GYPSUM IN CANADA

ITS OCCURRENCE, EXPLOITATION AND TECHNOLOGY

L. H. COLE

MINES BRANCH
DEPARTMENT OF MINES
OTTAWA
1915
No. 245

Lower quarry, Newport Plaster Mining and Manufacturing Company, Avondale, N.S.

CANADA
DEPARTMENT OF MINES
HON. LOUIS CODERRE, MINISTER; A. P. LOW, LL.D., DEPUTY MINISTER

MINES BRANCH
EUGENE HAANEL, PH.D., DIRECTOR.

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BY

L. H. Cole

OTTAWA
GOVERNMENT PRINTING BUREAU
1913

No. 245

Dr. Eugene Haanel,
Director of Mines Branch,
Department of Mines,
Ottawa.

OTTAWA, July 11, 1913.

Sir,

I beg to transmit, herewith, a report on gypsum in Canada: its occurrence, exploitation, and technology.

I have the honour to be,
Sir,
Your obedient servant,
(Signed) **L. H. Cole.**

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GYPSUM IN CANADA:
Its Occurrence, Exploitation, and Technology.

INTRODUCTORY.

The gypsum industry of Canada is one of the more important non-metallic mineral industries of the country, and one of which very little descriptive literature is available. The Mines Branch of the Department of Mines, in 1911, issued a report on the gypsum deposits of the Maritime Provinces. Previous to this, the only descriptions of the gypsums of Canada were to be found as incidental references in the reports of the Geological Survey; the Statistical Division of the Mines Branch, Department of Mines, and the various provincial Bureaus of Mines. The present report deals with the gypsum deposits of the whole of Canada. The field work was carried on during the summers of 1911 and 1912, and visits were paid only to those districts where actual operations are being carried on, or which are near enough to transportation and large markets to give promise of being opened up in the near future.

Brief descriptions only of the geology of the different districts have been given to enable one to obtain a clear idea of the properties. Questions of the origin of the different deposits have not been discussed. Special attention has been paid to the mining and quarrying of the material, and its manipulation and manufacture after it reaches the mills. An endeavour has been made to give some idea of the present condition of the industry, and also of the prospects for future trade.

The report is divided into three parts.

Part I deals with general matters relating to gypsum, its properties, theories of origin, and a brief review of the gypsum statistics of Canada, with a few remarks on the trade conditions.

Part II covers the detailed descriptions of the different occurrences in Canada, and of the plants in operation.

Part III takes up the technology, and uses of the mineral.

During the year 1912 nineteen companies were engaged in the quarrying or mining of gypsum in Canada. Nine of these companies produced crude gypsum only, most of which was exported to the United States for manufacture into the finer grades of plaster of Paris. During the early part of 1911 there were six calcining plants in Canada, operating, in all, thirteen kettles. At the close of the same year two new plants started, and two companies, already operating, have enlarged their plants, so that eighteen kettles are now running. One plant is using Cummer kettles as preliminary driers, preparatory to calcining in kettles, and two plants are using other types of driers. In three cases the gypsum was obtained from mines and the rest from quarries. The material, in all cases but one, was gypsum rock, either white or grey. The single exception was the small production from British Columbia, which was a high grade gypsum earth.

The gypsum industry of Canada consists, chiefly, in quarrying the crude gypsum, and in shipping it in that state to the United States. There it is calcined, and, in part, shipped back to Canada as a finished product. The industry on the whole is gradually increasing, but, as regards the extent to which calcining is at present carried on in Canada, there is still ample opportunity for growth. Even with the mills already operating at their full capacity, there is still considerable quantity of the finished product being imported from the United States.

It is only recently that any endeavour has been made to place the advantages of the hard wall plasters before the public; yet, by demonstrating the method of application of these plasters, and by means of advertising pamphlets describing their adaptability for different uses, the producers could readily increase the volume of their sales. Concerted effort along this line by all the producers manufacturing in Canada would greatly benefit the industry.

The following reports and articles, dealing with gypsum, have been freely consulted. Wherever quotations have been taken from them, credit has been given:—

Grimsley's "Michigan Gypsum."

Eckel's "Cements, Limes and Plasters."

Wilder's "Iowa Gypsum."

"Gypsum Industry of United States."

The thanks of the writer are due to the several managers of the properties visited, for their many courtesies and kindnesses, for the information, in most cases readily furnished, referring to their mills and processes, and for their revision of the manuscript of this report which deals with their own properties.

PART I.

GYPSUM AND ITS ASSOCIATED MINERALS. THEORIES OF THE ORIGIN OF GYPSUM.

PART I.

CHAPTER I.

GYPSUM AND ITS ASSOCIATED MINERALS.

The value of gypsum as a commercial commodity has been known from the time of the ancient Egyptians.

The origin of the word gypsum is somewhat obscure. It is supposed to have been derived from the Greek. Suffice it to say that the mineral gypsum was known to, and mentioned by many of the classic writers, such as Theophrastus, and Pliny.

Gypsum is found in many countries, particularly England, Italy, Switzerland, France, Sicily, United States, Newfoundland, Canada, and some of the South American republics.

The term "plaster of Paris", or calcined gypsum, was mainly applied to it because gypsum is mined in large quantities in the Tertiary deposits at Montmartre in the Paris basin, France. Under this name it was known in England as early as the thirteenth century.

In some countries the calcined gypsum is called stucco; in others, calcined plaster, or plaster.

To-day, plaster is revolutionizing the industrial arts. It is one of the best known fire resisting materials for building purposes, and its varied uses are being constantly enlarged.

Chemical Composition.

The mineral gypsum, when pure, is a hydrous calcium sulphate, having the chemical formula $CaSO_4.2H_2O$. This formula corresponds to the following when reduced to its final components:—

$$\text{Gypsum } (CaSO_4\ 2H_2O) = \begin{cases} \text{Lime sulphate } (CaSO_4) = 79\cdot1\% = \begin{cases} \text{Lime } (CaO) = 32\cdot5\% \\ \text{Sulphur trioxide } (SO_3). = 46\cdot6\% \end{cases} \\ \text{Water } (H_2O) = 20\cdot9\% = \text{Water } (H_2O) = 20\cdot9\% \end{cases}$$

It is very seldom that gypsum as pure as this is found in nature; for impurities such as clay, limestone, dolomite, iron compounds, silica, etc., are generally present in varying quantities.

Gypsum crystallizes in the monoclinic system, typical forms of which are shown in Fig. 1. The cleavage of gypsum parallel to its principal

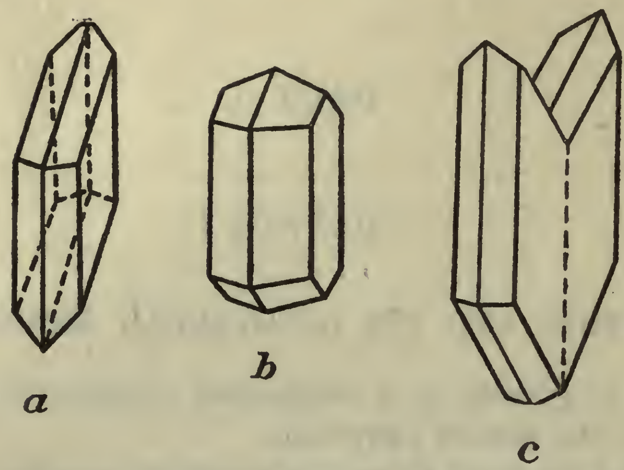

Fig. 1. Forms of gypsum crystals: *a*, *b*, common; *c*, twinned.

plane is very distinct. It separates into thin sheets along the cleavage planes, and, on this account, is often confused with mica; but it can readily be distinguished from the latter, since gypsum is flexible only to a limited degree, and not elastic.

Pure gypsum is white, and when in the crystalline form is transparent or translucent. The commercial material, as mined, is often grey, yellow, or flesh red, while in some cases, it is a very pale shade of blue. Impurities affect the translucency, and where these are present, to any extent, the colour may often be brown, red, reddish-brown, or black. In the crystalline form some of the faces have a pearly, others a subvitreous lustre. The massive varieties are sometimes glistening; varying to a dull, earthy appearance.

Gypsum is very soft, and this is one of the easiest means of distinguishing it from other minerals such as calcite, limestone, etc. It occupies the position of No. 2 on Moh's scale of hardness; and can be easily scratched with the fingernail.

Gypsum is soluble in hydrochloric acid; but does not effervesce. It is also soluble in 400 to 500 parts of water. The specific gravity of the pure mineral is from 2·30 to 2·33: that is, one cubic foot of gypsum is 2·3 times as heavy as one cubic foot of water.

Gypsum occurs in several varieties, usually classified as follows:—

(i.) Crystallized, foliated, transparent, variety selenite.

(ii.) Fibrous, and when fibres are long, satin spar.

(iii.) Rock gypsum or massive gypsum, in which the crystals are very minute, sometimes even microscopic.

(iv.) Gypsite, gypsum earth, or gypsum sand.

The following is a brief description of the mineralogy of the series:—

(i.) Gypsum, in the crystalline form, is called selenite, and is generally colourless and transparent, or translucent. When found in large folia or sheets it was sometimes employed, in ancient times, as a substitute for window glass.

(ii.) The fibrous variety is generally found in small narrow veinlets or seams, either in deposits of massive gypsum, or in the wall rocks adjacent to these deposits; but is never found to any great extent in this form.

(iii.) Rock gypsum, or massive gypsum, is the most frequent form in which the mineral is found in nature. It is in this form that most of the workable deposits are discovered. The massive variety is generally white and opaque, and occurs interbedded with sedimentary rock. When it is very fine-grained, and translucent, it is sometimes utilized for statuary, and is known as alabaster; a name that is, unfortunately, frequently used to denote calcareous rock, traverine, and stalagmite.

(iv.) Gypsite, or earthy gypsum, occurs in several forms in nature, and is sometimes found in sufficient quantity to form a workable deposit. It is, generally, a very desirable deposit to possess, on account of being easily mined, due to its being either in a sandy or earthy condition, or else very lightly cemented, and also because the deposits are usually near the surface. Many of these deposits are, however, very impure and consequently not available for plasters or for use in the finer arts.

Anhydrite.

Closely associated with gypsum in many of the deposits of this rock, the mineral anhydrite is to be found. It is calcium sulphate with the formula of $CaSO_4$, the same formula which dead burned gypsum has. If present to any considerable extent in gypsum, used as a plaster, it has the same injurious effect which the presence of so much dead burned gypsum would have, by retarding the setting of the plaster and weakening its tensile strength. By absorbing two parts of water it turns into gypsum, and this is supposed to be one of the actions occurring in nature, resulting in the formation of beds of gypsum from anhydrite, in which condition the rock was first deposited.

Several associated minerals are found in regions where there are gypsum deposits, such as the salts of sodium and potassium, and also sulphur in various forms.

CHAPTER II.

THEORIES OF THE ORIGIN OF GYPSUM.

There are several varieties of gypsum deposits, all of which have not had the same origin. Different theories have been advanced to account for their origin, some of which are generally accepted as being applicable each to its special type of deposit. The different theories have been roughly tabulated according to the method of formation of the deposits:—

a. Deposition from solutions:—
  (1) From sea water.
  (2) From rivers.
  (3) Vein deposition.
  (4) Hunt's chemical theory.

b. Produced by alteration either of material in place, or otherwise:—
  (1) From anhydrite.
  (2) By the action of sulphur springs and volcanic agencies on carbonate of lime.
  (3) By the action of pyrite on carbonate of lime.

c. Gypsum earth.

d. Gypsum sands.

Depositions from Solutions.

a—(1) Deposition from Sea Water.

The theory most generally accepted for the origin of all the larger bodies of gypsum is the theory of deposition from sea water by evaporation.

Sea water, according to the analyses in the Challenger reports, and quoted by the United States Geological Survey reports, contains 3·5 per cent of mineral salts in solution, according to the following table:—

	Per cent.
Sodium chloride (salt)	77·758
Magnesium chloride	10·878
Magnesium sulphate	4·737
CALCIUM SULPHATE	3·600
Potassium sulphate	2·465
Calcium carbonate	0·345
Magnesium bromide	0·217
Total	100·000

The calcium sulphate, however, is not precipitated until about 80 per cent of the water has evaporated. When a body of water is cut off from the ocean and evaporated, the calcium sulphate is deposited before the sodium chloride, which is not thrown down until 93 per cent of the water has been evaporated. Gypsum deposits are, therefore, more widely distributed than beds of salt, but in thinner beds.

To account for the great depth of many of the beds of gypsum that occur, a number of writers on this subject cite the Mediterranean sea as a present day example of the manner in which gypsum could be deposited from sea water. The depth at the Straits of Gibraltar being a great deal less than in either the Atlantic ocean or the Mediterranean sea, a partial barrier is formed between the two bodies. The flow of water from rivers into this sea, although considerable, is not sufficient to offset the rapid evaporation that is all the time taking place, and if the quantity of water from the Atlantic ocean which enters through the Straits of Gibraltar was greatly decreased it can readily be imagined that a deposition of some of the salts held in solution would soon take place. If this influx were regulated in such a manner as to maintain constantly the water of the Mediterranean at such a density that the calcium sulphate would be deposited, and the sodium chloride still held in solution, it can readily be imagined that a bed of gypsum would be formed and would keep on forming indefinitely. Similar conditions are supposed to have actually existed when some of the large gypsum deposits were formed. An arm of the ancient sea was shut off from the main body by a narrow channel with a barrier, and only sufficient water allowed to enter to keep the density of the inner body at a point at which the gypsum was deposited, while the sodium chloride was still kept in solution, and this went on for an indefinite length of time until at last the channel was closed, or in some way deposition was stopped.

a—(2) Deposition from Rivers.

Rivers, in some instances, are the means of forming deposits of gypsum. River waters, especially where they pass through deposits of gypsum, leach out and also carry away mechanically small quantities of gypsum, which is again deposited either at the mouth or on sand bars, where the current of the river is reduced. In these cases the deposits are very impure, and are of secondary deposition. A good example of this is afforded by the Grand river in Ontario, where small quantities of gypsum can be found on the sand bars in the lower stretches of the river below Cayuga.

a—(3) Vein Deposition.

Where cracks and fissures have occurred in gypsum-bearing rocks, and water has circulated along the bedding planes, some of the gypsum is dissolved and redeposited in these openings, thus forming veins. When formed in this way, it is generally in the form of fibrous gypsum or selenite.

In some cases these veins cut through the main bodies of gypsum, and are clearly seen to be of secondary origin. Large masses of selenite are probably formed in this way, due to the enlarging of the fissure by the force of crystallization.

a—(4) Hunt's Chemical Theory.

Hunt's chemical theory of the formation of gypsum is best given in his own words.[1]

"1. The action of solutions of bicarbonate of soda upon sea water separates, in the first place, the whole of the lime in the form of carbonate, and then gives rise to a solution of bicarbonate of magnesia, which, by evaporation, deposits hydrous magnesian carbonate.

"2. The addition of solutions of bicarbonate of lime to sulphate of soda or sulphate of magnesia gives rise to bicarbonates of these bases, together with sulphate of lime, which latter may be thrown down by alcohol. By the evaporation of a solution containing bicarbonate of magnesia and sulphate of lime, either with or without sea salt, gypsum and hydrous carbonate of magnesia are successively deposited.

"3. When the hydrous carbonate of magnesia is heated alone, under pressure, it is converted into magnesite; but if carbonate of lime be present, a double salt is formed, which is dolomite.

"4. Solutions of bicarbonate of magnesia decompose chloride of calcium, and, when deprived of their excess of carbonic acid by evaporation, even solutions of gypsum, with separation of carbonate of lime.

"5. Dolomites, magnesites, and magnesian marls have had their origin in sediments of magnesian carbonate formed by the evaporation of solutions of bicarbonate of magnesia. These solutions have been produced either by the action of bicarbonate of lime upon solutions of sulphate of magnesia, in which case gypsum is a subsidiary product, or by the decomposition of solutions of sulphate or chloride of magnesium by the waters of the rivers or springs containing bicarbonate of soda. The subsequent action of heat upon such magnesian sediments, either alone or mingled with carbonate of lime, has changed them into magnesite or dolomite."

In discussing this theory in a subsequent paper, Mr. Sterry Hunt says:—[2]

"Gypsum may thus be separated from sea water by two distinct processes—the one a reaction between sulphate of magnesia and chloride of calcium, and the other between the same sulphate and carbonate of lime. The latter, involving a separation of bicarbonate of magnesia, can, as we have seen, only take place when the whole of the chloride of calcium has been eliminated; and if we suppose the ancient ocean, unlike the present, to have contained more than an equivalent of lime for each equivalent of sulphuric acid, it is evident that a lake or basin of sea water free from lime-salts could only have been produced by the intervention of carbonate of soda. The action of this must have eliminated the whole of the lime as carbonate, or at least have so far reduced the amount of this base that the sulphates present would be sufficient to separate the remainder by evaporation in the form of gypsum."

Produced by Alteration Either of Material in Place, or Otherwise.

b—(1) By Alteration from Anhydrite.

Gypsum deposits are in some cases supposed to be formed from anhydrite ($CaSO_4$) by the taking up of two molecules of water. In this reaction an increase of volume of 33 per cent is caused and great pressure

[1]Hunt's Chemical and Geol. Essays, 1878, p. 90, also Quarterly Jour. Geol. Soc., Vol. XVI, p. 154, 1859.

[2]Chemical and Geological Essays, T. Sterry Hunt, p. 110, 1897. Am. Jour. Sci., March, July, Sept., 1865.

is obtained. This increase in volume and pressure is said to cause the hummocky contour characteristic of many of the gypsum areas. The change from anhydrite to gypsum is noticeable in a small way in many of the deposits in Nova Scotia and New Brunswick. Where the anhydrite is exposed to the atmosphere for any length of time it is soon coated with a thin film of gypsum.

b—(2) By the Action of Sulphur Springs and Volcanic Agencies on Carbonate of Lime.

Gypsum is deposited by thermal springs where it is formed by the action of acid dissolved in water on the volcanic tufa. The material acted upon is principally the carbonates of lime and magnesia, and the acid is sulphuric, formed from sulphurous vapours which have been oxidized. The gypsum formed in this way is carried to the surface by the ascending waters, and then deposited by the evaporation of the water, thus forming layers of gypsum either composed of fine crystals or of the fibrous variety.

Mr. F. A. Wilder in his report on the Gypsum of Iowa[1] says that small gypsum deposits occur around the fumaroles of craters and lava streams in Hawaii where sulphurous acid (SO_2) is converted into sulphuric and attacks rocks which contain lime.

According to Dana in his Manual of Geology, 1895, the origin of some of the gypsum deposits in New York State is accounted for by the action of sulphuric acid on beds of limestone in place. The acid is obtained from the sulphur springs by the oxidation of sulphuretted hydrogen, and this acid in solution passing through the cracks and bedding planes of the limestone acts on the carbonate of lime, changing it into gypsum.

b—(3) By the Action of Pyrite on Carbonate of Lime.

Many clay and shale deposits throughout the whole country contain either small flakes or else crystals of gypsum distributed through them. This gypsum is supposed to have been formed by the decomposing of the small quantities of pyrite or iron sulphide in the clay, and the resultant sulphuric acid acting on the carbonate of lime present forms gypsum. Where the climate is moist the gypsum is generally found evenly distributed in clusters of crystals throughout the clay, but where the region is dry these clays often show coarsely crystalline masses of gypsum on the outcrop, due to the leaching out of the gypsum in the body of the deposits and its being brought to the surface in solution and crystallizing out in large crystals on the evaporation of the water. Deposits of this nature are found frequently in the clays of western Canada, but are not of any economic importance.

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[1]Iowa Geological Survey, Vol. XII, p. 116.

c. Gypsite or Gypsum Earth.

Gypsite or gypsum in an earthy form is found in many places in the Western States and Canada. In all cases it is of secondary origin, and produced probably from gypsum deposits in place. Mr. G. P. Grimsley has advanced the following theory to account for the origin of this class of deposits:—

Spring Theory of the Origin of Gypsum Earth. (Grimsley).

"This theory of origin was first published by the writer in the Kansas report on Gypsum. The gypsum earth, then, must have been deposited in these places from solution. If from solution in surface streams, considerable sand and silt would have been carried in, and the chemical composition would vary in different parts of the mass. Further, as in most of these areas no gypsum is over the earth, the streams would have to bring the gypsum from long distances. Some sand, clay, lime carbonate, and organic material are shown by chemical analyses, and by the microscope, and these may be due to surface agencies. The water circulating through or near the underlying gypsum rock dissolved a portion of the rock and carried it upwards in the springs to the surface of the swamp, where the material was precipitated through evaporation, aided by the action of organic matter of the decaying vegetation.

A crust of gypsum would thus be formed and would increase in thickness until all the underlying rock was removed. Now, in some of these deposits, borings detect no gypsum below the deposits, but it is found in wells outside at a level below the earth. In such places probably all the gypsum rock adjacent to the gypsum earth area has been removed by solution. Again, by building up the swamp floor to a certain height, the rise of the gypsum water springs may have been checked so as to hinder the earth formation. Whatever the cause, the gypsum earth deposit is not now forming over the entire area in any appreciable amount.

The uneven thickness of the deposits, some varying from three to eight feet within the main part of the deposit, shows that the conditions were more favourable at certain points than at others. Possibly these thicker portions were nearer the outlet of stronger springs.

The deposits were formed in a comparatively short period of time. The presence of modern fresh water shells shows that the deposits were recent, formed long after the rock gypsum in the same region."

d. Gypsum Sands.

In the southern states a number of gypsum deposits are to be found in regions where wind erosion is very active. An example of this type of deposit is to be found in the white sands of southern New Mexico. This area is one in which the streams, and other surface waters, are highly impregnated with salts. The rapid evaporation of the district produces a deposit of these salts. The more soluble salts are redissolved, while the gypsum is disintegrated by wind erosion, and carried and accumulated, thus forming the white sands of the district.

PART II.

STATISTICS OF GYPSUM PRODUCTION.
OCCURRENCES IN CANADA.
GYPSUM IN NOVA SCOTIA.
GYPSUM IN NEW BRUNSWICK.
GYPSUM IN ONTARIO.
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GYPSUM IN BRITISH COLUMBIA.
ANALYSES OF CANADIAN GYPSUMS.

PART II.

CHAPTER III.

GYPSUM STATISTICS.

The gypsum industry of Canada is one of its oldest industries, and one in which it ranks high, being third in importance among the countries of the world.

Although known from the time of the first settlement of the Maritime Provinces, the first authentic recorded production is from Ontario about the year 1822. From this time the production has slowly but steadily grown to over half a million tons in 1910, and though there was a slight decrease in tonnage in 1911, the value of the product for that year was greater.

Nova Scotia, New Brunswick, and Ontario, for the early years, were the producing provinces. Manitoba entered the field in 1901, and ten years later—1911—witnessed the beginning of active operations in British Columbia.

The totals and details of production are shown in the tables following, which, except where otherwise noted, are taken from the annual reports of the Mineral Production of Canada.[1] The short ton of 2,000 pounds is used throughout, unless otherwise stated.

World's Production. The following table taken from the Mineral Industry of the United States shows that Canada is the third largest producer of gypsum in the world:—

TABLE I.

World's Production.

