc., to be obtained.

It is imperative that the combined plant above mentioned be erected, mechanically tried out, and commercially demonstrated, before the Peat Committee can offer a definite opinion regarding the general feasibility of manufacturing peat fuel on a commercial scale in Canada; but it must be understood that even though the equipment is placed on the field early next season, it will be absolutely impossible to more than operate it to determine weaknesses and changes which may have to be made in the design, and to give it a thorough mechanical test, at the same time, of course, manufacturing a small quantity of peat fuel The *commercial* demonstration of the combined plant cannot possibly be made until the following season, and its commercial feasibility may not be determined even at its conclusion; but the Peat Committee have every reason to believe that the demonstration which will have to be conducted during the season of 1922, in order to demonstrate the commercial feasibility of the new plant, will afford sufficient data to enable the Peat Committee to decide definitely whether or not peat fuel can be manufactured on a commercial basis, at a profit, under the average conditions existing in Canada at the present time.

In addition to the above programme of work, the Peat Committee has constructed a small peat machine which can be operated to advantage with two men and a boy, or say three men, by farmers or groups of farmers, for the purpose of supplying a cheap and satisfactory fuel for their own immediate use, or for the use of the inhabitants of villages and small towns. This machine is already constructed, and is partially erected, and its utility for the purpose for which it was designed can be determined without difficulty in a very short time. This part of the work will proceed along with the other.

The problem, therefore, with which the Peat Committee is confronted, and which it is hoped will be solved at the conclusion of the season of 1922, resolves itself, principally, into the design of a machine which will be capable of manufacturing a large quantity of peat during a comparatively short working season, with the minimum employment of manual labour, and at a cost which will permit the fuel so manufactured to compete with coal at ruling prices. The present day conditions which the Peat Committee have to meet are: (1) greatly increased labour costs—twice, and in certain cases three times what they were prior to the war—and (2) greatly increased cost of materials and machinery for general plant employed. These costs have mounted to two and three times what obtained prior to the war. These conditions, coupled with an unstable labour market, and great difficulty in getting plant fabricated and delivered at the required time, are mainly responsible for the time absorbed in the investigation, and have severely handicapped the Peat Committee's efforts.

OTHER METHODS TRIED IN THE MANUFACTURE OF PEAT FUEL

Since there are to-day, a great many people who still believe that it is possible to manufacture peat fuel continuously, by employing processes different from the one which the Peat Committee is demonstrating, it may be of interest to briefly state efforts which have been made to lengthen the manufacturing season and make the manufacture of peat fuel more or less continuous. It has been appreciated by all investigators, who have devoted their attention to the manufacture of peat fuel, that the development of the peat resources of the world would be greatly enhanced if peat operations could be conducted throughout the twelve months of the year instead of being limited to the summer season, and with this object in view, the possibility of separating the large quantity of water from the raw peat by pressure or by artificial drying, and then briquetting the residue obtained, *was thoroughly investigated.* These investigations have been conducted by the ablest men in European countries, and a very large amount of money has been expended and lost in the various attempts which have been made to adapt such processes to the manufacture of peat fuel. Despite the fact that the ablest investigators in peat devoted their entire attention to this problem, all such attempts have utterly failed. To-day, therefore, the only economic process which exists for the manufacture of peat fuel is that which depends upon the forces of nature for the removal of the large quantity of water contained in the raw peat, hence this is the only process which is being operated commercially in the peat-using countries of the world. This process is, moreover, the result of all the efforts which have been made by investigators, for a period covering more than a century, to utilize peat for fuel purposes.

The Peat Committee is not attempting to alter this process itself, but is endeavouring to conduct the various operations required in the process in a more economical manner than appears to be necessary at the present time in Europe. When the labour costs in European countries becomes as serious a factor as it is on the American continent—if it is not already as serious—then the peat-using countries of Europe will have to turn to Canada for information, instruction, and assistance concerning the manufacture of peat fuel. A very large amount of money, approximating several million dollars, has also been expended and wasted on various attempts made for manufacturing peat fuel in Canada, which involved the pressing of water from peat or its separation by artificial heat, and it is needless to state that all such attempts have absolutely failed because they were based on wrong principles. The British Isles have also suffered the loss of large amounts of money through similar futile attempts; for example, the amount of money which has been expended in exploiting the Ekenberg wet carbonizing process for the manufacture of peat fuel has amounted to over two million pounds sterling, and the Peat Committee has been recently notified that this process, developed at such an enormous cost, is also at the present day a failure.

While the Peat Committee place themselves on record as stating that the air-dried peat machine process is the only economic one known to-day, it desires it to be understood that improvements in the process of converting peat into a fuel for both domestic and industrial purposes may be greatly improved some time in the future. It is even within the realm of possibility that at some distant date peat fuel may be manufactured continually, or at least the length of the manufacturing season extended; but such improvements have not yet come to light; and if our peat resources are to be turned to the use of man at the present time, the only process which can be employed is that which makes use of the forces of nature for the removal of the water content. It is significant, that although the peat-using countries of Europe, namely, Ireland, Scotland, Norway, Sweden, Denmark, Holland, Germany, Russia, Italy, and other portions of the European continent, have been manufacturing peat fuel from their peat bogs for more than a century, Dr. Purcell, peat investigator for the British Fuel Research Board, made the following statement last year:—

"That the Fuel Research Board were convinced of the value of the work being carried out here is, I think, evident from the fact that they have sent me to Canada specially to report on the work carried out at Alfred. I have now spent some time at Alfred and I think it is only right that I should say that in my opinion the work carried out there is in advance of any work which to my knowledge has been done elsewhere."

Dr. Purcell is an independent investigator, and is thoroughly acquainted with the work which is being done along this line on the European continent. His opinion, therefore, carries great weight.

THE MANUFACTURE OF PEAT IN FOREIGN COUNTRIES

It may be of value here to state that the peat-using countries of Europe are, like Canada, handicapped by a short manufacturing season, yet, in spite of the short season, a very large portion of the fuel requirements of certain of the European countries is supplied by peat fuel; for example, 60 per cent of the fuel requirements of Ireland are supplied by the manufacture of hand-cut, air-dried peat fuel, while in Denmark alone the annual production of peat fuel is estimated at over a million tons. Sweden similarly produces large quantities of peat fuel; in fact, uses peat powder as a fuel on one of her state railways. Before the war, Russia manufactured very large quantities of peat fuel, according to some authorities as high as six million tons; and other European countries, notably Holland, Germany, and Italy, use peat fuel in industrial plants as well as for domestic purposes. It is, therefore, reasonable to assume that under similar conditions, Canada could manufacture sufficient peat fuel to very largely decrease the quantity of coal which it is now necessary to import annually.

COST OF MANUFACTURING PEAT FUEL

Inasmuch as the Peat Committee's investigation is not in any sense complete, and that certain essential data have not yet been determined, it is not advisable to state an estimated cost of manufacturing a ton of peat fuel based largely on assumptions. The cost of manufacturing peat fuel can, therefore, only be definitely stated at the conclusion of the investigation.

(Signed) **B. F. HAANEL,**
Secretary, Peat Committee.

OTTAWA, ONT., January 26, 1921.