Year.	France.		United States.		Canada.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		$		$		$
1900	1,761,835	2,722,221	594,462	1,627,203	252,101	259,009
1901	2,182,229	3,449,747	633,791	1,506,641	293,799	340,148
1902	1,975,513	3,318,070	816,478	2,089,341	333,599	379,479
1903	1,798,508	3,134,891	1,041,704	3,792,943	314,489	388,459
1904	1,749,875	2,916,453	940,917	2,784,325	345,961	373,474
1905	1,414,596	2,343,943	1,043,202	3,029,227	442,158	586,168
1906	1,517,603	2,423,615	1,540,585	3,837,975	469,022	643,294
1907	1,559,685	2,598,828	1,751,748	4,942,264	485,921	645,914
1908	1,553,173	2,559,521	1,721,829	4,075,824	340,964	575,701
1909	1,460,271	2,426,110	2,252,785	5,906,738	473,129	809,632
1910	(a)	(a)	2,379,057	6,523,029	525,246	934,446

[1]Annual Rep. Min. Prod. Can. 1911, J. McLeish, Mines Branch, Dept. Mines.

TABLE I.—*Continued.*

World's Production.

Year.	Great Britain.		German Empire. (Bavaria)		Algeria.		Cyprus.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
		$		$		$		$
1900.....	233,002	348,210	39,103	17,199	41,446	139,190	....	....
1901.....	224,919	344,650	*b*35,013	23,139	38,955	132,286	7,784	17,041
1902.....	251,629	384,263	34,944	12,732	*c* 6,889	52,253	7,874	17,443
1903.....	246,282	337,391	34,054	19,145	31,967	105,040	11,591	28,796
1904.....	262,086	354,138	25,095	17,307	33,951	93,287	12,449	31,721
1905.....	286,169	400,717	50,978	19,660	38,297	98,420	17,890	42,499
1906.....	252,030	362,761	55,956	22,011	30,809	85,446	23,069	55,658
1907.....	263,779	431,313	53,985	17,456	29,101	75,907	27,114	68,146
1908.....	255,714	431,551	56,563	18,953	28,109	66,537	23,511	57,561
1909.....	267,676	418,242	56,911	19,254	31,967	75,656	12,230	29,754
1910.....	286,226	478,095	59,962	22,658	(a)	(a)	(a)	(a)

(a) Figures not yet available.
b Includes Baden. *c* Includes Tunis.

Canadian Production. The following four tables show the results of the gypsum industry in Canada up to and including the year 1912:—

TABLE II.

Year.	Total gypsum mined.	Gypsum calcined.
	Tons.	Tons.
1905....................................	443,569	26,855
1906....................................	492,759	28,831
1907....................................	489,962	34,752
1908....................................	375,444	48,727
1909....................................	493,086	63,670
1910....................................	548,019	69,889
1911....................................	515,979	76,718
1912....................................	549,856	133,392

By far the larger part of this production is shipped to the United States without crushing and in the crude state, and is there calcined. This fact is shown in the graphic table, Fig. 2, by the heavy dotted line. From 8,000 to 10,000 tons are annually ground and sold as land plaster, but the demand for this is gradually decreasing. An increasing amount of crushed uncalcined gypsum is each year being asked for by the cement producers for use in the manufacture of Portland cement. The remainder, amounting to about 12 per cent of the total mined, is handled by the Canadian mills and manufactured into plaster of Paris, wall plaster, and other products.

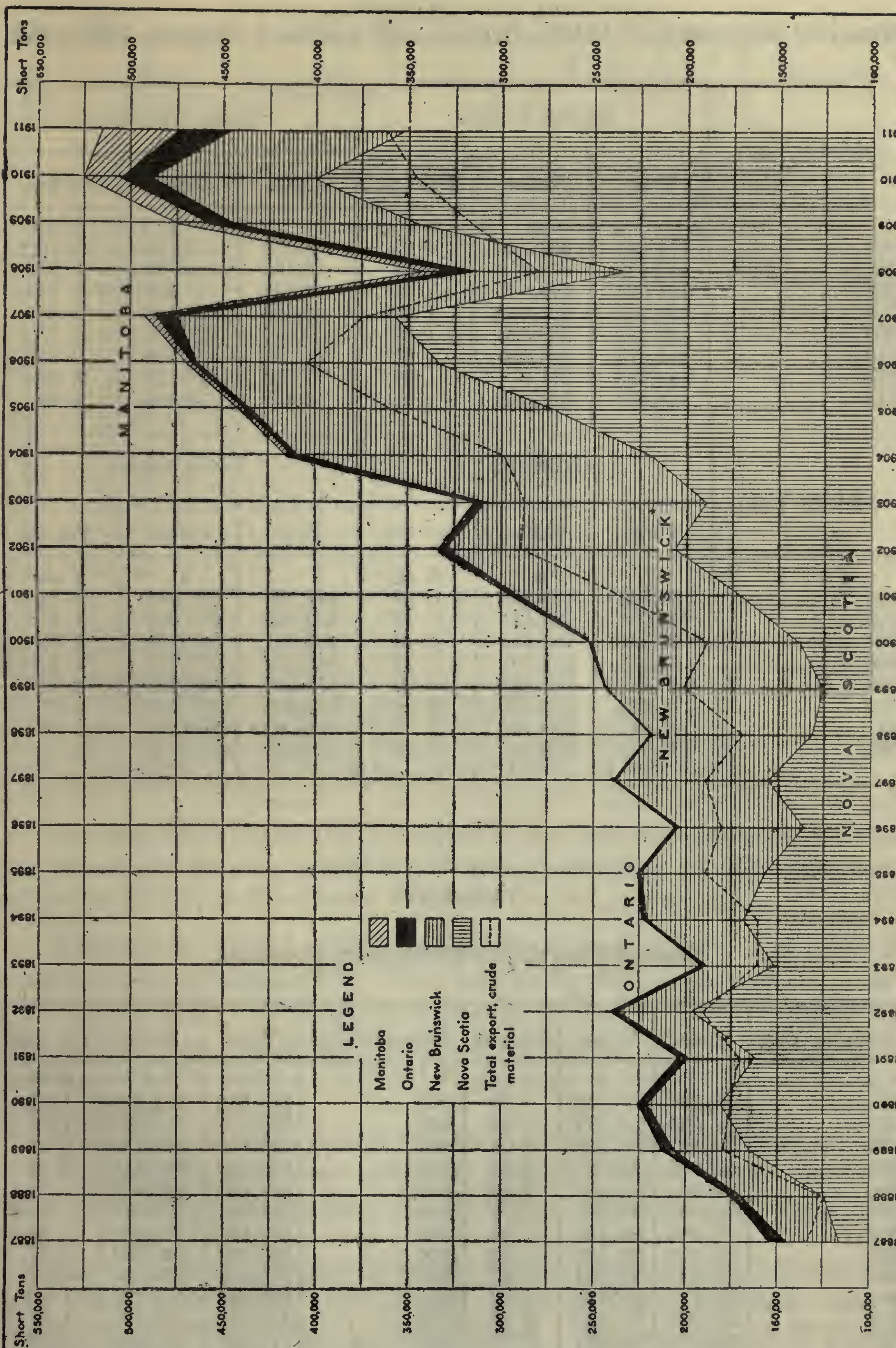

Fig. 2. Diagram showing twenty-four years' production by provinces.

TABLE III.

Sales and Shipments of Crude, Ground, and Calcined Gypsum, 1905-1912.

Calendar Year.	Crude (lump).			Crude (ground).		
	Tons.	Value.	Per ton.	Tons.	Value.	Per ton.
		$	$ cts.		$	$ cts.
1905	412,155	409,146	0 99	3,255	8,779	2 70
1906	442,132	473,960	1 07	3,195	9,823	3 07
1907	454,668	473,831	1 04	6,732	16,268	2 42
1908	298,188	307,532	1 03	9,504	25,468	2 68
1909	423,474	457,038	1 08	8,814	26,159	2 97
1910	469,573	508,686	1 08	6,121	17,390	2 84
1911	449,823	481,077	1 07	7,149	23,125	3 23
1912	453,577	525,345	1 16	15,487	29,244	1 89

Calendar Year.	Calcined.			Total sales.		
	Tons.	Value.	Per ton.	Tons.	Value.	Per ton.
		$	$ cts.		$	$ cts.
1905	26,748	168,243	6 29	442,158	586,168	1 32
1906	23,695	159,511	6 73	469,022	643,294	1 37
1907	24,521	156,815	6 40	485,921	646,914	1 33
1908	33,272	242,701	7 29	340,964	575,701	1 69
1909	40,841	326,435	7 99	473,129	809,632	1 71
1910	49,552	408,370	8 24	525,246	934,446	1 78
1911	61,411	489,192	7 97	518,383	993,394	1 92
1912	109,394	770,031	7 04	578,458	1,324,620	2 29

TABLE IV.

Annual Production of Gypsum Products.

Calendar Year.	Tons.	Value.	Per ton.	Calendar Year.	Tons.	Value.	Per ton.
		$	$ cts.			$	$ cts.
1886	162,000	178,742	1 10	1899	244,566	257,329	1 05
1887	154,008	157,277	1 02	1900	252,101	259,009	1 02
1888	175,887	179,393	1 01	1901	293,799	340,148	1 16
1889	213,273	205,108	0 96	1902	333,599	379,479	1 14
1890	226,509	194,033	0 86	1903	314,489	388,459	1 24
1891	203,605	206,251	1 01	1904	345,961	373,474	1 08
1892	241,048	241,127	1 00	1905	442,158	586,168	1 32
1893	192,568	196,150	1 02	1906	469,022	643,294	1 37
1894	223,631	202,031	0 90	1907	485,921	646,914	1 33
1895	226,178	202,608	0 89	1908	340,964	575,701	1 69
1896	207,032	178,061	0 86	1909	473,129	809,632	1 71
1897	239,691	244,531	1 02	1910	525,246	934,446	1 78
1898	219,256	232,515	1 06	1911	518,383	993,394	1 92
				1912	578,458	1,324,620	2 29

TABLE V.

Annual Production by Provinces.

Calendar Year.	Nova Scotia.		New Brunswick.		Ontario.		Manitoba.		British Columbia.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$		$
1887..	116,346	116,346	29,102	29,216	8,560	11,715	....	....	....	....
1888..	124,818	120,429	44,369	48,764	6,700	10,200	....	....	....	....
1889..	165,025	142,850	40,866	49,130	7,382	13,128	....	....	....	....
1890..	181,285	154,972	39,024	30,986	6,200	8,075	....	....	....	....
1891..	161,934	153,955	36,011	33,996	5,660	18,300	....	....	....	....
1892..	197,019	170,021	39,709	65,707	4,320	5,399	....	....	....	....
1893..	152,754	144,111	36,916	41,846	2,898	10,193	....	....	....	....
1894..	168,300	147,644	52,962	48,200	2,369	6,187	....	....	....	....
1895..	156,809	133,929	66,949	63,839	2,420	4,840	....	....	....	....
1896..	136,590	111,251	67,137	59,024	3,305	7,786	....	....	....	....
1897..	155,572	121,754	82,658	118,116	1,461	4,661	....	....	....	....
1898..	132,086	106,610	86,083	121,704	1,087	4,201	....	....	....	....
1899..	126,754	102,055	116,792	151,296	1,020	3,978	....	....	....	....
1900..	138,712	108,828	112,294	145,850	1,095	4,331	....	....	....	....
1901..	170,100	136,947	121,595	189,709	1,504	5,692	600	7,800	....	....
1902..	206,087	181,425	124,041	170,153	1,917	7,699	1,554	20,202	....	....
1903..	189,427	173,881	119,182	172,080	2,720	21,988	3,160	20,510	....	....
1904..	218,580	153,600	190,991	187,524	2,390	18,350	4,000	14,000	....	....
1905..	272,252	298,248	163,553	232,586	1,853	23,834	4,500	31,500	....	....
1906..	333,312	345,414	131,246	250,960	2,965	24,420	3,200	22,500	....	....
1907..	357,411	380,859	118,106	213,638	10,404	52,417	....	....	....	....
1908..	234,455	230,433	81,620	191,312	10,389	42,456	14,500	111,500	....	....
1909..	345,682	364,379	98,716	226,975	11,731	48,278	17,000	170,000	....	....
1910..	400,455	458,638	90,236	213,579	15,055	67,229	19,500	195,000	....	....
1911..	353,999	406,459	93,205	115,044	27,399	98,018	43,000	372,000	780	1,875
1912..	376,082	481,493	82,757	185,821	53,119	176,056	66,500	481,250	....	....

An interesting feature in this table is the fact that British Columbia has joined the list as a producing Province, shipping, in 1911, 780 tons, valued at $1,875, to Vancouver for use in cement manufacture.

Exports and Imports. Statistics of exports and imports of gypsum as compiled from the Reports of Trade and Navigation are shown in Tables VI, VII, and VIII. The exports of gypsum during the calendar year 1911 were 362,102 tons, valued at $425,161, or an average value of $1.17 per ton, as compared with exports of 346,081 tons, valued at $416,725, or an average of $1.15 per ton, in 1910.

There was also an export of ground gypsum in 1911 valued at $4,429, as compared with an export valued at $12,306 in 1910. The exports of crude gypsum since 1874 are shown in Table VI, and of ground gypsum since 1890 in Table VII.

The imports of gypsum during the calendar year 1911 totalled 32,234 tons, valued at $205,782, and included: crude gypsum 2,035 tons, valued at $11,792 or $5.79 per ton; ground gypsum 1,681 tons, valued at $3,619 or $2.15 per ton; and plaster of Paris 28,518 tons, valued at $190,371 or $6.68 per ton.

The imports during the calendar year 1910 totalled 38,006 tons, valued at $169,798, and included: crude gypsum 12,271 tons, valued at $21,073 or $1.72 per ton; ground gypsum 6,690 tons, valued at $13,242 or $1.98 per ton; and plaster of Paris 19,045 tons, valued at $135,483 or $7.11 per ton. The record given in Table VIII covers the fiscal year.

The imports of gypsum previous to 1905 were comparatively small. Since that year, however, the imports, particularly of plaster of Paris, have increased considerably. During the past six years the imports of plaster of Paris have increased from 6,000 tons to 28,500 tons per annum, whereas formerly the imports ranged from 150 to 720 tons annually. The imports classed as crude and ground have varied considerably, not only in quantity but also in grade of product, judging by the difference in average values.

Fig. 2 represents graphically the production of gypsum in Canada by provinces, and the heavy dotted line shows the large amount which is exported to the United States.

TABLE VI.

Exports of Crude Gypsum

Calendar Year.	Nova Scotia.		New Brunswick.		Ontario.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1874	67,830	68,164	....	....	....	....	67,830	68,164
1875	86,065	86,193	5,420	5,420	....	....	91,485	91,613
1876	87,720	87,590	4,925	6,616	120	180	92,765	94,386
1877	106,950	93,867	5,030	5,030	....	....	111,980	98,897
1878	88,631	76,695	16,335	16,435	489	675	105,455	93,805
1879	95,623	71,353	8,791	8,791	579	720	104,993	80,864
1880	125,685	111,833	10,375	10,987	875	1,240	136,935	124,060
1881	110,303	100,284	10,310	15,025	657	1,040	121,270	116,349
1882	133,426	121,070	15,597	24,581	1,249	1,946	150,272	147,597
1883	145,448	132,834	20,242	35,557	462	837	166,152	169,228
1884	107,653	100,446	21,800	32,751	688	1,254	130,141	134,451
1885	81,887	77,898	15,140	27,730	525	787	97,552	106,415
1886	118,985	114,116	23,498	40,559	350	538	142,833	155,213
1887	112,557	106,910	19,942	39,295	225	337	132,724	146,542
1888	124,818	120,429	20	50	670	910	125,508	121,389
1889	146,204	142,850	31,495	50,862	483	692	178,182	194,404
1890	145,452	139,707	30,034	52,291	205	256	175,691	192,254
1891	143,770	140,438	27,536	41,350	5	7	171,311	181,795
1892	162,372	157,463	27,488	43,623	....	....	189,860	201,086
1893	132,131	122,556	30,061	36,706	....	....	162,192	159,262
1894	119,569	111,586	40,843	46,538	....	....	160,412	158,124
1895	133,369	125,651	56,117	67,593	....	....	189,486	193,244
1896	116,331	109,054	64,946	77,535	....	....	181,277	186,589
1897	122,984	116,665	66,222	80,485	....	....	189,206	197,150
1898	99,215	93,474	70,399	81,433	....	....	169,614	174,907
1899	104,795	99,984	96,831	108,094	[1]½	12	201,626	208,090
1900	....	....	....	....	....	....	188,262	201,912
1901	....	....	....	....	....	....	236,247	231,594
1902	....	....	....	....	....	....	289,600	295,215
1903	....	....	....	....	....	....	287,496	311,580

[1]Exported from British Columbia.

TABLE VI.—*Continued.*

Exports of Crude Gypsum.

Calendar Year.	Nova Scotia.		New Brunswick.		Ontario.		Total.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
		$		$		$		$
1904	....	....	....	....	....	....	298,211	316,436
1905	....	....	....	....	....	....	359,246	388,474
1906	....	....	....	....	....	....	404,464	462,814
1907	....	....	....	....	....	....	375,026	424,794
1908	....	....	....	....	....	....	280,091	324,574
1909	....	....	....	....	....	....	315,201	372,286
1910	....	....	....	....	....	....	346,081	416,725
1911	....	....	....	....	....	....	362,102	425,161
1912	....	....	....	....	....	....	364,643	423,208

TABLE VII.

Exports of Ground Gypsum.

Calendar Year.	Value.	Calendar Year.	Value.	Calendar Year.	Value.
	$		$		$
1890	105	1898	6,448	1905	2,673
1891	588	1899	8,123	1906	2,934
1892	20,255	1900	19,834	1907	557
1893	22,132	1901	15,337	1908	9,765
1894	20,054	1902	5,101	1909	2,787
1895	22,233	1903	12,457	1910	12,306
1896	21,267	1904	2,333	1911	4,429
1897	6,763			1912	6,495

TABLE VIII.

Imports of Gypsum.

Fiscal Year.	Crude gypsum.		Ground gypsum.		Plaster of Paris.	
	Tons.	Value.	Lbs.	Value.	Lbs.	Value.
		$		$		$
1880	1,854	3,203	1,606,578	5,948	667,676	2,376
1881	1,731	3,442	1,544,714	4,676	574,006	2,864
1882	2,132	3,761	759,460	2,576	751,147	4,184
1883	1,384	3,001	1,017,905	2,579	1,448,650	7,867
1884	....	3,416	687,432	1,936	782,920	5,226
1885	1,353	2,354	461,400	1,177	689,521	4,809
1886	1,870	2,429	224,119	675	820,273	5,463
1887	1,557	2,492	13,266	73	594,146	4,342
1888	1,236	2,193	106,068	558	942,338	6,662
1889	1,360	2,472	74,390	372	1,173,996	8,513
1890	1,050	1,928	434,400	2,136	693,435	6,004
1891	376	640	36,500	215	1,035,605	8,412
1892	626	1,182	310,250	2,149	1,166,200	5,595
1893	496	1,014	140,830	442	552,130	3,143
1894	....	1,660	23,270	198	422,700	2,386

Crude gypsum, duty free. Ground gypsum, duty 15 per cent. Plaster of Paris, duty 12½ cents per 100 lbs.

TABLE VIII.—*Continued.*

Imports of Gypsum.

Fiscal Year.	Crude gypsum.		Ground gypsum.		Plaster of Paris.	
	Tons.	Value.	Lbs.	Value.	Lbs.	Value.
		$		$		$
1895.........	603	960	20,700	88	259,200	1,619
1896.........	1,045	848	64,500	198	297,000	2,000
1897.........	....	772	45,000	123	969,900	4,489
1898.........	1,147	1,742	35,700	293	329,600	2,025
1899.........	325	692	33,900	338	496,300	3,120
1900.........	77	958	6,300	69	849,100	6,492
1901.........	286	1,125	65,400	1,097	502,200	3,978
1902.........	541	1,697	56,700	249	475,300	2,641
1903.........	1,076	2,187	68,700	228	630,800	3,599
1904.........	249	663	106,800	559	625,100	2,885
1905.........	2,344	7,386	2,255,700	2,681	7,924,100	37,643
1906.........	6,332	22,008	1,968,600	1,799	12,866,500	43,742
1907 (9 mos.)..	9,189	23,410	609,600	1,619	19,849,400	58,364
1908.........	9,393	36,510	382,500	1,781	15,020,000	51,328
1909.........	10,317	35,268	6,286,200	5,765	17,009,000	64,849
1910.........	3,790	12,137	21,417,000	17,402	42,095,700	123,965
1911.........	12,500	22,872	13,764,300	12,298	38,562,800	135,837
1912.........	2,147	12,263	1,965,300	3,939	60,803,100	205,676

Crude gypsum, duty free. Ground gypsum, duty 15 per cent. Plaster of Paris, duty 12½ cents per 100 lbs.

The following list gives the duty on gypsum and its products coming into Canada.

	Rates of Duty.		
	Preferential.	Inter-mediate.	General.
764. Plaster of Paris or gypsum ground, not calcined, *bls*..................	10%	12½%	15%
765. Plaster of Paris or gypsum calcined and prepared wall plaster, *cwt*.....	8c. per 100 lbs.	11c. per 100 lbs.	12½c. per 100 lbs.

Free Goods.

Gypsum crude (sulphate of lime) is on the free list.

The present United States tariff on gypsum and gypsum products is defined in the following clause:—

"Plaster rock or gypsum, crude, thirty cents per ton; if ground or calcined, one dollar and seventy-five cents per ton; pearl hardening for paper makers' use, twenty per centum ad valorem; Keen's cement or other cement of which gypsum is the component material of chief value, if valued at ten dollars per ton or less, three dollars and fifty cents per ton; if valued above ten dollars and not above fifteen dollars per ton, five dollars per ton; if valued above fifteen dollars and not above thirty dollars per ton, ten dollars per ton; if valued above thirty dollars per ton, fourteen dollars per ton."

The United States tariff on gypsum was reduced in August, 1909, that on crude gypsum from 50 cents a ton to 30 cents a ton, and on ground or calcined gypsum from $2.25 per ton to $1.75 per ton.

During the first calendar year's operations under this reduced tariff, there was an increase of about 17 per cent in the shipments from Nova Scotia, but a decrease of about 16 per cent in the New Brunswick shipments, while during the same time the imports of plaster of Paris and ground gypsum into Canada were more than doubled.

The Gypsum Industry.

Large quantities of crude gypsum are being shipped at the present time from the Maritime Provinces into the United States, to be calcined and converted into plasters, etc. Canada thus loses the benefits accruing from their manufacture, and is forced to supply the deficit in home production by purchasing the higher priced material from the United States. The reason put forward by the exporting companies is, that up to the present time there has not been sufficient demand to warrant the erection of any more mills in that part of the country. Be that as it may, there appears to be ample opportunity for the starting of more mills in eastern Canada, as those already operating are being worked to their full capacity, and yet large quantities are being imported through the ports of Montreal and places farther east. For the finer grades of white plaster, such as dental plaster, and all grades of finishing plasters, there seems to be a rapidly growing Canadian market. With the increased demand for fireproof buildings, and the extensive building operations being carried on all over eastern Canada, there is bound to be a large demand for plasters which have gypsum as a base, and with increased facilities afforded for the eastern deposits by new railways, etc., there can be no doubt that the manufacturing end of the industry will steadily grow.

In western Canada, of late years, there has been a tremendous impetus to the building industry, and this has tended to increase greatly the demand for fireproof building materials, as the supply of lumber is so very limited. The following table from the Western Canada Contractor for May 1913, gives the values of building permits issued in the principal cities west of Port Arthur during the year 1912:—

Brandon, Man	$1,166,214
Calgary, Alta	20,394,220
Dauphin, Man	135,425
Edmonton, Alta	14,446,819
Fort William, Ont	4,211,285
Kamloops, B.C	559,703
Lethbridge, Alta	1,358,250
Macleod, Alta	200,500
Medicine Hat, Alta	2,836,239
Moosejaw, Sask	5,275,797
Nanaimo, B.C	321,422
Nelson, B.C	273,865
New Westminster, B.C	1,634,518
North Battleford, Sask	896,970
Oak Bay, B.C	1,138,051
Point Grey, B.C	3,004,815
Port Arthur, Ont	$2,494,179
Prince Albert, Sask	2,006,925
Red Deer, Alta	387,640
Regina, Sask	8,047,309
St. Boniface, Man	1,251,012
St. John (approx.), Man	650,000
Saskatoon, Sask	7,640,530
South Vancouver, B.C	2,550,000
Swift Current, Sask	791,014
Vancouver, B.C	19,428,432
Vernon, B.C	446,142
Victoria, B.C	8,208,155
Weyburn (9 mos.), Sask	766,660
Winnipeg, Man	20,475,350
Yorkton, Sask	735,966
Total	$133,083,207

Taking as a very rough estimate that the plaster used in all these buildings would represent 1·75 per cent of the total cost, this would mean that for 1912 there would be required $2,330,000 worth of plasters of different kinds. If half of this was hardwall or gypsum plaster, it would mean that over $1,000,000 worth would be used. In western Canada, during 1912, there was only $481,250 worth of gypsum products manufactured, so that well over half a million dollars worth either had to be imported from the western states or brought all the way from eastern Canada. This shows that there is a crying need for this gypsum product in the western provinces.

CHAPTER IV.

OCCURRENCES IN CANADA.

In order that some idea may be obtained of the extensive distribution of gypsum in Canada, the following chapter deals briefly with all the known occurrences in each province. Those deposits which are not at present of economic importance are given in more detail in this chapter than are the present working deposits, as the latter are taken up at greater length in the chapters relating to the different provinces.

Gypsum occurs in considerable extent in nearly every province of the Dominion. At present it is being developed in five of them.

NOVA SCOTIA.

Gypsum deposits occur widely distributed throughout this Province. Extensive deposits of economic importance are found and are at present being operated in the following districts or counties: Inverness and Victoria; Guysborough and Antigonish; Pictou, Halifax, and Colchester; Hants; and Cumberland. The mineral is found in beds, closely associated with anhydrite, and forms part of the strata of the lower Carboniferous series. The beds in many cases have a thickness of 100 feet. Details of these deposits, their extent, operations, and methods employed in mining and preparing the rock for market, can be found in the Report of Gypsum Deposits of the Maritime Provinces by W. F. Jennison, published by the Mines Branch.[1]

NEW BRUNSWICK.

The occurrences of gypsum in New Brunswick, although not as numerous as those of Nova Scotia, are, nevertheless, of considerable extent and furnish larger quantities of the white translucent variety of alabastine than those of the latter Province. The gypsum is found in beds and occurs in the lower Carboniferous measures. The principal deposits are found in the south of the Province in the counties of Kings, Albert, and Westmorland. Only one occurrence is known in the northern part of the Province, that being Plaster Rock, on the Tobique river, Victoria county. Further details concerning the industry in this Province are to be found in W. F. Jennison's report above referred to.[2]

[1]Bulletin No. 84, Dept. of Mines, Mines Branch, 1911, W. F. Jennison.
[2]Bulletin No. 84, Mines Branch, Department of Mines, 1911, W. F. Jennison.

QUEBEC.

The only gypsum deposits in the Province of Quebec are to be found in the Magdalen islands. These islands, which are situated in the Gulf of St. Lawrence, at a distance of 60 miles from Meat cove, Cape Breton, and 150 miles from Gaspé, consist of ten distinct islands. Similar in appearance and occurrence to the Nova Scotia deposits, these beds of gypsum form part of the measures of the lower Carboniferous. The principal deposits of economic importance are to be found on Grindstone, Alright, Amherst, and Entry islands.[1]

ONTARIO.

The mineral gypsum is to be found in two districts in the Province of Ontario.

In the northern part of the Province it has been noted to be present in considerable extent on the banks of the Moose river, between 30 and 40 miles south of Moose Factory. The beds most likely belong to the Onondaga series. These deposits have not, as yet, been developed, and it is probable that some time will elapse before any extensive work can be carried on because of the inaccessibility of the district and consequent lack of market.

The southern gypsum field in Ontario, and the only one in the Province from which material is being mined, lies almost altogether in the vicinity of the Grand river, from one mile above Paris in Brant county to a point a few miles below Cayuga in Haldimand. The gypsum occurs in the Onondaga formation, the beds being interstratified with beds of limestone, dolomite, and shale. Both these Ontario deposits will be dealt with at fuller length elsewhere in this bulletin.

The following extract taken from Dr. Robert Bell's report in the Geological Survey of Canada, 1863–66, page 178, indicates the presence of gypsum on the east end of Manitoulin island:—

> "Gypsum.—This mineral is said to occur in promising quantities on the east end of the island, about three miles south of Wequemakongsing, but as this information was only communicated to me as we were leaving the island, it was found impossible to visit the locality. In the same geological position, on the east side of West Bay, about a mile and a half from the Metch-je-wedchong, small quantities of gypsum occur in the limestone, near the junction of the Hudson River and Clinton formations."

No further reference is made to this deposit in any Survey reports, and no definite information as to its probable extent is at hand. It is quite possible, taking into account the formation and character of the rocks on this island, that a deposit of economic importance may be located and developed.

Reference is made in several of the Geological Survey Reports to the finding of crystals of gypsum in dolomite in several parts of Canada, but these are of no economic importance.[2]

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[1]See Bulletin No. 84, Department of Mines, Mines Branch, Ottawa, 1911, W. F. Jennison.

[2]Report of the Geological Survey of Canada, Vol. XIV, p. 101A. Report of the Geological Survey of Canada, Vol. II, p. 18R.

MANITOBA.

Gypsum is found in several places in Manitoba; one district is already producing and others may in the near future prove to be of economic importance.

The producing district lies in the northern part of the Province, about 10 or 12 miles in a northwesterly direction from Lake St. Martin. The deposits are of large extent, exposures being found over an area of about 8 square miles. Rumors of the discovery of gypsum on the west shores of Lake Winnipeg have been noted in the newspapers from time to time, but no definite prospecting for this mineral has been done in the district. To the southwest of the working deposits, and on the west bank of the Vermilion river about 20 miles from where it flows into Lake Dauphin, in a drill hole sunk by the Manitoba Oil Company in 1888, a bed of gypsum 15 feet in thickness was encountered at a depth of 550–565 feet.

In the southern part of the Province, a new discovery of gypsum was made during the summer of 1911. A syndicate of Winnipeg men, while drilling in the valley of a stream about 18 miles to the east of Dominion city, a small town on the Canadian Pacific railway, encountered a deposit of very solid, pure, white gypsum at a depth of about 325 feet. This deposit, as well as the deposits in the north which are being operated, will be referred to in detail elsewhere in this report.

ALBERTA AND MACKENZIE.

In the Province of Alberta, small deposits of gypsum have been noted from time to time by different parties of the Geological Survey. None of these are, however, easily accessible by railway, so for some time to come they will not be of any economical importance. Practically no development work has been done on any of them.

At La Saline, on the east bank of the Athabaska river, and 28 miles north of Ft. McMurray, a series of mineral springs occur, and the deposits from these contain small quantities of gypsum, besides salt, native sulphur, etc.[1]

Mention is made by Mr. Charles Camsell of the presence of gypsum at La Butte. He says:—

> "At La Butte, on the Slave River, 40 miles above Smith Landing, there is an outcrop of limestone associated with some gypsum and some mineral tar; but no fossils were found by which it could be compared with the exposures in the escarpment at the brine springs; lithologically and in their associations with beds of gypsum they appear very similar."[2]

A cliff of impure gypsum is to be seen on the banks of the Little Buffalo river about a mile or two south of the mouth of Lobstick creek. The gypsum here is found at the base of an escarpment consisting of bedded limestone. The general direction of this escarpment seems to be

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[1]Annual Report Geol. Survey of Canada, Vol. V, Pt. I, page 35D, McConnell.

[2]Annual Report Geol. Survey of Canada, Vol. XV, p. 167A, Charles Camsell.

northwest and southeast. Another exposure of gypsum, 20 feet thick, is to be found near the base of this same series of limestones, and situated about a mile to the south of the forks on Salt river.[1]

Along the Peace river, between Bouille rapid and Peace point, beds of gypsum are said to be seen from 10 to 15 feet in thickness, and blocks of gypsum, several feet in diameter, which are found on the Peace river above its confluence with Loon river, and on the Red river a few miles above its mouth, are supposed to come from this deposit and to have been carried up the valley of the Peace river by ice during the Glacial period.[2]

What appears to be the largest and most important occurrence of gypsum in the district to the north of the Province of Alberta is to be found at Bear Rock mountain, situated about a couple of miles to the west of Ft. Norman and at the junction of the Bear river with the Mackenzie river. Mr. McConnell describes this deposit as follows:—

"Bear Rock is separated from the main range and is built of limestones, quartzites and shales, bent into the form of an anticlinal. A small stream cuts deeply into the heart of the mountain and exposes a very good section. The lowest beds seen, consist of reddish and greenish shales, alternating with layers of pink coloured gypsum, and cut by numerous veins and seams of a white fibrous variety of the same mineral. The gypsum in part of the section replaces the shales almost altogether, and the layers are separated by mere films of greenish and reddish argillaceous material. The base of the gypsiferous shale was not seen, but they are at least several hundred feet in thickness. They are overlain by a series of dolomites, quartzites and limestones, six to seven hundred feet thick, and then by the bluish coral bearing limestones of the Devonian."[3]

Gypsum also occurs at the banks of the Great Bear river in several places where it is associated with the Devonian limestone, as well as on the east bank of the Mackenzie river, about half way between the Liard and Bear Lake river. The rock at this latter point consists of limestone, dipping at high angles, and cut by veins of gypsum.[4]

FRANKLIN.

In Dr. Dawson's report of 1887 the following reference to the occurrence of gypsum in Franklin district is made:—

"From the appendix to Parry's Third Voyage, we learn that in association with the limestone of the east side of Prince Regent Inlet, are subsidiary beds of gypsum. Gypsum also occurs on the west side of the inlet in North Somerset, where it is said to occur in beds several feet thick, extending for at least thirty miles through the country." (App. p. 147.)[5]

OTTAWA ISLANDS, LABRADOR PENINSULA.

Mention is made by Dr. Robt. Bell in the Geol. Survey Rep. of Can. Vol. I, p. 58A, of the occurrence of a small mass of gypsum in a loose fragment of rock, being noticed on one of the islands on which he landed.

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[1]Annual Rep. Geol. Sur. of Can., Vol. XV, p. 159A and 167A, Charles Camsell. Annual Rep. Geol. Sur. of Can., Vol. IV, p. 63D, McConnell.

[2]Ann. Rep. Geol. Sur. of Can., Vol. V, Pt. I, p. 64D, McConnell.

[3]Ann. Rep. Geol. Sur. of Can., Vol. IV, Pt. D, p. 101D, McConnell.

[4]Ann. Rep. Geol. Sur. of Can., Vol. II, Pt. R, p. 18R, Dawson.

[5]Ann. Rep. G. S., Vol. II, p. 45R, Dr. G. M. Dawson.

Base map Dept. of Interior

BRITISH COLUMBIA.

Gypsum is found in several places in British Columbia in deposits that will most likely prove to be of considerable economic importance as the country develops and railway facilities improve. One of these deposits is already producing, with the prospect of others being shortly added to the list.

To the north of Kamloops, about 20 miles distant and on the east bank of the Thompson river, a large deposit of gypsum can be distinctly traced for a long distance up the mountain side. It is within easy reach of the river.[1]

One of the first discoveries of gypsum in the Province of British Columbia was that of a deposit situated about 11 miles east of Grande Prairie, in the southern part of the Kamloops Mining Division. This gypsum occurs on the north side of the Vernon-Kamloops wagon road, and is about 26 miles in a northwesterly direction from the town of Vernon. Two exposures, about 1½ miles distant from each other, are to be seen on the hillside of the north bank of the Salmon river. Reference in detail will be made to this district elsewhere in this report.

Two exposures of gypsum occur on the hills forming the west bank of the Thompson river, immediately opposite Spatsum, a station on the main line of the Canadian Pacific railway, 189 miles northeast of Vancouver. These outcrops are located about 2,000 feet apart, and appear as large white masses which are visible for a long distance. Details regarding these deposits will be found in another part of this report.

The mineral gypsum is to be found on a property situated on the slope of a hill at a distance of about one-half mile north of Merritt, B.C., a town on the Nicola branch of the Canadian Pacific railway. This district is the only one at present making any shipments, and further reference is made to the deposits elsewhere.

Reports of the discovery of gypsum in the Tulameen district were noted in many of the western newspapers during the spring of 1911. A deposit outcropping along the banks of Granite creek, a small tributary stream which enters the Tulameen river, some 10 miles above Princeton, B.C., has lately been staked, and development work will soon be carried on to prove whether the property is of any considerable extent.

[1]Annual Rep. Geol. Sur. of Can., Vol. XVI, p. 593.

CHAPTER V.

GYPSUM IN NOVA SCOTIA.

The gypsum deposits of the Province of Nova Scotia are the largest of any at present known in Canada. Owing to their wide distribution and numerous outcrops, and the limited time at the disposal of the writer, only the actual deposits at present being worked could be visited. Complete descriptions have already been published, along with analyses of samples taken from all the exposures, in a report by Mr. W. F. Jennison, Bulletin No. 84 of the Mines Branch, Department of Mines.[1]

The gypsum in Nova Scotia, like that in New Brunswick, occurs in the lower Carboniferous formation and is closely associated with beds of anhydrite and limestone. In nearly all cases, the gypsum is found resting on beds of anhydrite or with lenses of this latter mineral enclosed in it. Where the quarries have been excavated to a sufficient depth the floors are generally anhydrite. The gypsum on the whole is massive and is a good quality of white rock. Selenite is found associated with the massive gypsum, sometimes in veins up to a foot in thickness, and sometimes as small crystals evenly disseminated through the massive material. The overburden is, in most of the deposits, of considerable thickness, making the problem of its removal one of great importance.

Numerous outcrops are encountered throughout the whole of the northern half of the Province, extending from the district in the neighbourhood of Windsor, Hants county, eastwards to the district around Antigonish, Antigonish county, and also throughout the northwestern half of the island of Cape Breton.

There are seven companies operating quarries in this Province. Of these, five ship the crude material direct to the United States there to be calcined, while the other two companies have calcining plants at which they treat all their production.

Descriptions of the several properties follow, taking them in order from east to west.

The Great Northern Mining and Railway Company, Limited.

The Great Northern Mining and Railway Company's mill and quarry are situated at Bellemarche, Eastern harbour, Cheticamp district, C.B. The gypsum area under lease consists of 3 square miles, and is estimated

[1]As this report is out of print the chapters dealing with the deposits in Nova Scotia, New Brunswick, and the Magdalen islands are attached as an appendix to this bulletin.

Mill and plant of the Great Northern Mining and Railway Company, Eastern Harbour, Cheticamp district, Cape Breton.

to contain several million tons of a very good grade of gypsum. The gypsum beds are inclined at an angle of 45° to the northwest, and are interbedded with beds of limestone. The lower bed is that in which the quarry of this Company is being operated. The Company was incorporated in the year 1907, and immediately commenced operations by erecting a mill for calcining the gypsum. Since then operations have been carried on continuously.

Quarry. The first quarry of the Company was in the hill directly behind the mill, but the grade of the rock obtained from this quarry was found to be poor, so that a second quarry (Plate III), the one at present being worked, was opened in the lower bed at a distance of one-fourth of a mile farther east from the mill. It is connected with the mill by a narrow gauge track with a falling grade, so that the loaded cars descend by gravity and are hauled back to the quarry by a horse.

The quarry has a face of gypsum 70 feet high with little or no overburden, so that the rock goes to the mill in a very clean condition. The percentage of loss in quarrying is, on this account, very low, being somewhere around 3 per cent. Occasionally mud seams are encountered, but as the walls of these are well defined they do not cause much trouble. The drilling is done by hand augers and the explosive used is 40 per cent dynamite. The broken rock is loaded by hand into one-ton cars and sent to the mill, the empties being hauled back to the quarry by a horse. A small hoist lowers the cars down the incline of 40 feet in length, where they are dumped into the hopper bin.

Plant. The mill and accompanying buildings of the Great Northern Mining and Railway Company are situated at the base of a hill, 3½ miles directly east of the village of Cheticamp, C.B. A general view of this mill is shown in Plate II. The plant consists of a calcining mill and power house, storage building 160′ × 75′ with a capacity of 4,000 tons calcined plaster, blacksmith shop, office, and several small buildings for general use.

Power Plant. Until the summer of 1912, the mill consisted of a one kettle unit with all the accompanying machinery, operated by electrical power, but during last autumn a second kettle unit was installed and an additional engine was placed in the engine room. This second unit is operated by steam power, the first unit being driven by electricity.

The original power plant consists of:—

Two 72″ × 18′ boilers of 150 horse-power each; one 16″ × 15″ Robb engine of 250 horse-power; one 125 K.W. generator direct driven from engine, with exciter; one 50 horse-power motor for driving shafting for rock breaker, rotary crusher, elevator to dryer, dryer and dryer fan; one 40 horse-power motor for shafting operating set of buhr mills, conveyers, and elevator to ground gypsum bins; one 40 horse-power motor for driving conveyer from hot pit and elevator to screens, conveyers above screens, screens, mixer, hair picker, barrel packer, and bolter; one 30 horse-power motor for driving kettle agitators; and one 5 horse-power motor for operating elevator to dried uncalcined gypsum bin.

The new power installation consists of one 15″ × 30″ engine, 120 r.p.m. of 200 horse-power, manufactured by F. X. Drolet of Quebec, with the necessary shafting to operate the whole of the second kettle unit.

Mill. The mill building consists of a two storey frame structure on concrete foundations, and contains the power plant as well as all the mill machinery.

The rock gypsum from the quarry is lowered down an incline in cars and dumped into the hopper bin above the crushers. From this bin it drops by gravity on the grizzly, the overs going to a Mogul jaw crusher, while what passes through the bars goes directly to a rotary crusher. The product from the jaw crusher is fed to the rotary crusher and the product from it is conveyed by an open belt elevator, provided with 12″ eight ply rubber belt, 12″ × 7″ malleable iron buckets, double belt pulleys, shafts, boxes and takeups complete, and delivered into a stock bin over the dryers. From this bin a No. 1 Triumph automatic feeder feeds the crushed gypsum from the stock bin into the dryer. The dryer or roaster is a Triumph direct heat rotary cylindrical dryer, 31 feet long and rotating at the rate of 7 r.p.m. set with a drop of ½″ in 1 foot. A complete drying of the gypsum is obtained in this machine. A steel cased dust tight elevator with 8″×5″ heavy malleable iron buckets delivers the dried material into a distributing screw conveyer which places it in two bins. From these bins it is fed by gravity to four 36″ underrunning gear driven French buhr mills manufactured by C.O. Bartlett and Co., Cleveland, Ohio, and to one Sturtevant vertical rock emery mill. A two way screw conveyer delivers the ground gypsum to a No. 14 steel cased elevator similar to that previously described. This elevator empties on another screw conveyer which feeds to two bins, one over each kettle. From these bins the gypsum is fed directly into the kettles. There are two kettles (10 tons capacity) each 10′ × 8′—3″, with solid cast iron bottoms. They are manufactured by Messrs. C. O. Bartlett and Snow of Cleveland, Ohio, and are fitted complete, with stack, brickwork, bevel gears, driving pulleys, agitators, furnace bed, etc. When the run is completed the hot material is allowed to slide through a door into two cooling pits lined with concrete and brick, with sloping bottoms. This construction of the cooling pits enables the calcined rock to run by gravity into a screw conveyer which carries it to an elevator, No. 14 steel encased, like the previous ones. This elevator delivers to a conveyer which in turn deposits the material on a two way conveyer, from each end of which it feeds into two Newago separators with two screens (60 and 80 mesh) each. A distributing screw conveyer conveys the material to a three compartment bin, from which it is taken to the Broughton mixer as required.

Face of quarry of the Great Northern Mining and Railway Company, Eastern Harbour, Cheticamp district, Cape Breton.

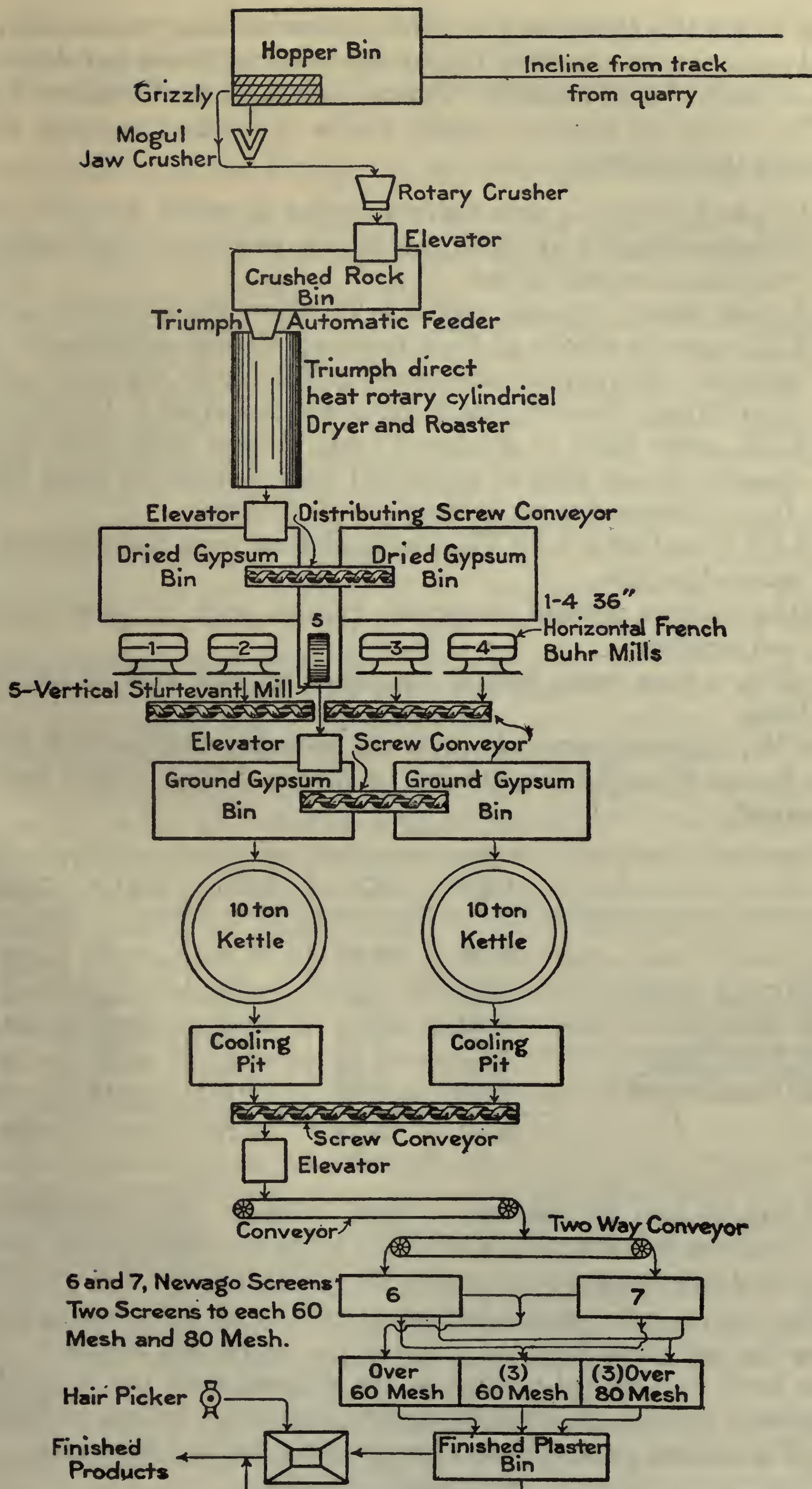


Fig. 3. Flow sheet of mill of Great Northern Mining and Railway Co., Eastern Harbour, Inverness Co., Nova Scotia.

A Day's hair picker on this floor prepares the hair for the mixer. A barrel packer is also placed on the ground floor, and it can be fed from the finished plaster bin as required. For the flow sheet of this mill see Fig. 3.

The Company prepares several grades of finished products among which are the following:—

Alba OX, wall cement, a pure calcined plaster to which has been added certain materials to retard the set for two hours, and containing the proper amount of hair.

Alba X, wall cement, a plaster similar to the above but containing no hair.

Alba XX, stucco, a plaster of Paris produced by the calcination of pure gypsum. It is not as finely ground as XXX, but the greater part will pass through 60 mesh, and it will commence to set in 15 minutes.

Alba XXX, white finish or plaster of Paris, a snow white pure calcined plaster, 90 per cent of which will pass through 80 mesh screen. It is guaranteed to set in from 5 to 10 minutes.

Alba XXXX, and Alba XXXXX, dental plasters, very finely ground and pure white; also

Alba land plasters, ground uncalcined gypsum used for farm purposes and fertilizer.

Terra Alba, a very finely ground uncalcined gypsum used in the paper trade.

In Mr. Jennison's report he gives the following analyses made for the Mines Branch Chemical Department, by Messrs. Milton Hersey and Co., of Montreal.[1]

	OX	XX	XXX	XXXX	XXXXX
Lime	39·19	38·87	39·45	39·29	39·34
Magnesia	tr	tr	tr	tr	0·09
Ferric oxide and alumina	0·04	tr	0·16	0·06	0·08
Sulphuric anhydride	54·80	55·19	53·96	54·95	54·33
Carbonic anhydride	0·96	0·91	1·07	0·61	.....
Water, loss on ignition	4·45	4·40	4·90	4·65	4·70
Insoluble mineral matter	0·18	0·36	0·16	0·16	0·16
	99·62	99·73	99·70	99·72	99·64

It will be seen by reference to these analyses, that the amount of water remaining is below what is generally taken as a theoretically calcined gypsum, but this does not seem to alter the setting qualities of the products.

The Company has a standard gauge railway 3½ miles in length connecting the mill plant with the shipping pier at Eastern Harbour. This railway hauls the finished product to the shipping dock and brings back the coal used for fuel. A 70 ton locomotive does all the hauling on this railway. The finished product finds a market in Quebec and Montreal.

[1]Bulletin No. 84, Mines Branch, Dept. of Mines, Ottawa.

The Company employs about 18 men in the quarry, 35 men in the mill, and 12 on the railway, making a total of 65 men.

The capacity of the mill is about 100 tons per day of 24 hours.

The Victoria Gypsum Mining and Manufacturing Company, Limited.

At St. Ann, Victoria county, C.B. (South Gut, Dist. No. 4), an extensive gypsum deposit is being operated by the Victoria Gypsum Mining and Manufacturing Company, Limited.

Two quarries have been opened and both are worked at the present time. The larger quarry, the one near which all the buildings of the Company are located, has a working face of over 80 feet in height at its highest point, and a length of about 300 feet. The present floor of the quarry is anhydrite, and no attempt has been made to ascertain whether or not gypsum is to be found beneath it. The overburden is very light and is easily removed by hand labour. The gypsum is of a soft variety, mostly white, with small patches of grey, and drills and breaks easily. Both hand augers and power drills are employed, and a low power of dynamite is used in breaking the gypsum. Radiating tracks are laid from the shipping platform in the centre of the quarry to all parts of the face, and small 1 ton cars handle the rock and dump directly into the railway cars or into small storage bins if the empty train is not waiting. The loss in handling the gypsum in this quarry is only about 4½ per cent.

The second quarry, about one-half mile to the west of the larger one, has only lately been opened up (See Plate IV B). The surface of the district is very uneven, and develops numerous sinkholes, consequently an even face has not yet been obtained. The gypsum obtained, however, is a splendid quality and small patches of pure translucent alabaster are sometimes encountered. The waste material taken from the stripping and sinkholes is being used to fill up a small marsh to the rear of the quarry, thus affording ample room for stock piles or railway accommodation. At the present time the gypsum excavated is carted in single horse Scotch carts to the nearest spur of the Company's railway and there loaded directly into cars.

The Company owns 4½ miles of track, 42″ gauge, and has two locomotives hauling the gypsum to the shipping pier located at Munro point, on St. Ann bay. The distances are 3½ miles and 4 miles respectively from the first and second quarries.

At the first quarry are located the Company's office, about 20 shacks and 20 dwellings for the men, a stable large enough to accommodate 15 horses, a large lecture hall, and a residence for the superintendent. A small powder shack is located at the second quarry.

An average of 175 men are employed throughout the whole year. The yearly output reaches 30,000 tons of crude gypsum, and this is shipped directly in steamers and barges to Chester, Pa., U.S.A.

The Newark Plaster Company.

The Newark Plaster Company, with head office at New York, is operating a small quarry for gypsum at Ottawa brook, Victoria county, about half a mile to the north of the Intercolonial railway and about 8 miles to the west of Grand Narrows. They hold under lease an area 6 miles long by 5 miles wide.

Considerable difficulty is experienced in this quarry owing to the extensive occurrence of sinkholes which prevent the Company from obtaining a working face of any size, consequently the quarry at the present time consists of a number of small working faces, none of which are more than 15 feet in height. Although the stripping is very light—about 15 feet—the clay and refuse from the sinkholes cause a large percentage of the gypsum to be thrown away, on account of the difficulty of getting it clean. Anhydrite is also being encountered in large lenticular masses throughout the gypsum, and this has to be sorted out by hand. The gypsum when obtained is of a splendid quality of soft white rock. It is possible that better conditions will prevail in the present quarry when greater depth is reached, and when the railway is extended to other parts of the deposits where the sinkholes are not so numerous.

The gypsum is drilled by hand augers, and black powder or rack-a-rock dynamite is used in breaking. The broken material is carted in one horse Scotch carts to a loading platform and dumped into cars of 2½ tons capacity. A narrow gauge railway, 3 ft. gauge, 40 pound rails, owned by the Company, affords easy handling to the Company's pier on the Bras d'Or lake, a distance of one mile from the present quarry. Automatic tipples empty the loaded cars into the vessels. Preparations are being made to replace the present wooden piers of this wharf by concrete, on account of the destruction of the piles by teredos.

The production from these quarries is about 3,000 tons each year, and the Company gives employment to 25 men.

Walton Quarry.

One of the oldest quarries in the Province is the quarry situated in Hants county, about a mile and a half south of the village of Walton, on the south shore of Minas basin. This quarry, which has been operated almost continuously for about 100 years, yields a compact variety of greyish white and blue gypsum. Anhydrite occurs in small lenticular masses throughout the whole deposit, but not in large quantities. The overburden is very light and can be readily removed by hand, thus making the shipping product very free from impurities. The loss in handling is only from 2 to 3 per cent. The face of the quarry is about 100 feet in height and a face of 400 feet in length is now exposed. All the drilling is done by hand, and a low power of dynamite is employed in breaking the rock. The broken rock is loaded into four wheel carts and hauled to the

A. Upper quarry, looking northwest, Newport Plaster Mining and Manufacturing Company, Avondale, N.S.

B. Western quarry, Victoria Gypsum Mining and Manufacturing Company, Ltd., St. Anns harbour, C.B.

shipping pier in Walton village, where it is either stored in stock piles or loaded directly on barges and shipped in the crude state to New York.

Mr. Albert Parsons, of Walton, is operating the quarry, and the whole of the product is bought by Messrs. J. B. King & Co., of New York, and transported by that firm in its own barges. The yearly output is in the neighbourhood of 25,000 tons. The quarry and loading pier give employment to an average of 35 men for 11 months in the year. The nearest railway station is Scotch Village, on the Dominion Atlantic railway, 15 miles to the south of Walton.

Cheverie Quarries.

To the west of Cheverie, a small village situated on the south side of Minas basin, about 6 miles east of the mouth of the Avon, an extensive gypsiferous area occurs, and quarries are being operated by Mr. Albert Parsons of Walton. Operations are carried on at two points, at Cove quarry and the Upper Head.

The Cove quarry extends from the shipping pier, southwards for 600 to 700 yards to the main road (See Plate V A). Numerous faces have been worked from time to time. The district is undulating and sinkholes are prominent, so that a continuous face of any great extent cannot be obtained. The face at present being quarried has a height of 40 feet and a length of 200 feet. An overburden of 15 feet of clay handicaps the work to some extent. At this place the gypsum has been undermined by water to such an extent that large caves are formed, and these natural openings have been utilized for tunnels to reach the gypsum which lies underneath the roadway. Anhydrite is found in the floor of the quarry, but it is probable that if tested a good quality of gypsum would be found underneath. The gypsum is drilled by hand augers and loaded into Scotch carts and hauled to the stock pile, where it is left and afterwards loaded into barges at the shipping pier beside the pile.

The Upper Head quarry is situated along the shore (See Plate V B) commencing at a point about one hundred yards to the east of the shipping pier and extending for several hundred yards in length. The gypsum is covered by an overburden of 10 to 15 feet of clay, and is closely associated with anhydrite and carbonate of lime. It is not as good a grade of rock as is obtained from the Cove quarry, but is easily broken and landed on the stock pile.

An average of 40 men are employed in these two quarries.

The Newport Plaster Mining and Manufacturing Company.

About 3 miles to the east of Avondale, a small village on the east bank of the Avon river, quarries are being worked by The Newport Plaster Mining and Manufacturing Company. The property owned by this Company consists of 4,000 acres, all of which is supposed to be underlain by gypsum.

Two quarries are being operated by this Company. The main quarry has an overburden of from 10 to 15 feet of clay and loam. The topography of the district is very undulating, and consequently the working face obtained varies from 15 feet to 70 feet. Plates IV A and VI A and B give three views taken in this quarry. The overburden is removed by a steam shovel, and the clay is allowed to cave as the gypsum is quarried from underneath it and it is then lifted by the steam shovel directly into the cars. The tracks of the Company's railway run directly into the quarry and the cars are loaded from a loading platform by single horse Scotch carts which transport the broken gypsum from the different working faces. Great difficulty is being encountered on account of the floor of the quarry being on the water level of the surrounding district. In order to remedy this and also to enable easy access to the second quarry, a large tunnel is being driven on a slope of 15° in a northeasterly direction towards the second quarry. A small hoist placed at the mouth of this incline hoists the cars and a derrick lifts the shallow trays or boxes and empties them into the cars. This tunnel acting as an outlet for the surplus water is expected to make accessible all the gypsum beneath the present floor of the quarry. The cars used to transport the gypsum to the shipping pier are steel truck, wooden box, side dump cars of 5 ton capacity.

The second quarry (See Plate I, Frontispiece), situated about 300 yards to the northeast of the first one and on a lower level, has a face of 30 feet and an overburden of 10 feet. A small loading platform enables the carts to dump directly into a small tramcar, which is hauled up an incline track to the top of the hill back of the first quarry and there loaded again into carts and hauled to the nearest loading platform on the railway. A start has been made on an upraise in an endeavour to connect with the incline being run from the first quarry.

The gypsum in both these quarries is of good quality and very soft. Very little anhydrite is encountered, but considerable salmon pink gypsum is to be seen.

The Company's railway is 36″ gauge, and lands the gypsum on the shipping pier, where it is loaded directly into barges of 2,200 tons capacity for shipment to New York city.

About 125 men are employed throughout the year.

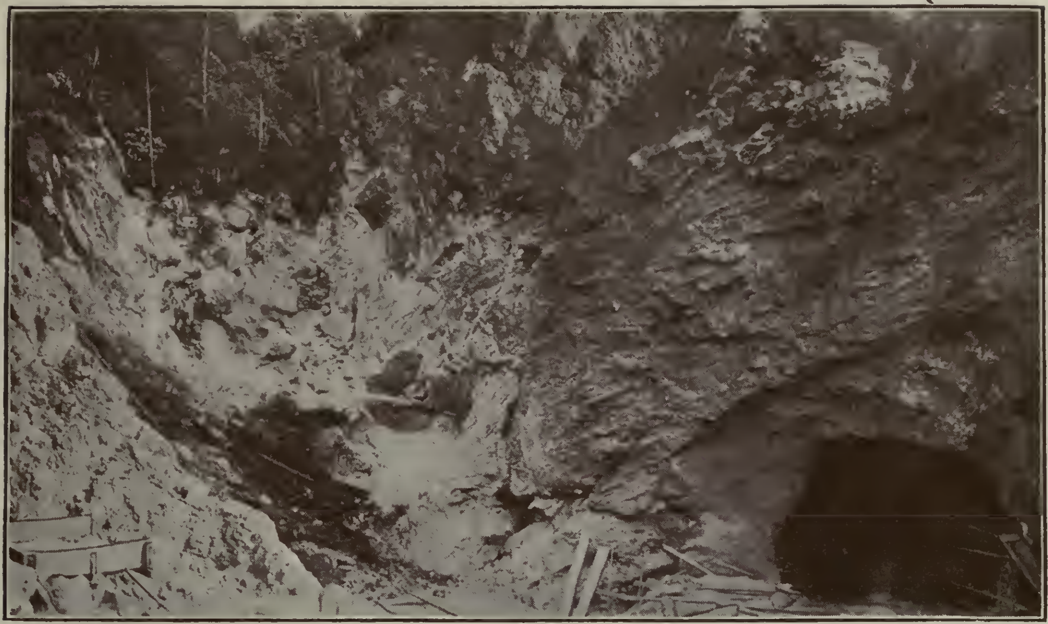
The Wentworth Gypsum Company.

By far the largest operators carrying on quarrying of gypsum in Nova Scotia are the Wentworth Gypsum Company. The quarry of this Company is situated in Hants county, about 5 miles to the east of the town of Windsor, N.S. The deposits cover an area of over 1,200 acres, most of which is, however, covered by a heavy overburden.

The overburden, which in some cases is as thick as 35 feet, is being stripped by two steam shovels, one working on the top of the deposit, taking

A. Cheverie quarry, one-half mile inland from shipping pier. (Note natural cave formed by underground waters.)

B. Gypsum cliffs exposed on shore, Cheverie quarry, N.S.



A. Upper entrance to incline tunnel, Newport Plaster Mining and Manufacturing Company's quarry, Avondale, N.S.

B. Steam shovel at work stripping, Newport Plaster Mining and Manufacturing Company's quarry, Avondale, N.S.

A. Wentworth Gypsum Company's quarry, looking west from loading platform. (Note thickness of overburden.)

B. Wentworth Gypsum Company's quarry, looking northeast. Steam shovel at work on waste material in bottom of quarry.

A. Wentworth Gypsum Company's quarry. General view of western half, showing portion of loading platform.

B. Storage sheds of the Wentworth Gypsum Company.

Shipping pier and loading device, Wentworth Gypsum Company.

off the clay in benches, and the other working in the quarry, removing all the waste material that caves into the quarry. Plate VII shows two views taken in this quarry and gives a good idea of the overburden and the steam shovel at work in the quarry. The floor of the quarry as seen in these photos is principally anhydrite.

The gypsum obtained in this quarry is of very good quality, but the loss in handling, due to the heavy overburden, is about 15 per cent. Anhydrite is found in irregular patches throughout this deposit, sometimes in the floor and sometimes as high cliffs. In Plate VIII A the cliff to the right of the photo is all hard rock or anhydrite.

The gypsum is drilled by hand power augers and broken down by dynamite of 40 per cent strength. It is then loaded into single horse Scotch dump carts and hauled to the loading platform in the centre of the quarry and dumped directly into the five ton railway cars, as shown in Plate X A. It is then hauled 2½ miles over a narrow gauge railway owned by the Company to the Company's shipping pier on the St. Croix river. In the winter months when navigation is closed, the gypsum quarried is stored in the storage sheds situated half way between the quarry and the shipping pier (See Plate VIII B). From the storage bins it is shipped in the early months of navigation. This enables the quarry to be operated all the year round.

Plate IX shows the dumping arrangement at the pier on the St. Croix river. Here the gypsum is loaded into barges of 2,000 to 2,200 tons capacity, and then towed by tugs to the United States, where all of the gypsum produced by this Company is taken by Messrs. J. B. King and Co., Staten island, N.Y.

The Company employs in the neighbourhood of 122 men.

The Windsor Plaster Company.

At West Gore, Hants county, about 20 miles to the northwest of the town of Windsor, N.S., the Windsor Plaster Company are opening up a new quarry which will supply their calcining mill at Windsor. Quarrying is to be carried on in the usual manner, and the crude material will be shipped over the Dominion Atlantic railway to Windsor.

At Windsor the Company have a calcining plant consisting of the following buildings: boiler house and engine room, three storey calcining mill, blacksmith shop, two storage bin buildings 175′ × 60′ and 100′ × 30′, office, cooperage, storeroom 75 feet in length, barn, etc.

The power plant consists of one horizontal return tubular boiler of 100 H.P. capacity, one long stroke, single acting engine with 8 ft. flywheel, and a small auxiliary vertical engine used to drive an electric generator for lighting purposes.

Calcining Mill. The calcining mill is a frame building three stories in height. Plate No. XII gives a general view of the plant.

The crude gypsum after coming from the quarries is stored in the large

Railway Cars (30 ton capacity)
↓
Storage Sheds
↓
Incline tram to Mill (Drum)
↓
Jaw Crusher (Butterworth and Lowe)
↓
Rotary Crusher
↓
Double Elevator
↓
2-Hoppers
↓
4-Horizontal French Buhr Stones
↓
Shutes ← Horizontal Screw Conveyor

↓	↓
Bagged for Land Plaster	Elevator

↓
Distributing Screw Conveyor
↓
Receiving Bins (two)
↓
2-10 ton Calcining Kettles (Butterworth and Lowe)
↓
Cooling Bins
↓
Elevator
↓
Screens → Overs

↓	↓
Mixing Machine	Small Buhr Stone
↓	↓
Shipped as Hard Wall Plasters Selenite Hard Wall Plaster	Packed as fine Plaster

Fig. 4. Flow sheet of the Windsor Plaster Company, Windsor, Nova Scotia.

A. Loading platform and train of cars, Wentworth Gypsum Company.

B. Loading pier and train of cars, Windsor Gypsum Company, Windsor, N.S.

A. View in Windsor Gypsum Company's quarry, Newport, N.S.

B. View in Windsor Gypsum Company's quarry, Newport, N.S.

Mill and buildings of the Windsor Plaster Company, Windsor, N.S.

storage bins and from there it is hauled up an incline to the mill as required. The car on this incline holds approximately one ton, and this is dumped directly into the hopper for the jaw crusher. This crusher reduces the material to 1″ size and is manufactured by Butterworth and Lowe. From this crusher it falls, by gravity, directly into a rotary crusher and is then hoisted by two elevators working in series to the top of the building, where it is deposited into two hopper shaped bins.

These bins are directly over the buhr mills and the material is fed into these grinding stones by gravity chutes. These buhrstones are ordinary French buhrstones running horizontally with gear underneath. A screw conveyer carries the ground material across the building to an elevator which again elevates the gypsum and places it in the large receiving bins over the kettles. Two chutes beneath the screw conveyer enable part of the crushed uncalcined gypsum to be taken off for use as land plaster. From the bins over the kettles the gypsum is run by gravity into two ten ton calcining kettles, manufactured by Butterworth and Lowe. When the charge is calcined, which takes from 2½ to 3 hours, the hot calcined gypsum is run by gravity into two cooling pits beneath the kettles. When cooled, it is again elevated and passed through screens and bolted, the overs being carried and reground in a small French buhrstone and then packed as fine calcined plaster. The material passing through the screens is fed to a mixing machine and manufactured into several grades of hard-wall plaster. The name *Selenite* has been adopted as a trade name for the manufactured product marketed by this Company. (Fig. 4 shows a diagrammatic flow sheet of this mill).

The Windsor Gypsum Company.

About 5 miles to the east of Windsor the Windsor Gypsum Company is operating a gypsum quarry on a property 180 acres in extent. Plate No. XI shows two views of the work being carried on in this quarry. The overburden is lighter than in most of the quarries in this district and rarely exceeds 12 feet in thickness. It is all stripped by hand, and only about 5 per cent of the gypsum is lost in handling. A face of 20 feet is being worked at present, but there is every opportunity for increasing this as the quarry is further opened up. The quality of the rock obtained is a splendid grade. The usual unevenness of the surface is to be found here and numerous sinkholes are encountered.

The gypsum is drilled by hand augers and broken down by blasting powder and a low grade of dynamite. It is then loaded into single horse Scotch carts and hauled two hundred yards to the siding connecting with the Dominion Atlantic railway. The shipping pier of the Company, situated at Windsor, N.S., is shown in Plate X B.

Last year (1912) part of the product was shipped to the Windsor Plaster Company at Windsor, and the balance was shipped in the crude state to the United States.

The Maritime Gypsum Company, Limited.

In Cumberland county, at a distance of about $1\frac{1}{2}$ miles to the north of Nappan station on the main line of the Intercolonial railway, a gypsiferous area occurs, 800 acres in extent, the principal deposit being operated by the Maritime Gypsum Company, Limited. This deposit covers an area of some 14 acres, and is covered by an overburden of loose clay and calcareous material, which, however, does not extend to a greater depth than 10 feet. This is being removed by hand. On account of this light overburden only about 3 per cent of the gypsum is lost in quarrying. The upper strata of the deposit are considerably broken up and impure, but a high grade of white rock is being obtained from the quarry from the lower part of the beds. The quarry at the present time has a working face of 60 feet of good commercial gypsum, with slight or no sign of anhydrite being present. The floor of the quarry is all below the drainage level of the surrounding country, and it is the intention of the Company to go still deeper, as they have tested the gypsum for a further depth of 90 to 100 feet by drill hole. Plates XIII and XIV show views of this quarry.

The rock is drilled by auger drills operated by hand power, and 40 per cent Dupont dynamite is used to break it. Small trucks running on tracks to all parts of the quarry place the transport trays or shallow boxes at the working faces. These trays, when filled, are run to the centre of the quarry and hoisted by means of a Ledgerwood cable system, installed in 1909. This cableway handles a load of $1\frac{1}{2}$ to $1\frac{3}{4}$ tons and dumps either on to the stockpile, or into bins, or cars as required. It is operated by electricity received at 11,000 volts and stepped down to 550 volts. A centrifugal pump is also operated by electric power, and this is sufficient to keep the bottom of the quarry free from water.

The rock is shipped in 3 ton cars over a private railway owned by the Company, to their shipping pier at Amherst point, at tide water on Cumberland bay, a distance of $2\frac{1}{2}$ miles from the quarry. A branch line also connects the quarry with the main line of the Intercolonial railway.

The equipment of the Company consists of a Ledgerwood cable way, already mentioned, ore bins, electric pump, two locomotives, office, blacksmith shop, engine house, and sub-station.

Operations are carried on throughout the whole year, giving employment to an average of 60 men.

The rock is shipped in the crude state in barges to New York. An average of 25,000 tons is quarried each year.

A. General view of the quarry of the Maritime Gypsum Company, Nappan, N.S., showing aerial cableway and carrier.

B. Stock pile, Maritime Gypsum Company, Nappan, N.S.

Carrying device and loading platform, Maritime Gypsum Company, Nappan, N.S.

CHAPTER VI.

GYPSUM IN NEW BRUNSWICK.

The lower Carboniferous formation, which has an extensive distribution in the Province of New Brunswick, carries all the gypsum which is found in this Province. It has its greatest development in the southeastern part and with the exception of a small isolated area in the north in Victoria county at Plaster Rock all the most valuable deposits are situated in this area. Outside of the Hillsborough deposits, and those at Plaster Rock just mentioned, none of the occurrences of gypsum have been properly developed, so that very little reliable information can be obtained in regard to them. From their surface indications, however, several of the larger among them would well pay for systematic prospecting with the diamond or other form of drill. Prospecting in this manner is to be strongly encouraged, as it leaves no room for doubt as to the value of a property both as regards its quality and extent. So much loose surface excavating has been carried on, taking only the weathered surface of the outcrops, that many properties have been condemned by the quality of this inferior material, whereas if the properties had been drilled, an idea would have been obtained of the quality, and only the better material need have been excavated.

Plaster Rock Deposits.

In the northern part of the Province of New Brunswick, an area of lower Carboniferous rocks occurs in the vicinity of Plaster Rock, on the Tobique river in the county of Victoria. The presence of extensive deposits of gypsum in these rocks has been known for a long time. Mr. Chas. Robb, in the late sixties, visited these deposits and gave the following description of them:—

"Superimposed on the beds of limestone and marl, one sees here extensive beds of gypsum which are first encountered at the mouth of the Wapskehegan, but which have their greatest development at Plaster Cliff, a mile and a quarter higher up, where for a distance of 80 to 100 yards, they rise perpendicular on the left bank to a height of 120 feet. The greater part of this rock is impure gypsum, red and greenish, massive but dirty and foliated, containing a variable proportion of carbonate of lime and siliceous material, nevertheless it is streaked with bands of pure white gypsum and fibrous selenite, containing, according to the late Dr. Robb, 77·7% sulphate of lime and 3·0% carbonate of lime. Practically pure nodules of calcium carbonate are sometimes met with embedded in the red gypsum. The whole seems to dip to the southeast at a very low angle and having only a small exposure where it outcrops on the river, but I am told that these bands of plaster can be followed for at least four miles up the Wapskehegan, alternating with the other rocks of the formation."

Unlike the deposits of gypsum found in the southern part of the Province, the deposits in the vicinity of Plaster Rock have distinct characteristics of their own. The gypsum is very impure and its colour varies from a dark reddish brown to a light green. These different varieties of coloured gypsum occur in distinct bands with a well divided line of cleavage between them, thus giving to the deposits a mottled appearance. Thin layers of a reddish shale, in which numerous small crystals of selenite are seen, tend to make this mottled appearance more marked. The deposits have a decided bedded appearance, the beds varying from an inch to a foot or more in thickness, very similar in appearance to the deposits found in northern Manitoba.

The rock is very soft and readily breaks along the lines of cleavage. According to the late Mr. H. E. Kramm the numerous parallel veins of fibrous gypsum or satin-spar are due to secondary deposition. No anhydrite has been found associated with these deposits.

On account of the impure nature of the gypsum found here it is unsuited to the manufacture of a high grade of wall plaster, but considerable quantities have been quarried for use as a fertilizer, and in late years its use has been principally as a retarder in the manufacture of cement.

Previous to the year 1880 a small mill was erected in this district at which the gypsum was ground and sold to the farmers in the vicinity of the upper St. John, and in Aroostook county in the state of Maine, for use on their fields as a fertilizer. In this connexion a railway was built, now known as the Plaster Rock branch of the Canadian Pacific railway, from Perth Junction, opposite Andover on the St. John river, to Plaster Rock, a distance of 28 miles. In the year 1893 the Tobique Valley Gypsum Mining and Manufacturing Company, Limited, was incorporated and erected a large mill, adjacent to the railway, for the crushing and grinding of gypsum. For a few years a good sale was obtained for the land plaster thus prepared, but owing to numerous difficulties the plant was closed down.

At the present time the Stinson-Reeb Supply Company, with headquarters at Montreal, are operating quarries at this point. They have a small crushing plant, and the gypsum is quarried and shipped in the crushed state to the cement works.

Mr. J. Stewart, of Andover, N.B., also quarries about 1,000 tons each year from this district.

Upham District.

A gypsum district, where little work has been done, but which on further developing may prove of considerable importance, occurs to the south of Upham station on the St. Martins railway, a short line connecting with the Intercolonial railway near Hampton Station. Very few outcrops occur in this area, and it is only by numerous ponds and sinkholes taken in connexion with the few outcrops that any idea of its approximate extent can be obtained. Mr. W. Jennison estimates its surface area at 250 acres.[1] The general trend of the lower Carboniferous rocks in this district is northeast and southwest.

Small quantities were quarried from one of the outcrops of this area in 1907 and shipped to St. John, but operations were soon abandoned. The grade and quality of the gypsum can only be determined by further development work.

At the southern terminal of this branch railway near St. Martins there is a small deposit of gypsum, but it is of poor quality.

Petitcodiac Deposits.

In Salisbury township, Westmorland county, about 2½ miles to the northwest of Petitcodiac station, on the Intercolonial railway, a gypsiferous area, somewhat similar to the Hillsborough deposits, is found. Outcrops occur in a number of places along Fawcett brook, and the deposit can be traced for a distance of 2½ miles with an average width of 600 feet. The gypsum is associated with a bed of crystalline limestone, from which it may possibly have been formed through the transition stage of anhydrite, which latter material will most likely be found associated with the deposit at depth.

The gypsum is greyish in colour on the surface, and is associated with masses of selenite. For this reason it has, up to the present time, only been utilized in the manufacture of land plaster. Gypsum of a good white appearance can be obtained from several of the outcrops, but as only a little development work has been done, no idea can be obtained of the value of the material for wall plaster.

Several deposits are noted in Kings county in Sussex valley, but as yet these have had very little work done upon them, so that no definite data concerning them are to be had. The more important of these are known as the Apohaqui, Mount Pisgah, and the Smith Creek deposits.

New Horton District.

From New Horton, 28 miles south of Hillsborough, to the south shore at Cape Enrage, an outcrop of the lower Carboniferous is found, and from several small excavations and surface indications it is supposed to be underlain by a body of gypsum. The whole area is covered by Millstone Grit.

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[1]Mines Branch, Dept. of Mines Report, No. 84, p. 91.

Hopewell Cape.

A gypsum occurrence has been noted at Hopewell cape, but on account of the heavy overburden of soil and Millstone Grit only a small amount of prospecting has been done to determine its quality and extent. About 200 tons were quarried and proved to be a good quality of massive gypsum.

Hopewell Hill.

About 15 miles to the south of Hillsborough district a gypsiferous area is known to occur in the vicinity of Woodworth settlement and to extend southerly to Hopewell hill. A couple of quarries were operated here a number of years ago, but nothing at present remains except a number of small excavations. Only a few small outcrops occur and the whole district is covered with Millstone Grit.

Cape Maringouin.

On the southwestern peninsula of Westmoreland county, which juts out into Chignecto bay and terminates in Cape Maringouin, a gypsum area occurs in the lower Carboniferous formation, which is exposed in this district. The New Brunswick Gypsum Company, a subsidiary company of the Albert Manufacturing Company, has under lease in this district, an area of one square mile in extent, and a small amount of gypsum is quarried each year, which is shipped in the crude state to the United States.

The gypsum occurs in association with anhydrite and varies from the white to the pink and grey varieties. It is mostly massive, but small quantities of the coarse granular form may be noticed in several places.

Curryville District.

The Demoiselle Creek deposits of Curryville, also in Albert county, lie along the line of the Salisbury and Albert railway at the head-waters of Demoiselle and Wilson creeks. Here for the last 15 or 20 years the Hillsborough Plaster Company has been extracting a good grade of gypsum, both quarrying and underground methods being employed. In the underground work a tunnel has been driven into the deposits, and pillars have been left to support the roof. The rock, which is massive in character, rests, like the Hillsborough deposits, on a floor of anhydrite, and is covered by an overburden or roof of varying thickness, carrying the characteristic pebbles of Millstone Grit.

In connexion with these deposits, the surface waters have dissolved out a large subterranean cavern or lake, said to be some six acres in extent.

The Hillsborough Plaster Company was first established about the year 1892, under the management of C. H. Dimock and Co., of Windsor, N.S. In that year some 600 tons of crude gypsum was quarried and shipped to the New York market. For a few years work was suspended, but in 1897 shipments were resumed and have continued regularly ever since. Of late years the Company has come under the control of the Wentworth Gypsum Company, of Windsor, N.S. The gypsum is hauled a distance of 18 miles over the Salisbury and Albert railway to the Company's shipping pier at Greys Island wharf, on the Petitcodiac river, a few miles above the town of Hillsborough. Here it is loaded on barges of 2,200 tons capacity and is shipped in the crude state to the United States markets.

The Hillsborough District.

Among the deposits of gypsum found in the Province of New Brunswick, those which occur in Albert county, in the vicinity of the town of Hillsborough, are by far the largest and most important, producing considerably over 80 per cent of the total output of the Province. The deposits are closely associated with the rocks of the lower Carboniferous formation and generally overlie beds of crystalline limestone and anhydrite. Anhydrite occurs in extensive beds with the gypsum and is to be found underneath the gypsum with no definite dividing line between them, or else extending into the gypsum bed in the form of lenses. The thickness of the gypsum varies in the different localities, and the beds are undulating, conforming to the general topography of the district. The overburden consists of a varying thickness of residual soil, but in a number of the deposits the gypsum is covered unconformably by quartz conglomerates and beds of greyish coarse grained freestone of the Millstone Grit.

The gypsum of this district is noted for its purity, and large quantities of pure white alabaster are found and mined for use as terra alba. The colour of the gypsum varies from a colourless to the grey and pink varieties Small amounts of impurities occur, such as calcium carbonate and vegetable matter, but only in small isolated areas which can readily be avoided in mining and quarrying. In places the gypsum has a distinctly bedded structure, which is accentuated by seams of darker gypsum of a semi-translucent crystalline nature. The gypsum is usually of the massive variety, but occasionally the other varieties are encountered. Crystals of selenite, from ½″ to 3″ in length, are found embedded in parts of the deposits. These crystals, which have a dark smoky appearance, impair the quality of the gypsum in which they occur.

The topography of the district is typical of the occurrence of gypsum, being undulating and developing numerous sinkholes. The total gypsiferous area is supposed to be about 14 square miles in extent, but the actual outcrops of gypsum are limited to a district of only 1½ square miles. It is in this area that all the principal quarries are at present being operated.

HISTORY OF DISTRICT.

Of the first discovery of gypsum in the district adjacent to the town of Hillsborough, very little is known. Evidence of very early work having been carried on is shown by the signs of excavation and small deposits of waste now covered over by small undergrowth.

Small shipments were made from time to time previous to the year 1847, by farmers of the district. These shipments were taken from points where the gypsum was easiest to obtain and hauled by sleds, in the winter, to the nearest shipping point on the Petitcodiac river. It was purchased in the summer by the masters of the small coasting vessels, who made a profitable revenue by selling the crude gypsum to the calcining mills situated on the Atlantic seaboard of the United States. The freight on these cargoes of gypsum was very little, owing to the fact that the coasting vessels would otherwise have to return to the United States empty. The principal destination of this gypsum was Lubec in the State of Maine, where Messrs. Fowler Bros. had plaster mills in operation. About the year 1847, these gentlemen obtained the rights for some of the properties in this district and operated them for a number of years. They constructed a plank road, $3\frac{1}{2}$ miles in length, from the principal quarry, later known as the Fowler quarry, to the Petitcodiac river. This enabled shipments to be made both in summer and winter, but the production never exceeded more than three thousand tons in any one year.

In the year 1854 more active operations were commenced, when Mr. Calvin Tompkins of New York, obtained the rights to the properties owned by the Fowler Bros., and also rights for railways, buildings, docks, and other purposes. He established a company known as the Albert Manufacturing Company, and had it incorporated by an act of the legislature of New Brunswick in the same year. This Company erected a large milling establishment, and also laid tracks to the several points where they were quarrying gypsum, as well as to the river, where wharves and timber beds for the accommodation of vessels were also constructed.

The mill was the largest of its kind then operating in Canada. It contained a very complete plant for crushing, grinding, and calcining gypsum, and was operated by steam, using wood as fuel. This wood was all obtained locally. In addition to this mill, there was a small mill for sawing logs, and arrangements were also made for grinding grain.

At this time the Canadian market was not available to the Hillsborough producers, owing to the excessive freight rates in competition with the gypsum quarried and shipped from Antigonish and other points in Nova Scotia, and also on account of the very low rate of duty then imposed on manufactured plaster entering Canada from the United States. This low rate allowed the mills situated at Grand Rapids, Michigan, to deliver plaster in Toronto and Montreal at a cost very much lower than the producers of Hillsborough could possibly do, so consequently they had to depend entirely on the trade with the United States, and on whatever small local trade could be obtained. About the year 1873 the Albert Manufacturing Co. was further handicapped by the total destruction of its mill and adjacent buildings by fire, but a new mill was built and placed in operation in the year 1875. In spite of these decided drawbacks the industry progressed, and when in 1876 the Intercolonial railway was opened the Canadian market was made available. The pure quality of the Hillsborough deposits, and also the increased import duty placed in 1866-7 on plaster imported from the United States, soon gave nearly the whole of the Canadian market to the product from this district, and the trade rapidly increased.

In the meantime legislation in the United States greatly affected the shipments of both the crude rock and the manufactured plaster to that country. On August 28, 1894, the Wilson bill came into effect. This was a low tariff measure passed under the Cleveland administration and imposed a duty of $1.25 per ton on calcined plaster. This low rate of duty enabled the Canadian manufacturers to successfully compete with the American producers of the finished product, but the gain made under this tariff was soon lost under the higher rates of duty imposed under the Dingley bill, which came into effect on July 24, 1897. Under that bill a duty of 50 cents per ton was imposed on crude gypsum, while the rate on calcined plaster was raised to $2.25 per ton. This difference of $1.75 per ton between the crude rock and the calcined plaster more than offset the increased cost of the manufactured article in the United States as compared with the cost of manufacture in Canada. The present tariff, commonly known as the Payne bill, came into effect on August 5, 1909, and is the tariff at present in force. This tariff imposes a duty as follows:—

Section 88.

"Plaster rock or gypsum, crude, thirty cents per ton; if ground or calcined, one dollar and seventy-five cents per ton; pearl hardening for paper makers' use, twenty per centum ad valorem; Keene's cement, or other cement of which gypsum is the component material of chief value, if valued at ten dollars per ton or less, three dollars and fifty cents per ton; if valued above ten dollars and not above fifteen dollars per ton, five dollars per ton; if valued above fifteen and not above thirty dollars per ton, ten dollars per ton; if valued above thirty dollars per ton, fourteen dollars per ton."

It will readily be seen that under this tariff it is only the superior quality of the gypsum obtained in Canada that enables the Canadian manufacturers to, in any way, compete with the manufacturers in the United States.

The low duty imposed on crude gypsum entering the United States has tended to largely increase the shipments of the crude rock to the mills along the Atlantic seaboard of that country.

The new mill built by the Albert Manufacturing Co. in 1875, ran continuously until March 16, 1911, when it was completely destroyed by fire. Preparations were at once made for the erection of another and more up-to-date mill, which was placed in operation a year later. A view of this new mill is shown in Plate XV.

THE ALBERT MANUFACTURING COMPANY.

The Albert Manufacturing Company's property and plant are situated in the Province of New Brunswick, in the county of Albert, near the town of Hillsborough on the Petitcodiac river. This town is distant 39 miles by rail from Moncton on the main line of the Intercolonial railway, and 95 miles from St. John, N.B. The shipping pier of the Company is approximately 635 miles, by water, from New York.

Property. The property of the Company is situated in the town and village of Hillsborough, and is connected with the mill and shipping pier by a narrow gauge railway, 4 or 5 miles in length. The gypsum is obtained both by quarrying and by mining. Quarries are about 3 miles to the west of the town.

Quarries. There are at present several quarries being operated, from which the greater bulk of the material treated at the mill is taken. These quarries also supply the material which is shipped in the crude state to New York and other points in the United States.

In some of the quarries very little stripping has to be done as the overburden is light, hence the material is shipped in a very clean condition. The usual auger bits are employed in boring the holes for blasting the rock and black powder or a very low strength of dynamite is used. After the gypsum is quarried, it is broken by hand into convenient size for handling, and is then carted by single horse Scotch carts to the nearest siding of the narrow gauge railway and dumped directly into 3½ ton cars. One locomotive makes about six trips per day, taking 30 cars at each trip. Another locomotive shunts the cars at the wharf. The face of these quarries varies from 10 to 60 feet in height, according to the general contour of the country, the gypsum being found to follow the undulating character of the ground with considerable uniformity. The quality of the rock is also varied, and almost any variety from dark grey to pure white alabaster can be found. The different grades are kept separate at the quarries and are handled separately both there and at the mill.

Mining. During the winter months mining operations are carried on to the north of these quarries, and gypsum of a very pure white variety of alabaster is mined. The rock is broken down and allowed to slide, by gravity, or else hauled to the main haulage tunnel, whence it is taken by cars to a siding of the Company's railway and transported to the mill and used in the manufacture of terra alba. This rock is found in limited

Mill and buildings of the Albert Manufacturing Company, Hillsborough, N.B.

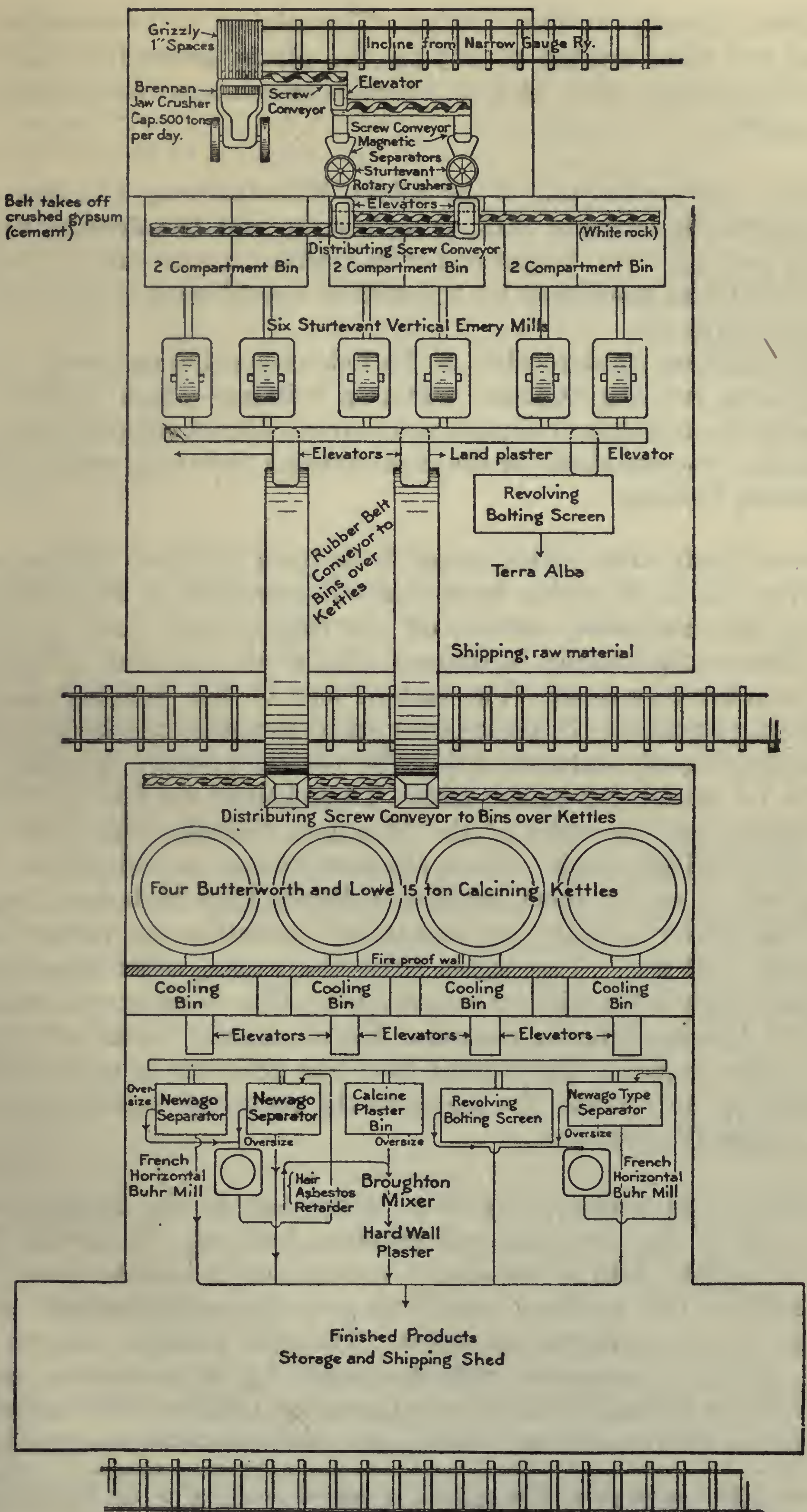

Fig. 5. Flow sheet of the Albert Manufacturing Co., Hillsborough, N.B.

quantities and only in this district. The mining is carried on by the chamber and pillar method of mining, the pillars generally being composed of the poorer grade of rock, which is encountered intermixed with the alabaster.[1]

Mill. The present mill of the Albert Manufacturing Co. was completed during the spring of 1912, to replace the mill destroyed by fire the previous year. It is the largest mill of its kind in Canada, and is equipped with all the latest machinery for the milling and calcining of gypsum (See Flow Sheet, Fig. 5).

The complete plant consists of the following buildings: power plant, crushing and grinding building, calcining building—which includes the packing plant—cooperage building, and several other smaller buildings for storage, etc. Storage sheds for the crude gypsum have been erected beside the crushing building.

Power Plant. The power house is a brick structure with concrete foundations 50′ × 60′, with a brick mid-wall extending to the peak of the building, thus completely cutting off the engine room from the boiler room. The whole building is covered with a concrete roof, making the danger from fire very small. The eastern half of this building contains three tubular boilers of 175 horse-power each, manufactured by the Robb Engineering Co., of Amherst, N.S. The normal pressure of steam employed is 125 pounds per square inch. These boilers are fired by natural gas obtained from the wells of the Maritime Oilfields, Ltd., situated 4 miles north of Hillsborough. There are four burners to each boiler. The western half or engine room contains a Porter-Allen high speed engine of 400 horse-power capacity, running at 165 revolutions per minute, with a fly wheel of 11 feet. This engine drives the shafting which operates the several machines in the mill, by a rope drive. This building also contains a 25 K. W. Crocker-Wheeler generator belted directly from a 5 ft. fly wheel on the engine. The current from this generator is used to light the buildings, to operate the motor in the cooperage building, and to run the magnetic separators.

Crushing and Grinding Building. Fifty feet to the north of the engine room is the crushing and grinding building, 90′ × 75′, four floors in height, with a lean-to of two stories in height. The lean-to is used for the crushing machinery and its accompanying elevators, also for the magnetic separators. The main building contains the shafting, which is connected with the engine by a rope drive, manufactured by the Dodge Manufacturing Company, and also all the grinding mills and bins with screens and bolting screens to handle the finer grades of

[1]About 2,500 tons of pure white gypsum is shipped each year to the United States for use in the manufacture of paper pulp.

alabaster for the manufacture of terra alba. Between this building and the calcining building, which is placed 25 feet to the north side, are two railway tracks, which connect with the siding of the Salisbury and Albert railway, thus affording means for shipping the crushed and uncalcined gypsum, which is sold to the manufacturers of Portland cement.

Calcining Building. The calcining building is built entirely of brick, with concrete floors and foundations, thus ensuring safety from fire. It is four stories in height, and contains four calcining kettles. The upper floors in this building contain the plaster bins for feeding the kettles, dust chambers, etc. A brick partition wall, extending clear up to the roof, separates the calcining department from the packing department. There are two openings from one building to the other, and these are protected by metal-covered automatic self-closing fire doors.

Screening and Packing Buildings. The building used for screening and sizing the calcined plaster is seven stories in height and measures 25′ × 75′. The lower floors are all concrete and contain the cooling bins into which the hot plaster is run by gravity from the calcining kettles. On the ground floor above the cooling bins arrangements are made for the packing of calcined plaster of second grade and also the hard wall plaster. The first floor contains the packing machines and the upper floors contain the screening and sizing machinery.

A lean-to building, attached to the north side of this building, is used for a storage and shipping building. It is 25 feet wide by 125 feet in length and is two stories in height, the lower floor being on the same level as the floor of box cars on the track which runs along the full face of the building. This building is used for storage and for shipping, the barrelled plaster being rolled directly from the building into the car. The upper floor of this building is on the same level as the packing floor of the mill and open to it, and has a capacity for over 2,000 barrels of plaster, with the barrels standing on end. This storage space allows the plaster to stand twenty-four hours before being shipped. One half of the floor is occupied with the day's output while the coopers who head and trim up the barrels are working at the other end of the floor on the barrels placed there the previous day. As the barrels are trimmed they are run down to the lower or warehouse floor and are either placed directly in the cars for shipment or are stored for later shipment.

Cooperage Building. To the east of the screening building is a large building which is used as a cooperage shop. It is 50 feet wide and 75 feet long and two stories in height. It is furnished with eight barrel heaters, work benches for fifteen coopers, and all the latest machinery for assembling barrels. Power is furnished by a 10 horse-power Crocker-

Wheeler D.C. motor operating on 220 volts. An elevator conveys the barrels to the first floor, where they are left to dry, and are then carried by a barrel conveyer over a covered bridge directly to the packing floor of the main building. The capacity of this cooperage shop, when in full operation, is 1,000 barrels per day. A saw mill for cutting barrel staves is situated to the rear of the cooperage building.

All the buildings, with the exception of the power and calcining buildings, are built of heavy southern pine, the whole exterior being covered with metal lathes and then plastered with a heavy coating of cement. The ground floors in all the buildings are made of concrete. The upper floors are all mill floors, or what is known as slow burning construction, i.e. the boards are all laid on edge instead of horizontally.

The whole plant is connected with the engine room by an electric signalling system, having on its circuit twenty stations, which are visited hourly both day and night by watchmen, the signals being recorded on an electrical watchman's clock located in the engine room.

In addition to the buildings already described, there are several smaller buildings used for blacksmith's shop, repair shop, engine house, and saw mill, where the barrel staves are cut.

Mill Operation. The crude gypsum when brought from the quarries is either dumped on to the storage piles in the storage shed or the cars are hauled directly up an incline and the rock dumped on a grizzly with 1 inch spaces, the oversize falling by gravity into a Brennan jaw crusher with a capacity of 500 tons per day. The crushed material, together with that passing through the grizzly, is carried by a steel screw conveyer to an elevator. This, in turn, delivers it to a distributing screw conveyer, which feeds the material to two magnetic separators. These separate out any pieces of steel or iron which may have become mixed with the rock, either at the quarry or elsewhere. The rock, after passing through these separators, is delivered to two Sturtevant rotary crushers, each with a capacity of 250 tons per day, crushing to $\frac{1}{2}''$ size.[1] The crushed material from the two crushers passes, by gravity, into two steel bucket elevators, and these in turn convey the material to the top of the building, where it is delivered into three 2-compartment bins by means of two distributing screw conveyers. These screw conveyers are so arranged that the product from either crusher can be placed in any compartment wished. The size of the bins is $10' \times 18' \times 4'$ high.

From these bins the gypsum is fed by gravity chutes into 6 vertical rock emery mills, manufactured by the Sturtevant Mill Co. of Boston, U.S.A.

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[1]A belt conveyer is employed to carry off the crushed material from the rotary crusher when the material being crushed is to be shipped to the cement manufacturers. It is crushed to about $\frac{1}{4}''$ size and dumped by the belt on a pile outside the building.

A screw conveyer, extending along the front of all the emery mills, conveys the finely pulverized material to three steel bucket elevators. Two of these elevators carry the gypsum to the top of the building, where they discharge on to two rubber belt conveyers. The third elevator empties into a revolving bolting screen. This is used only for the manufacture of terra alba, which requires great care in sizing. Arrangements are made so that the powdered gypsum can be taken and shipped directly from the emery mills, for use as land plaster or fertilizer.

The rubber belt conveyers, mentioned before, carry the material through covered bridges to the calcining building, and the gypsum is deposited by two steel distributing screw conveyers to bins located over the kettles.

A railway track between the grinding building and the calcining building enables ready handling and shipping of the raw material for fertilizer, terra alba, etc.

The calcining house, which is built entirely of fireproof material, contains four circular calcining kettles with a capacity of 15 tons each. These are manufactured by Butterworth and Lowe, of Grand Rapids, Mich., and are similar to the kettle described elsewhere in this report. The kettles are fired by natural gas supplied by the Maritime Oilfields, Ltd., and this system of firing is found to be very satisfactory, giving a more regular heat and better chance of controlling the temperature when the kettle is charged. The time saved in heating up the empty kettle before charging is also considerably less than when coal or wood fuel is used. The kettles are charged by gravity from the bins situated over them, and when the charge is calcined to the required degree the kettle is emptied from a door in the side, allowing the hot plaster to slide into the cement cooling bins beneath the next building.

When the material has cooled completely, it is carried by four steel bucket elevators to the top of the screening and packing building, underneath which the cooling bins are located. These elevators deliver the calcined material to a distributing screw conveyer, running the full width of the building. From this conveyer the material is fed into three Newago separators, one revolving bolting screen, and a large bin which holds the supply for the manufacture of hardwall plasters. The oversize from the Newago separators and from the bolting screen is delivered to two horizontal French buhr mills and reground. The material that goes to the hard wall plaster bin is mixed with a retarder and hair or asbestos, in a Broughton mixing machine, and the mixed product is barrelled and shipped. The material passing through the separators and the bolting screen is packed into barrels and shipped as different grades according to the quality of the rock and also its fineness.

The capacity of the mill is 1,000 barrels a day.

The following table gives the grades manufactured by this Company.

Grades of Gypsum Manufactured by the Albert Manufacturing Co.

[1]F. Com. Bls., Canada.
[1]F. F. Com. Bls., Canada.
F. F. Half Bls., Canada. Same.
[1]Dental Com. Bls.
Dental Com. Half Bls.

Terra Alba No. 1, 300 lbs. Terra Alba No. 1, 500 lbs. Terra Alba No. 2, 500 lbs.	Taken from buhr mills and packed. Made from best material.
Coarse Cal., 150 lb. Bags Coarse Cal., 100 lb. Bags	From coarse ends of bolts.
Land Plaster, Bls. Land Plaster, 100 lb. Bags Land Plaster, 140 lb. Bags	Taken off from product of buhr mills. Run of quarry.

[3]F. F. Com. Bls., Boston.
F. F. 250 lbs. gross Bls., Boston.
[3]F. F. F. Com. Bls., Boston. Finest grade.
F. F. F. Com. Bls.
F. F. F. 250 gross Bls.
[3]Trowel Brand, Bls.
[2]F. Com. Bls.
[2]F. F. Com. Bls.
[2]No. 2 Calcined, 50 lb. Bags.
No. 2 Calcined, 100 lb. Bags.

Hard Wall, Bls. Hard Wall, Bags	Hair, asbestos, and retarder, etc.

Coarse crushed run of quarry used to supply market for cement use. $\frac{1}{4}''$ size.

[1]Canadian Trade.
[2]American Trade, Philadelphia.
[3]American Trade, Boston.

Base map Dep^t. of Interior

CHAPTER VII.

GYPSUM IN ONTARIO.

There are two localities in which gypsum is found in any abundance in Ontario. Of these the district bordering on the Grand river in the southern part of the Province is the only one which has been exploited, the northern deposits being too far from transportation facilities at present to make them of economic importance.

Northern Ontario Deposits.

Gypsum was among the first of the minerals of economic importance to be found on the Hudson Bay slope. Dr. Robt. Bell[1] described these deposits briefly, and Dr. James M. Bell gives a full description of the occurrence of this mineral in the Report of the Bureau of Mines, Ontario, Vol. XIII, Part 1, page 156.

Mr. Sydney Ells, of the Mines Branch, Department of Mines, Ottawa, Canada, who during the summer of 1911 examined these deposits, has kindly furnished the following description of their occurrence:—

"The occurrence of deposits of gypsum has, for many years, been a recognized feature of that part of the coastal plain which lies to the south of James Bay.

The geology of the coastal plain in which these deposits of gypsum occur, is simple, and is represented by an extensive tract of Palæozoic rocks. These rocks, lying between the southern shores of James Bay, and the well-defined escarpment of the Archæan formation, consist of almost horizontally bedded Silurian and Devonian sediments. Owing to the protection afforded by the unyielding mass of the Archæan rocks, the members of the sedimentary series still retain, for the most part, the almost horizontal position in which they were originally deposited in the ancient sea bottom. In this respect they present a striking contrast to the often highly-contorted Archæan rocks immediately to the south.

Associated with the Devonian sediments the deposits of gypsum occur. From time to time these have been observed at a number of points, chiefly in the Moose River basin, and reference has, in the past, been made to them by various travellers. So far as is at present known, the most important of these deposits occurs on the Moose River at a point some ten or twelve miles below the mouth of the Mattagami. Here the gypsum constitutes two distinct beds, the upper outcropping along both shores of the river for a distance of quite two and one half miles, while the lower bed may be traced along the southeast shore throughout a distance of upwards of one mile. These beds, as exposed along the river above mean water level, show a variable thickness of from 10 to 16 feet, although in cases where the gypsum disappears below the water level these figures are very probably subject to more or less modification. Owing to the fact that as yet no detailed exploration has been made and no development work undertaken, there is at present no evidence—beyond such indications as may be seen from the river—to show the probable extent of these deposits. Similarly as regards the quality of the gypsum, there is no information

[1]Rep. G. S. Can., 1875, p. 321.

available beyond such results as have been obtained from sampling of the most casual description. Yet, considering the results of the few analyses of the gypsum that have been made, together with the probable extent of the beds themselves as at present recognized, there seems to be little doubt that, with the opening up of this section of Ontario, the gypsum of the Moose River will prove a mineral asset of no little value to the Province. In the careful examination of these beds there still exists a virgin field for detailed work, which, in its results, should prove of very real value.

Apart from the gypsum deposits alluded to above, other occurrences are known to exist in the Moose River basin—notably on the French River and near mile post 276 on the Nipissing-Algoma boundary. But while these deposits appear to be of considerable extent, there is at present practically no definite information available, either as regards the quality of the material or the extent of the beds themselves. Until these occurrences shall have been systematically explored, their value as a factor in the mineral resources of Ontario must remain largely a matter for conjecture."

Grand River District.

The gypsum industry of Ontario has had a long and varied history. Starting in the early years of the eighteenth century, when a small amount was mined every year for fertilizing purposes, it has continued to the present time with more or less varied success until it has at last become a steady and ever increasing industry.

The district in which gypsum is found in the southern part of the Province lies in the valley of the Grand river north of the eastern end of Lake Erie.

The exact boundaries of the district that is so far known to be underlain by gypsum have never been defined. They are roughly outlined on the accompanying map in dotted red lines. The data for this were obtained from observation in the field and from a series of records of drill holes obtained from the numerous gas and water wells in the district.

Approximately the area included lies on either bank of the Grand river between a point about 4 miles below Cayuga to a point about one mile above the town of Paris. The deposits, although occurring in isolated masses or lenses, appear to be, generally speaking, lying in the form of a syncline, with the greatest depth between Brantford and Onondaga. It is probable that anywhere in this area outlined gypsum is to be found, but whether in workable areas cannot be told.

Geology. The rocks associated with the gypsum in this district have been classed by Dr. Robt. Bell as belonging to the Onondaga formation of the upper Silurian. He refers to the occurrence of this formation in Ontario as follows:—

"This formation is named after Onondaga in the state of New York, and is celebrated for its salt-bearing character. It consists principally of yellowish and drab coloured dolomites and greenish and drab shales with some reddish layers, especially near the base of the formation. It occurs along the east shore of Lake Huron from Goderich to the mouth of the Saugeen river, from which it turns east and south, rounding the northern end of a wide synclinal between Southampton and Owen Sound, and running thence south-easterly to the Grand river, from which it takes an easterly course to the Niagara."[1]

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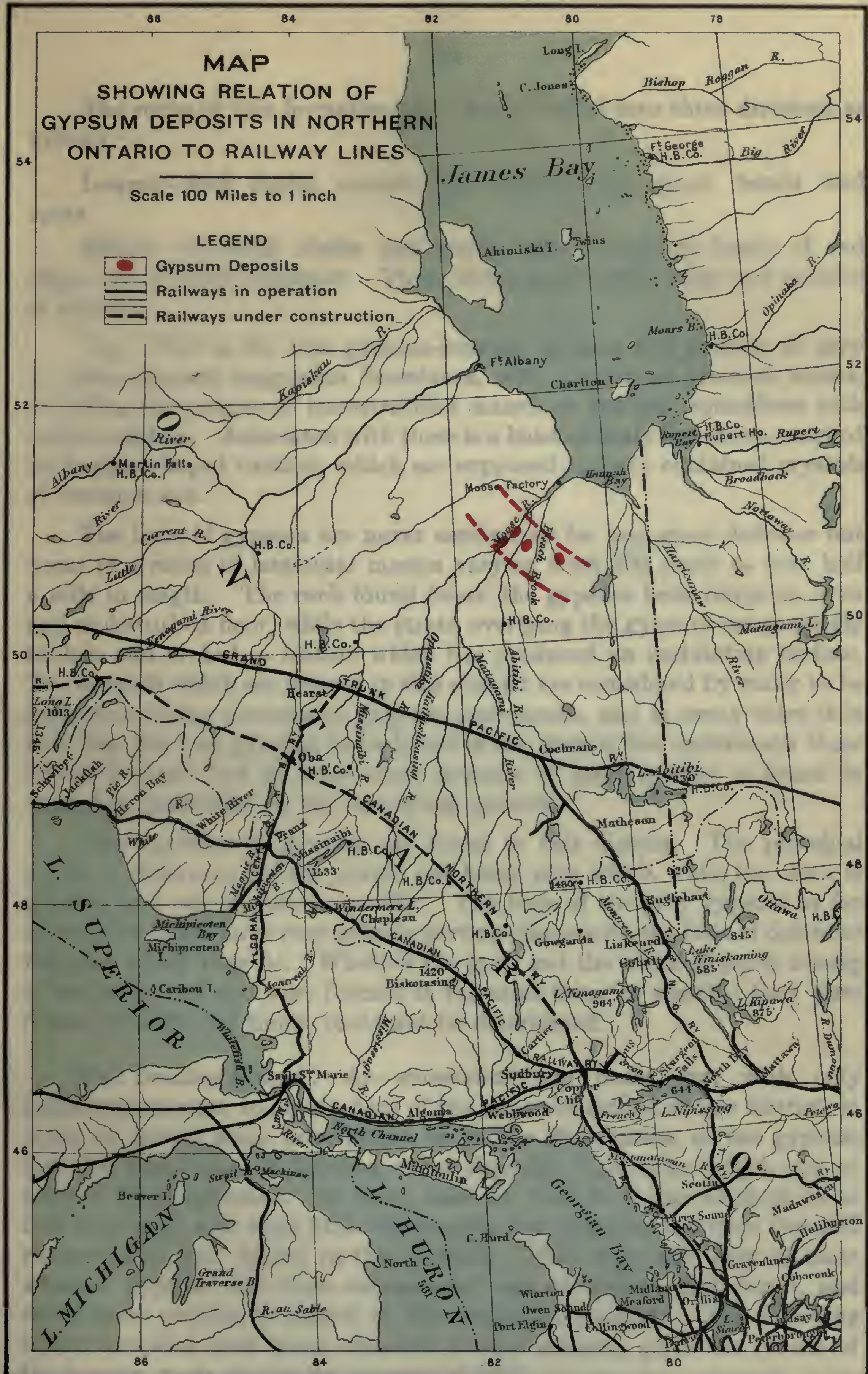
[1]Report, R. C., Ont., 1890, p. 45.



Base map Dept. of Interior

Table of Mileage (approx.)
from Cochrane to

Moose River Gypsum Deposits	*125 Miles*
Ottawa	*500 "*
Toronto	*480 "*
Sault Ste. Marie	*511 "*

The rocks of this formation have been divided into three divisions as follows:[1]—

Lowest—Red shales occasionally marked by green bands and spots.

Middle—Greenish shales and marls, with occasional bands of red shale and of shaly limestone. These strata carry small veins and nodules of gypsum.

Top—This is the true gypsum-bearing division and consists of grey or drab-coloured magnesian limestones, with greyish or greenish shales, including two ranges of interstratified masses of gypsum, sometimes with native sulphur. Associated with these is a band of shaly limestone, marked by hopper-shaped cavities, which are supposed to have contained crystals of common salt.

The beds of gypsum are never continuous for any great distance but occur in a series of lenticular masses varying from 100 yards to over half a mile in length. The rock found below the gypsum beds forms an even and undisturbed floor, while the strata overlying the gypsum are generally broken and arched, a feature which has produced an undulating surface. The mounds which are present in this district are considered by many to be indicative of the presence of gypsum underneath, and in many cases it is true that the best gypsum to be found in the district lies underneath these elevated areas, but in some cases gypsum of good quality is found in workable quantities in the low-lying ground.

Two varieties of gypsum are found in this district. The principal points of difference are the colour, one being pure white, while the other is greyish, and not as pure in quality. The beds of the grey gypsum as far as could be noted have very definite parting planes with the beds of dolomite between which they lie. Whether the grey and the white gypsum belong to the same bed and were formed at the same time, or whether they were formed at different times, could not be determined.

Well Drilling Records. An endeavour was made, but with only indifferent success, to obtain data of the gas wells drilled in this district, in order to obtain some information as to the distribution of the gypsum and the possibility of locating other deposits than those which are at present being operated. In many cases no records or logs of these holes had been kept, and what little information was obtained was from the drill runners who had drilled in this district. They were able only to state whether gypsum had been encountered and at about what depth, and could state nothing in regard to the quality or quantity. The following table, compiled from notes obtained in this manner, gives the results of the inquiry made during the summer of 1911.

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[1]See G. S. Rep., 1863, pp. 345-352.

No.	Elev. above sea-level.	Locality, etc. Name of farm owner.	Depth from surface at which gypsum was encountered.	Remarks.
			Feet.	
1	......	½ mile north Onondaga.....	515	Questionable.
2	......	Ludlow's, Onondaga........	70	9 feet encountered.
3	......	Campbell's, Onondaga......	70	5 feet encountered.
4	......	Ferinhough................	50	10 feet in water well.
5	......	J. Jackson................	55	....
6	628	Jan. Patterson............	20	....
7	618	Dave Patterson............	28	....
8	654	Geo. Smith................	59	15 feet thick.
9	645	Matt. Richardson..........	?	Gypsum encountered, but poor.
10	627	John Cummings.............	?	Gypsum encountered, but poor.
11	635	Hagers....................	80	2 feet showing.
12	638	Hagers....................	80	2 feet showing.
13	614	Lem. Creswell.............	55	4 feet to 5 feet encountered.
14	614	Wm. Brown.................	55	10 feet to 15 feet.
15	612	Matt. Richardson..........	?	A very little gypsum.
16	787	James Ramsay..............	40	4 feet gypsum.
17	835	James Moore...............	60	6 feet to 8 feet.
18	812	James Whicher.............	?	A little.
19	890	Robt. Thompson............	40	A little.
20	825	John Brooks...............	100	1 foot.
21	634	Bert Mellish..............	41	6 feet good gypsum and 16 feet gypsum.
22	665	John Lee..................	?	A little.
23	647	Jos. Hudspeth.............	?	A little.
24	674	Wesley Taylor.............	?	Water well drilled 30 years ago. Struck plaster.
25	650	Jas. Ramsay...............	55	7 feet gypsum.
26	693	Bert Mellish..............	48	Shaft showing 4 feet good white plaster.
27	625	Robt. Holstein............	....	Old drift at water's edge in 4 ft. bed.
28	691	Robt. Holstein............	60	Old, abandoned, and caved shaft.
29	696	Robt. Holstein, new shaft...	60	2 feet pink plaster. 3 feet rock —by drill—9 feet plaster.
30	674	John O'Reilly.............	55	7 feet plaster water well.
31	654	Pat Frazer................	60	16 feet plaster.
32	689	Carson mine...............	50	4 ft. bed; white plaster.
33	......	John Beal.................	40	4 feet gypsum in shaft.
34	......	Merritt mine..............	30	Incline tunnel, 4 ft. bed.
35	650	Caledonia Gypsum Company..........	....	....
36	650	Alabastine Co.............	....	....
37	......	1 mile above Paris........	....	On banks of Grand river—4 feet.
38	......	1½ miles below Paris.......	....	On banks of Grand river—2 to 7 feet.
39	......	Crown Gypsum Co...........	70	Mine. 4 ft. bed, white gypsum.
40	......	Well of Gypsum Co.........	70 and 100	15 feet gypsum at 100 feet.
41	......	Well of Gypsum Co.........	60 and 100	15 feet white gypsum at 100 feet.
42	......	Dunnville.................	205	Hard shale with gypsum (O.B.M., Vol. I, p. 137.)
43	......	Teasdale mine.............	40	2 shafts and tunnel.
44	......	Imperial Plaster Co.......	30	Shaft and tunnel.
45	......	Mansell McCallum farm....	between 56–346	Log well No. 2, ½ mile south Darling road station, Wabash Ry., Canborough tp.
46	648	Prov. Nat. Gas Co., lot 64, con. I, tp. Colchester S. ...	between 203–290	....

Wherever possible, vertical sections were worked out from shafts, etc., and these are given.

(1.) Section in shaft Crown Gypsum Co., York.

Elevation 683.	Feet.	
Clay	1–49	49 feet
Broken limestone and gravel	49–57	8 "
Limestone	57–59	2 "
Mudseam (Watercourse)		2 inches
Limestone (broken)	59–63	4 feet
Dolomite	63–68	5 "
Broken gypsum and dolomite	68–72	4 "
Dolomite	72–73	1 "
Gypsum (workable bed)	73–77½	4½ "
Dolomite		

Gypsum in this shaft is found at 73 feet.

(2.) Kerr Mine station on line of Buffalo and Goderich (N. ½. lot V, Cooks block, tp. Haldimand).

Shaft down 80 feet on incline 1 in 10.	Feet.	Vert. Feet.
Clay and hard pan	39	4
Slate	11	1
Gypsum (pink variety) mixed	30	3

(3.) Windmill water well at west side of compressor house Crown Gypsum Co., York.

Elevation 676.	Feet.	Feet.
Clay	1–35	35
Hard pan	35–53	18
Shale and dolomite	53–69	16
Gypsum	69–74	5 (white), water at 97 feet.
Dolomite	74–104	30
Gypsum	104–120	16 (fairly good), second bed.
Shale	120–125	5 bottom of hole.

This hole shows up the presence of a second bed of gypsum on this property underneath the one at present being mined. In a drill hole being sunk on the eastern part of the property, the following record was obtained, the elevation of the collar being 688.

(4.)

	Feet.	Feet.
Clay and soil	1–30(?)	30
Hard pan	30–60(?)	30
Shale	60–75	15
Broken dolomite and open chamber (Probably abandoned working of ancient mine)	75–78	3
Dolomite	78–100	22
Gypsum (good quality)	100–115	15

The second bed also appears in this hole, and if it is continuous, a large tonnage may be obtained from it in the future. An analysis of the core from the above hole (second bed) was made and the results are given elsewhere in this bulletin (See Chapter X).

(5.) In the shaft of the Alabastine Company at Caledonia, now timbered up so that the walls are covered, the following section was given as representing the occurrence of the different beds:—

	Feet.	Feet.
Clay and hard pan	1–40	40
Slate	40–46	6
Gypsum, with 40% slate	46–55	9
Mixed slate with gypsum	55–70	15
Gypsum	70–74	4
(Upper seam not mined at present)		
Gypsum	74–81	7

The term slate in this case is used to designate country rock.

(6.) At the farm of Bert Mellish in Seneca township, Haldimand county, a gas well was sunk which passed through the following material:—

Elevation 634	Feet.	Feet.
Clay	1–15	15
Shale	15–35	20
Limestone	35–41 (hard)	6
Plaster	41–47 (good quality)	6
(Mixed)	47–63 (questionable)	16

(7.) In a shaft sunk on the Holstein property on the south side of the Grand river, and opposite Caledonia, the following rock was encountered:—

Elevation 696	Feet.	Feet.
Clay and shale	1–55	55
Gypsum (pink)	55–57	2
Dolomite	57–60	3

From the bottom of this shaft a drill hole was sunk to a farther depth of 9 feet, and was in good white gypsum all the way.

(8.) About a mile below Paris, on the north bank of the Grand river, gypsum outcrops are to be found. Here the gypsum is about 3 feet in width. The section of the bank is as follows:—

	Feet.	Feet.
Clay	1–30	30
Shale	30–50	20
Cemented gravel	50–60	10
Limestone (broken)	60–62	2
Gypsum	62–65	3
Broken limestone	65–	

Although the gypsum in the district in which active operations are being carried on appears to be lying in the form of a syncline, the whole formation has a dip to the west and southwest, so that in the salt wells of the Windsor and Sarnia districts gypsum is encountered, but only in small amounts, and at considerable depth. There is a possibility of other gypsum districts being found, and operated to the northwest of the present field, but systematic drilling and prospecting will have to be employed.

A. Gypsum outcrop in bank of Grand river, one mile below Paris, Ont.

B. Boulders of gypsum on bank of Grand river, one mile below Paris, Ont.

HISTORY OF THE GYPSUM INDUSTRY IN ONTARIO.

The beginning of the gypsum industry in the Province of Ontario dates back to the beginning of the nineteenth century. Gypsum was first discovered near the locality where the town of Paris now stands. At first it was used entirely as a land plaster among the farmers of this district, who made use of it quite extensively as a fertilizer on their clover fields. Mr. Archibald Blue, in the first Annual Report of the Ontario Bureau of Mines, page 113, makes the following footnote, which bears directly on the earliest history of the gypsum industry in this district:—

"The history of the county of Brant gives some account of the early history of gypsum mining and the manufacture of land plaster at Paris. Henry Capron, who founded the town of Paris, was born in Vermont in 1796, came to Canada in 1822, and joined Joseph Van Norman in the manufacture of pig iron from bog ore in the county of Norfolk. It was hard work, but Capron made money, sold out his interest in the iron furnace May 7th, 1828, and visiting the forks of the Grand river in 1829, bought 1,000 acres of land there from William Holmes. This included nearly all of the present site of Paris. In the same year he hired a Mr. Cushman, a wheelwright, to build a mill with two run of stones, one for grain and the other for plaster. This mill stood on the river Nith, a little way from the junction of that river with the Grand. One Charles Conklin was employed as manager, and at the end of 1830 he rented the mill from Capron, and threw himself into the business with great energy and success, mining and grinding gypsum, making brick, etc. The first mill, for manufacturing gypsum, was built in 1823, by William Holmes. From him it passed into the hands of Thomas W. Coleman. It is now worked by Gill, Allan and Co., of Paris."

This note was made in the year 1891. In order to follow the history of the gypsum industry in this district, a brief description of the different mines that have operated from time to time will cover all the facts in the most concise manner. These properties will be dealt with in the order of the date of their starting operations.

Paris Plaster Mine. This property was where the first gypsum in the Province of Ontario was mined. Some time about the year 1822 a man by the name of Wm. Holmes opened up a bed of gypsum, and extracted a few tons for local use as a fertilizer. In 1823 he erected a mill for grinding this gypsum. He operated this for a few years, after which it passed into the hands of Thos. W. Coleman. The property is situated on the west bank of the Grand river, about $1\frac{1}{4}$ miles below the present location of the town of Paris.

The mine has been one of the largest producers of gypsum in the district, and it was worked continuously by several different companies, with only a few shut downs, until a few years ago. In the year 1890 it was purchased by the Alabastine Company, the present owners.

The gypsum was found in a bed of about 5 feet in thickness, overlain by limestone of a few feet in thickness, and above this boulders and clay to the surface.

The mining was carried on by means of a tunnel driven in from the river's edge, the gypsum bed being above the general level of the water in the river.

The gypsum mined was the grey variety, interstratified with narrow bands of soft white. This was ground, and used extensively for fertilizer, and in later years for stucco. Large quantities of the rock have been taken from this mine during its life.

Cooks Mines. Although these were among the earliest quarries to be operated, they do not seem to have been of great importance, their product being used only locally as a fertilizer. They were situated on the south side of the Grand river, one mile below the village of York, and the gypsum was hauled by teams to this village, where it was handled by a mill erected in 1838 by Cook. The rock was of a good grade of white gypsum.

Martindale Mine. This property, lying very near the Cook mines on lots 56 and 57 R.R. on the south side of the Grand river, was discovered accidentally by John Martindale, while digging a cellar for his house. He immediately saw the opportunities in his discovery, and operations on a small scale were at once started. This was in the year 1846. A tunnel was run in from the river, and the rock, which was a very good grade of white gypsum, was teamed to the village of York, where it was crushed in a mill operated by water power. For a time Mr. Martindale operated a small calcining works, but in the later years the rock was only crushed in preparation for fertilizer. The calcining mill had a daily capacity of about 10 tons. This property was operated with only minor shut downs until 1896, when it was closed. For about 12 years it lay idle, until it was taken over in 1908 by the Crown Gypsum Co., which Company is at present operating it.

Grand River Plaster Co. This Company, which obtained control in 1880 of the Merritt and the Glenny mines, was one of the later companies operating in this district. The mines, however, which they operated, were among the older ones, the Merritt having started operations about the year 1850, and the Glenny in 1874. A grinding mill had been erected in 1878, and in 1886 a calcining mill was in operation. About 25 to 30 tons per day were handled, and made into wall plaster and land plaster, and the product was shipped by boats down the Grand river, or in later years by rail from Cayuga. A short description of the mill may be quoted:—

"The rock is treated as follows: It is first sorted, then passed through a Kelly crusher and falls into the disintegrator, and thence it is elevated to a hopper, which feeds the buhr stones for grinding. When ground it is again elevated into a bin and shovelled into the kettle for roasting. A batch of 35 or 40 barrels is treated in about three hours, being actively stirred with mullers during the time of roasting. After roasting it is again screened and put into sacks and barrels for the market."[1]

The kettle employed in this mill was of about 5 tons capacity. This Company ceased operations about the year 1893.

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[1]Ontario Bureau of Mines, Vol. I, p. 242, 1891.

Merritt Mine. The Merritt mine was first opened up about the year 1850, and was operated for local use practically continuously until taken over in 1880 by the Grand River Plaster Company. The material obtained from this bed was a fair grade of white gypsum. The bed had an average thickness of 4½ feet, and was said to extend over an area of 35 acres. The mine was operated by a tunnel driven on a level, and, with the exception of about 30 yards at the beginning, the tunnel was in good clean white gypsum all the time. The mill, located on this property, has been described under the Grand River Plaster Company. The property is located on lots 2 and 3 in Huff tract, township of South Cayuga.

Garland Mine. The Garland property, consisting of 29 acres on lot 13, in concession V, township of Oneida, was opened up by Mr. Joseph Brown, who, while sinking a water well on this property, which he then owned, ran into about 4½ feet of white gypsum of good quality. Brown sold the property to Mr. N. Garland, of Toronto, who started mining very shortly after. The mine was opened up by an incline drift, driven southwestward from a few feet above the level of Mackenzie creek. This incline caved and filled with clay overburden, consequently a new opening was started on lot 13, concession VI, on an incline of 1 to 9, and the gypsum was reached at a vertical depth of 57 feet. The roof consisted of about 5 inches of soft dolomite, and the gypsum bed averaged about 4½ feet in thickness.

In 1881 the property passed into the hands of L. H. Johnson, of Caledonia, who operated it for 9 or 10 years. In 1891 it again passed into the hands of Mr. N. Garland, who operated it until 1895. The Alabastine Company of Paris are at present operating this property under the name of the Carson mine.

The gypsum from this mine was hauled by teams to the town of Caledonia, where it was ground at a mill and shipped all over Ontario for use as a fertilizer.

Mount Healy Mine. This mine was first opened about the year 1870 by W. Donaldson & Co., who worked it continuously for about 18 years. It is situated about one mile below the village of York on the south bank of the Grand river on what is known as the Cook block. (Probably this was the same property as operated first by Cook in 1838). The bed is about 4 feet in thickness, and of a good grade of white gypsum. This property now constitutes part of that held and operated by the Crown Gypsum Company.

Glenny Mine. The property known as the Glenny mine is situated on lot 3 of the Jones tract. This is about 3 miles below the town of Cayuga and on the south side of the river. It was worked for six years by Mr. Glenny, who then sold it in 1880 to the Grand River Plaster Co. This Company operated it for three or four years. Since that time it has been idle.

Excelsior Mine. On lot 2 of the Jones tract, Grand River road, a mine was opened up in 1875, and a fairly large tonnage was extracted. The property covers an area of 65 acres.

The property was first opened and operated for four years by A. W. Thompson, and then disposed of to Messrs. Gill, Allan, and Brown of Paris. This latter firm sold it in 1890 to the Adamant Manufacturing Company of Syracuse, N.Y.

The mine was operated by an incline with a slope of 1 in 10, and reaches the bed of gypsum at a depth of about 50 feet. The back and floor consist of a very hard limestone. The gypsum bed itself is of white rock about 4 feet thick.

Shortly after the bed was first opened, a mill to grind the rock was erected on the property, and was operated until 1879, when the material intended for the manufacture of wall plaster was shipped to Paris and treated at the mill of Messrs. Gill, Allan, and Brown.

In 1891, shortly after the Adamant Manufacturing Company obtained control, they erected a calcining plant and shipped the product to the Adamant Mills in Toronto. Here it was mixed and prepared by machinery into hard wall plaster ready mixed with sand, etc. In 1893 the Alabastine Company of Paris took a lease on this property, but it has not been operated since 1895.

Teasdale Mine. The Teasdale mine situated on lot 1, Huffman tract, township of N. Cayuga, and lot 4, Jones tract, was opened by Mr. Thomas Teasdale in 1889. In the first year about 100 tons of rock were extracted. The bed averaged about 4½ feet thick of a good quality of white gypsum. The Alabastine Company of Paris very soon obtained a lease of the property and mining was carried on until the year 1895.

Torrence Mine. This prospect, consisting of 133 acres, on lot 16, concession I, township of Brantford, was opened up by Wm. Hynes and James Wright, but was only operated for a short period, for although some good gypsum was encountered in spots of the drift the main bed was not located. Prospecting was first carried on here in 1846.

Imperial Plaster Company. This Company was incorporated in 1902. They obtained control of a gypsum property about 2½ miles below Cayuga, on the Grand river, and operated it continuously until 1910. They erected a one kettle mill for calcining in Toronto. This Company was taken over by the Toronto Plaster Co. in 1911.

Crown Gypsum Company.

Carson mine.

Albastine Co., Caledonia mine.

Caledonia Gypsum Co., mine.

These properties are all working at present, and are described fully elsewhere.

THE CROWN GYPSUM COMPANY.

The Crown Gypsum Company has its mine situated about 1½ miles southeast of the village of York, in the county of Haldimand. The area of property under lease is 400 acres.

The Company has also under lease a property of 100 acres, about 4½ miles to the east of York, known as the Kerr property. This property is situated on the Grand Trunk line, from Buffalo to Goderich, at Cooks station. A shaft has been sunk to a depth of 80 feet, the last 30 feet being in a variety of pink gypsum. No further work has been done on this property, so no further record of the quality or extent of the deposit could be obtained.

The property on which this Company's working mine is situated is one of the first places in this district from which gypsum was mined. With the exception of about 12 years this gypsum bed has been operated continuously since about 1866.

The beds are covered with about 70 feet of drift, shale, and limestone. The one which is being worked is reached by an incline tunnel 500 feet in length with a bearing of N. 73°E. This bed consists of a very high grade white gypsum suitable for the best grades of plaster of Paris, and breaks clean to both floor and back so that very little waste has to be sorted out underground. Hand power is employed for drilling the waste rock in the mine. The bed has an average thickness of about 4 feet, and as only the gypsum is broken, the workings are consequently very low, thus making moving around underground very difficult.

The method employed for mining the gypsum in this mine is very similar to the room and pillar method employed in coal mines. At present the workings extend over only a small area, so that no regular method has been adopted, but pillars of the gypsum have been left wherever it has been thought they were needed. These pillars will vary from 10 feet to 30 feet in diameter. The bed seems to be flat with only local variations, and is found to pinch out, in some cases altogether, and in others to a very thin bed, too thin to work to advantage. Underground waters and streams have in places dissolved the lower part of this bed, leaving large underground channels or caves extending in some cases over 100 feet in length and varying from 5 to 30 feet in width (See Plate XVIII for two views underground in this mine.) In the particular cave shown in the illustration the lower half of the bed has been completely dissolved away for a width of 20 feet and a height of about 2 feet in the centre of the arch. The rock which forms the back, although not of very great thickness, gives good support to the mass of drift which overlies it. The floor of the workings is generally fairly smooth, the gypsum breaking easily to both bedding planes.

The drilling is done by two auger power drills, the holes varying from 5 to 7 feet in depth. The charge used in breaking the gypsum is made up as required, and consists of 25 per cent to 40 per cent dynamite, mixed with 75 per cent or less of black powder. This is found sufficient while working in plaster.

The ten hour shift is in force but a good deal of overtime is put in, as no night shift is employed.

Small end dump cars, with a capacity of 3,500 pounds, are loaded directly at the working face, and these are hauled up the incline, six or seven being drawn up at one time.

Surface Plant. The surface plant of the Crown Gypsum Company is of the simplest form possible, consistent with the satisfactory and economic operation of the mine. One frame building holds the complete plant (See Plate XVII).

This plant consists of 100 H.P. Scotch marine tubular boiler, one small two cylinder compressor, made by the Blaisdell Machinery Company, Bradford, Pa., one single cylinder engine with necessary gearing, and drum for hoisting rock, one small 6″ Cameron pump for boiler feed, and blacksmith shop. Soft coal from Pittsburgh is employed for the boiler. Two windmill pumps, about 100 yards apart, supply sufficient water for the use of the boiler. This water, however, is very hard, and sodium phosphate and zinc compounds have to be used constantly.

The rock is handled in small cars with a capacity of 3,500 pounds each. A narrow gauge railway, 3 miles in length, affords facilities for transporting the gypsum from the mine to the mill. A small locomotive hauls about ten tons each trip.

Mill. The crushing and calcining plant of the Crown Gypsum Company is situated on the north side of the track of the main line of the Michigan Central railway from Buffalo to Windsor, at a station named Lythmore. A siding affords easy shipping facilities for the loading and shipping of the finished product.

This Company was organized under the Ontario Company's Act, in February 1908, and a mill was shortly after erected at which the gypsum mined was calcined. This mill was operated continuously until its complete destruction by fire in July 1911. To replace the old mill, a new fireproof mill has been built and is now in full operation. The main mill building is constructed throughout of brick, steel, and concrete. In order to safeguard against a repetition of the fire of 1911, approved fire doors have been added, and it is proposed to protect those portions of the building used for the storage of bags and supplies with a thorough system of automatic sprinklers of the dry pipe type, served by a large tank independent of the mill structure. This tank will also supply water for the sprinklers to be located in the packing house and mixing room, as well as all other buildings that are not of wholly fireproof construction.

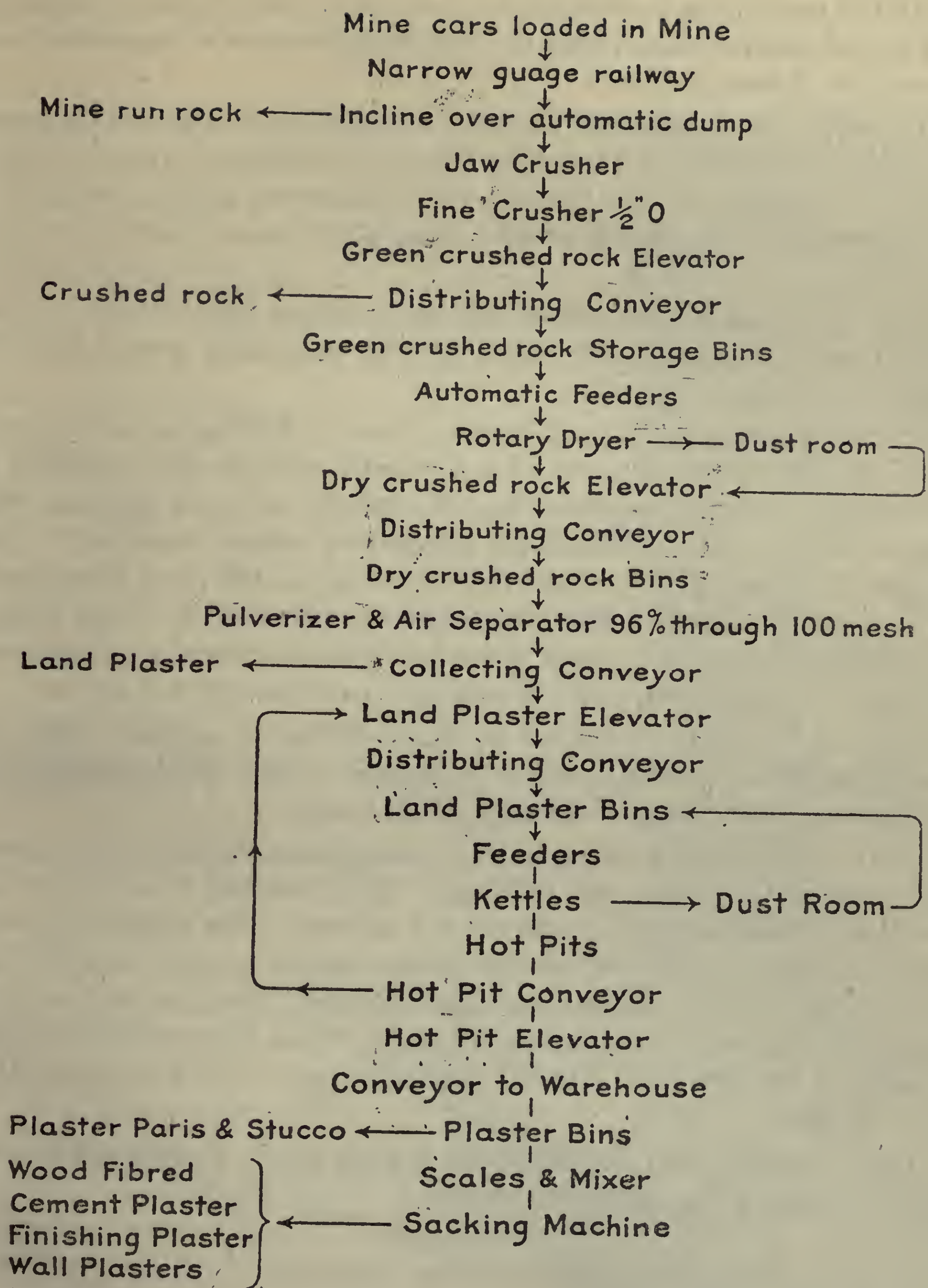
The mill has been equipped with all the latest machinery of approved gypsum manufacture. By a reference to Fig. 6, the flow sheet of this mill can be seen.

A. Mine building, Crown Gypsum Company, York, Ont.

B. Hoisting apparatus and cars, Crown Gypsum Company, York, Ont.

A. Underground cave, waterworn, Crown Gypsum Company, York, Ont.

B. View underground in mine of Crown Gypsum Company, York, Ont., showing width of bed being worked.



Notes: Crusher capacity 30 Tons per Hour
Dryer " 40 " " "
Elevating & Conveying Machinery 45 Tons per Hour
Calcining capacity finished Mill 20 " " "
Loading capacity:
Crushed rock 30 Tons per Hour
Unfibred Goods 30 " " "
Fibred Goods 22 " " "

Fig. 6. Flow sheet, Crown Gypsum Co., Ltd., gypsum plant, Lythmore, Ontario.

All the machinery is electrically driven by a combination of individual and group drives so located that the different processes of manufacture are independent of one another.

Electric power is obtained from the Hydro-Electric Power Commission of Ontario, at 13,500 volts, from the Dundas sub-station, and is delivered by the commission to the Company's transformer station, where it is stepped down to 550 volts, at which voltage the current is used throughout the mill.

The Company's transformer station contains three banks of three 75 Kv.a. single phase transformers, giving something over 1,000 H.P. available for use in the mill.

All the gypsum is thoroughly dried before grinding in a large rotary drier. The pulverizing is done by a new type of roller mill, replacing the old fashioned buhrstones which are so common in many gypsum mills. Air separation in connexion with the pulverizers ensures material of a fineness which will permit 96 per cent to pass through a 100 mesh sieve, and at least 75 per cent through a 200 mesh standard testing sieve. Such material is recognized as making a better plaster, will carry a greater proportion of sand, make a denser wall, and will not age to any perceptible extent.

The calcining is carried on in three kettles of special design, the temperature in each being recorded by automatic individual thermometers, thus ensuring uniformity of material at all times.

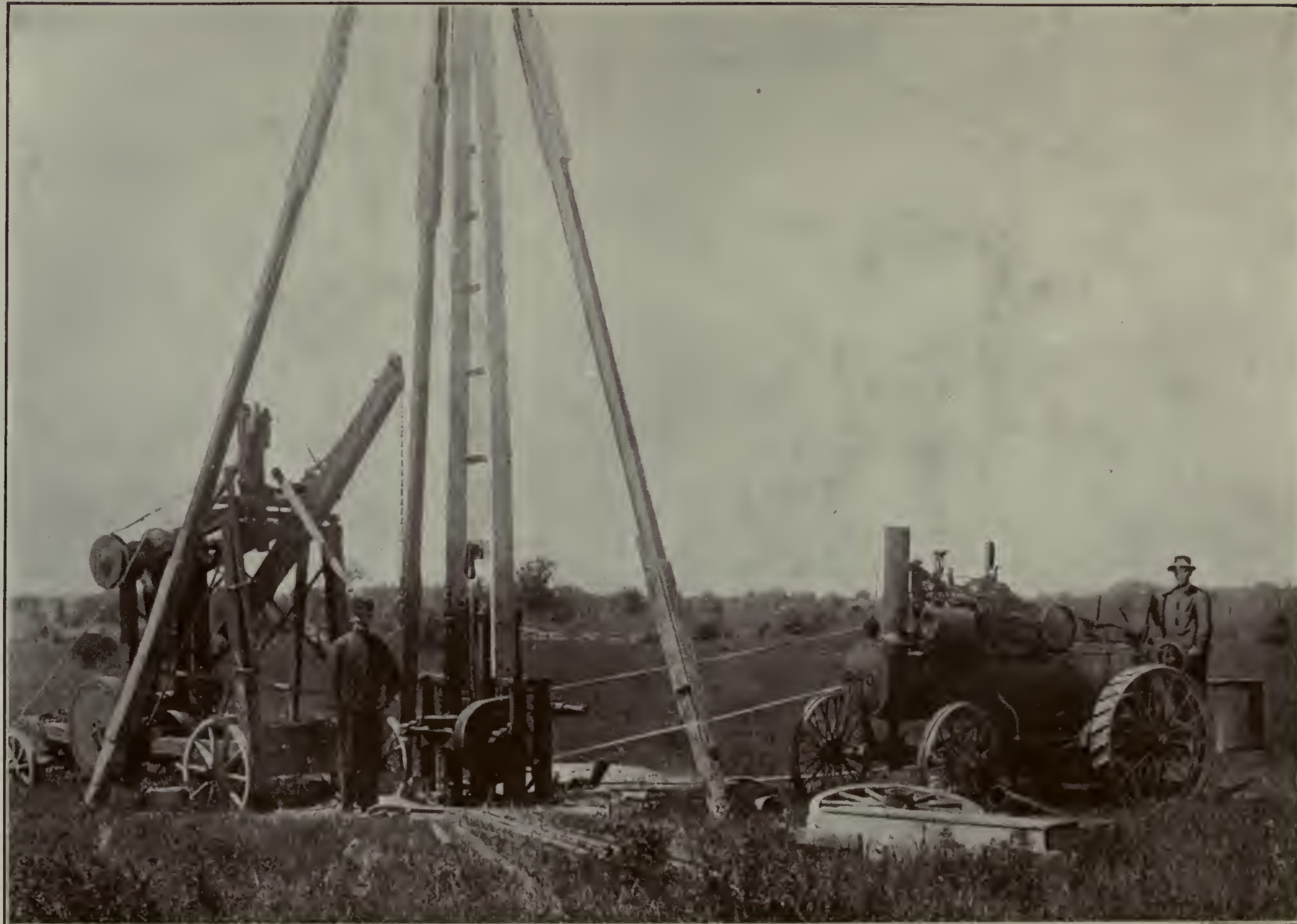
All the mixing and packing is done in a separate building removed some distance from the main mill building. This building is of heavy type construction, having cribbed bins for the storage of the calcined material. All ingredients going into the mixed wall plasters are weighed carefully in an automatic hopper scale suspended over the mixer. Sacking is done by the Bates process of valve-bagging machines, by which the packages are filled and weighed and delivered into the car by a conveyer at the rate of about 30 tons an hour.

The Company owns a large supply of a fine grade of white gypsum rock which produces a high grade of plaster.

THE ALABASTINE COMPANY.

This Company has its head office in Paris, Ont., with one mill there and another in Caledonia. Its larger mine is at the latter place under the property on which the mill stands, and the Carson mine, from which it obtains its white rock, is situated about 3 miles to the south of Caledonia, and on the south side of the Grand river.

The Alabastine Company was organized about the year 1887 with the primary object of making alabastine wall tints. They obtained most of their crude material from their property about 3 miles below Cayuga, where a very white grade of gypsum was mined. At first a very little of this material



Drilling on the property of the Crown Gypsum Company, York, Ont. Churn drill used until rock was encountered and core drill now in position.

was manufactured and sold as stucco or wall plaster, Nova Scotia product supplying most of the trade, but now a very healthy market for this material has been established by this Company, so that the principal product is wall plaster in its different forms. The crude material is being obtained from the two mines above mentioned. The surface area of these properties is about 134 acres.

Carson Mine. The Carson mine covers an area of 100 acres, and is situated about 3 miles to the south of the town of Caledonia. The rock obtained from this mine is very white, of a pure quality, and well adapted to the manufacture of the finer grades of plaster where whiteness and purity are the essential factors. The bed which is covered by drift, shales, and dolomite to the depth of about 60 feet, has been opened up by an incline tunnel 500 feet in length on an incline of 1 in 8, and air shaft 70 feet in depth. No estimate of the extent of the bed has been made, but where the rock has been taken out, the bed has averaged a thickness of 4 feet. The present workings extend over an area of 1½ acres. The rock breaks to a very well defined slip along the floor and fairly clean along the back, thus enabling it to be taken out free from waste by only a small amount of sorting. The back consists of a very fine grained dolomite of a slatish grey colour. The line of junction between this dolomite and the gypsum is uneven, and although well defined, has a narrow band of mixed dolomite and gypsum forming an intermediary transition bed between them.

Like other deposits in this district, the bed is not continuous for any great distance, cutting off either abruptly or gradually pinching until it becomes too narrow to work at a profit. Where the bed cuts off abruptly there is no change in thickness and the material encountered is generally a soft mud seam. Prospecting farther than this mud seam generally fails to locate any continuation of the bed. The form or contour of the surface generally indicates the possibility of the beds being present or absent according as the surface shows an elevation or depression.

The bed averages about 4 feet in thickness, and is very uniform in quality throughout. Drilling is carried on by hand power, using auger bits, and a low power dynamite is used for breaking. The broken rock is loaded into wooden box cars of three-fourths ton capacity, and these are hauled singly up the incline to the surface by a horse.

A storage shed is located at the mouth of the incline and directly beside the wagon road, and here the rock is piled ready for hauling away by wagons and teams to the mill at Caledonia.

Caledonia Mine.

The Alabastine Company's mine at Caledonia has the largest output in the district. It is situated on an area of 34 acres, about one-fourth of a mile to the north of the town.

The bed which is being worked is about 11 feet in thickness. A well defined horizontal slip about 8 feet above the floor divides this bed into two distinct parts, and at present only the lower part, that below the slip, is being mined. The upper part, although a very good gypsum, is not quite as high a grade as the lower, and is being held in reserve. This is partly due to the fact that the bottom of the upper bed is very smooth along the slip and forms an excellent back to break to, thus taking less breaking power and leaving the broken rock clean and ready to be loaded directly into the skip without any hand sorting. Pillars are left every 20 feet to support the back. These are generally about 20 feet in diameter. Two electric rock drills are employed, and these are sufficient to drill enough ground to supply the tonnage required by the mill each day. A shaft to the west of the incline has been sunk to the bed to afford better ventilation in the mine. A horse is employed to haul the steel cars to the bottom of the incline. The incline, which is about 800 feet in length, has a grade of about 1 in 10. It is only wide enough for a single track and consequently balanced hoisting is not employed. The mill is situated at the top of this incline. A view of the mill is shown in Plate XX.

Buildings. The Alabastine Company's mill at Caledonia is a concrete structure, with the exception of the mixing mill, which is a wood frame with galvanized iron sheeting. The concrete building measures 40′ × 96′ and the mixing and shipping building 40′ × 60′. A concrete wall separates the wooden structure from the calcining kettles and boilers. As will be seen from the illustration, the shipping cars are placed on a spur on either side of the shipping room.

Power Plant. Power for running the machinery in the mill, such as crushers, buhr mills, conveyers, elevators, and the mechanical stirrers in the kettles, is furnished by two 2-cylinder Bessemer gas engines of 75 H.P. and 150 H.P. respectively, and one Westinghouse vertical 3-cylinder engine of 125 H.P. These revolve at the rate of 225 r.p.m. and operate a Canadian General Electric Co. generator—225 volts, 200 amps. (60 H.P.) —as well as the drive shafting for the above-mentioned machinery. In addition to the gas power, 300 H.P. Hydro-Electric power is now installed. The rock is hoisted from the mine in a 3 ton semi-cylinder steel skip, by a hoist operated by a 40 H.P. motor. The power plant is located in the northwest corner of the concrete building. Natural gas, from the wells on the Company's property, is employed to operate the engines.

Mill. The rock, after reaching the head of the incline at the top of the building, is dumped directly into a rotary crusher made by Butterworth and Lowe. This reduces the material to inch size and under. It is then hoisted to a storage bin by an elevator. From this bin it is fed to four disintegrators or buhr mills which reduce the material so that it will all pass through a 50 mesh. A conveyer and an elevator place it in two 15 ton bins above and to the side of the kettles. The kettles are of 15 tons capacity, with

PLATE XX.

Mill of the Alabastine Company, Ltd., Caledonia, Ont., showing incline from mine and gypsum being teamed from the Carson mine.

four 12″ flues for heating, 4″ rotating shaft with paddles for agitating the material, and sectional kettle bottoms of cast iron. The pulverized rock is run into these kettles from the bin until the kettles are filled. A tempera-

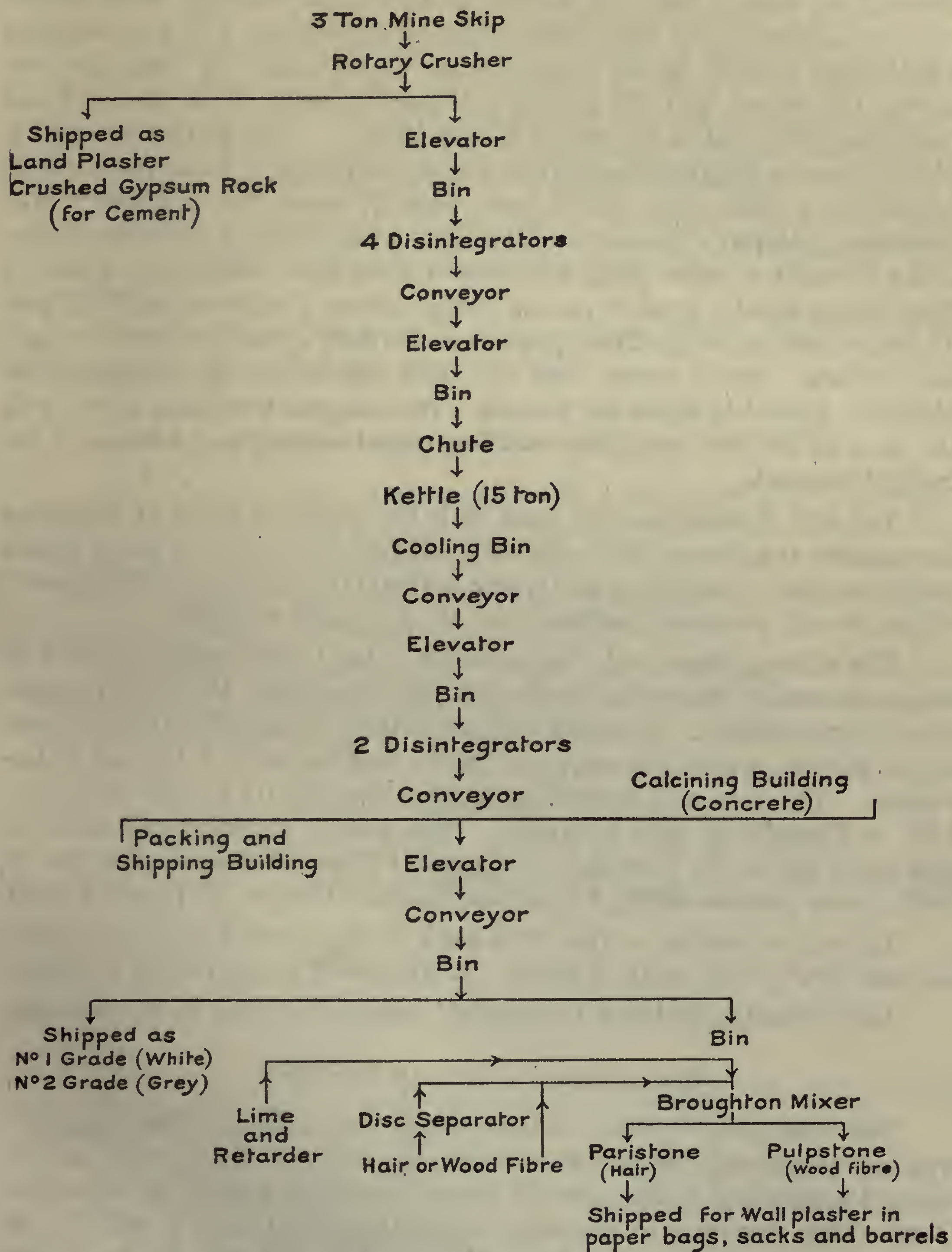


Fig. 7. Flow sheet of the Alabastine Co., Caledonia, Ont.

ture of 360° F. is used to start the run, and this is gradually increased to about 420° F., when the calcined material is allowed to drop by gravity down a chute from the bottom of the kettle to concrete cooling bins. The complete run in a kettle takes from $2\frac{1}{2}$ to 3 hours. Passing over another conveyer and elevator the calcined gypsum is deposited in a steel circular bin similar to those in which material is deposited before being run into the kettles. From these bins it flows by gravity to two disintegrators, which reduce any lumps which may have formed during calcination, and pulverize the whole mass so that it will pass through an 80 mesh. A long conveyer carries the stucco into the mixing and packing mill. It is elevated and conveyed into a bin at the top of the building. Part of this material is placed either in bags and barrels and shipped as plaster of Paris (white rock) called No. 1 grade, and stucco (grey variety) called No. 2 grade. The remaining material is transferred by a chute to another bin, and from thence into a Broughton mixer along with hair or wood fibre, retarder, and lime to form the marketable product known to the trade as *Paristone* and *Pulpstone*. These are both good hardwall plasters and obtain a ready market throughout Ontario. Stout paper bags are used extensively in packing these plasters. Each bag holds 100 pounds. The shipping floor is on a level with the floor of the box cars, thus enabling easy handling and loading of the finished product.

The mill is designed and built with the object in mind of extending its capacity at a future date. Space is left for the erection of three kettles and all necessary machinery pertaining to their installation, and the capacity of the present crushers is sufficient for the increased tonnage.

The white gypsum rock that is mined at the Carson mine is hauled by wagon, as seen in the photo, to the mill just described. Here it is crushed, ground, and calcined. It is then shipped to the second mill of the Company at Paris, Ont., where it is employed in the manufacture of Church's Alabastine. This is a wall decorating mixture covered by patents which are held in Canada by this Company. The patent covering this material was taken out in the Dominion of Canada Patent Office on September 11, 1895, under number 49956, by Melvin Batchlor Church, of Grand Rapids.

The mill is located on the north bank of the Grand river, just opposite the main part of the town of Paris. It consists of several small buildings.

The quantity produced in this mill varies according to the demand.

THE CALEDONIA GYPSUM COMPANY.

The Caledonia Gypsum Company, with head office at Hamilton, Ont., was organized and incorporated under the Ontario Companies' Act to operate a property of 105 acres in Seneca township, known as John Olds' farm. This property is situated about three-fourths of a mile to the northwest of the town of Caledonia, Ont., and is connected with the Grand Trunk railway by a short spur line, 200 yards long. The Alabastine Company's property adjoins it on the east, and prospecting was carried on in an endeavour to locate and open up the same bed as this latter Company was operating.

When this property was visited during the summer of 1911, an incline tunnel, about 70 feet in vertical depth, had been driven and a shaft sunk from the top of the hill to tap this and afford ventilation. This tunnel was at an incline of about 1 in 10, and had a direction of about N.25°W. At a vertical depth of 55 feet a small bed of low grade gypsum was encountered and some of this was crushed and shipped for use in cement. At the depth of 70 feet, small quantities of gypsum were encountered, mixed with the rock, but both were so closely intermingled that the gypsum could not be readily separated. A small crushing plant was erected on the property at the mouth of the incline, consisting of two gas engines, small hoist, small rotary crusher, electric motor for operating electric drill, and building.

Unfortunately, late in July, 1911, a fire destroyed the complete plant, after which the enterprise was abandoned.

THE TORONTO PLASTER COMPANY, LIMITED.

The Toronto Plaster Company, Ltd., was organized in September, 1911, to take over and operate the mine and mill of the Imperial Plaster Company, located at Cayuga and Toronto respectively. Work had not been commenced when visited in the autumn, but preparations were under way to begin operations as soon as possible.

The mine is situated about 3 miles to the southeast of the town of Cayuga, and embraces probably the property which was operated before by the Glenny and Excelsior mines. When visited nothing could be seen, as the tunnel was fastened up. Several tons of a good class of white plaster were piled at the mouth of the tunnel ready for shipment.

The mill of this Company, located at Toronto (King St. W.) will, when in operation, manufacture only plaster of Paris. The plant consists of the following:—

1–175 H.P. Corliss engine.

1–175 H.P. boiler

1– 10 ton kettle plant complete (Butterworth and Lowe).

Sturtevant grinders.

Permission could not be obtained to see through this plant, so further details are lacking.

The Company is now prospecting with a drill in the vicinity of Cayuga, in an endeavour to locate further beds of gypsum of a quality sufficiently pure for the best grades of plaster of Paris.

List of Principal Gypsum Mines in the Grand River Distict, Ontario.

Name of mine.	Location.	Date first opened.	Date shut down.	Average yearly tonnage.	Number of men employed	Area of property.	Remarks.
Paris plaster mine	On west bank of Grand river; on farms of Messrs. Millar and Martin, 1 mile below town of Paris	1822	....	1,000 tons	3	140 acres	Controlled by Alabastine Co. of Paris.
Grand River Plaster Co.	Lots 2 and 3, in Huff tract; township of North Cayuga	....	1865	....	20 to start 2	....	Two mines were opened up; second one soon closed.
Martindale mine	Lots 53 and 54, R.R. side Grand river, Martindale farm	1846	1896	1,000 tons	6	....	....
Merritt mine	Lots 1, 2, and 3, in township of Cayuga	1850	1893	2,000 tons	15	300 acres	Taken over by Grand River Plaster Co. in 1880.
Garland mine	Lot 13, concession VI, township of Oneida	1870	1897	1,000 tons	4 to 6	29 acres	Now operated as Carson mine by Alabastine Co.
Mount Healy mine	Cook block	1870	1894	1,000 tons	....	70 acres	Part of area now owned by Crown Gypsum Co.
Glenny mine	Lot 3 of the Jones tract	1874	1892	1,000 tons	....	106 acres	Taken over by Grand River Co. about 1880.
Excelsior mine	Lot 2, Grand River road, Jones tract	1875	1895	1,000 tons	3–6	65 acres	Taken over by Adamant Co. of Syracuse in 1890.
Adamant Mfg. Co.	Same as above	....	....	....	....	....	Leased by Alabastine Co. of Paris from Adamant Co.
Teasdale mine	Lot 1, on the Huffman tract and Jones tract	1889	1895	100 tons	2	....	Leased by Alabastine Co., Paris.
Torrence mine	Lot 16, concession I, township of Brantford	1896	1897(?)	Small amount	....	133 acres	Prospecting first carried on in 1846, but abandoned.
Imperial Plaster Co.	Lot 3 of Jones tract	1902	1910	....	....	....	Now operated by Toronto Plaster Company.
Cooks mines	South side of Grand river, about 1 mile below York	before 1838	?	....	....	....	First mill erected in York in 1838 by a Mr. Cook.
Crown Gypsum Co.	Old Martindale mine	1908	....	....	....	....	....
Carson mine	Garland mine	....	....	....	....	....	....
Alabastine Co. mine	New property	1908	....	....	....	....	....
Caledonia Gypsum Co. mine.	New property	1910	1911	....	....	....	Ceased operations in autumn of 1911. Mill burnt

CHAPTER VIII

GYPSUM IN MANITOBA.

The existence in the northern part of Manitoba of the mineral gypsum in commercial quantities has been known for nearly thirty years. It was not, however, until about the year 1888 that any steps were taken to determine the possibilities and extent of these deposits, when Mr. J. B. Tyrrell made a survey of the district and gave an admirable description of them in his report to the Geological Survey.

The district in which gypsum outcrops are known to occur covers an area of about 7 miles north and south and 8 miles east and west, being located principally in township 33, range VIII; township 33, range IX; N. ½ township 32, range VIII; N. ½ township 32, range IX; all west of the principal meridian.

TOPOGRAPHY AND GEOLOGY.

The country in which these deposits are found is very rough and irregular, consisting of a series of ridges which rise on an average of 60 feet above the level of Lake St. Martin. Between these ridges the ground consists of a series of long narrow, low lying meadows and muskegs, having a general trend north and south. The ridges support a good growth of poplar and birch, as well as an occasional forest of spruce and tamarack. At present the country is very swampy, but gradually as the lower ridges and meadows become cleared and put under cultivation, the country will become dryer and the fertile soil which covers the lower parts of the district will be able to support a large agricultural population. Already the land is being taken up for homesteads to a considerable extent.

In these irregular ridges, so characteristic of this district, small holes and caves are found in which are exposures of soft, white gypsum.

On the accompanying map, the areas under which gypsum are found have been designated.

Secs. 26 and 35, Tp. 32, R. IX, Part of Sec. 2, Tp. 33, R. IX, and Part of Sec. 25, Tp. 32, R. IX.

Underlying the above sections is the largest deposit so far known in this district. It is from this that all the gypsum so far mined in Manitoba has been taken. Mr. J. B. Tyrrell in his description of the occurrence of gypsum refers to the northern end of this deposit as follows:—

"In a northwesterly direction the ridge was followed for two miles further, to a rather conspicuous hill a short distance north of the Ninth Base Line in section 2, township 33, range 9, west of the principal meridian. In this distance it appeared to be broken through by considerable gaps in several places, but where it was well marked it invariably showed the irregular surface so characteristic of country underlain by gypsum deposits. In many places, small caves would extend in from the bottoms or sides of the pits, some of which held beautifully clear, cold water.

"The thickness of the exposure of gypsum in these holes and caves was nowhere very great, ranging as a rule from three feet to six feet six inches, but in none of them was the total thickness of the deposit seen.

"The hill at the furthest point to which the ridge was followed, rises as a rounded knob, twenty feet above its general level. This hill, like the others, appears to be composed of gypsum, as on its sides are holes extending down twenty feet below its top, in which beds of gypsum are well exposed."[1]

The southern part of this deposit has been bared of trees and partially stripped of its overburden preparatory to quarrying the gypsum. As this area is the one which is at present being operated, it will be described at greater length later in this chapter.

Tp. 32, R. VIII, Part Sec. 31.

In this section a portion of one of the ridges of the district is seen rising about 30 to 35 feet above the surrounding meadows and swamps. Mr. J. B. Tyrrell refers to it as follows:—

"In the northwest corner of township 32, range 8, west of the principal meridian, is a rounded hill rising thirty-five feet above the plain, its greatest length being about 600 feet, and its greatest breadth 150 feet. Its surface is overgrown with small canoe-birch. Two holes, each about eight feet deep, have been dug by prospectors in this hill. One at the top shows, below a foot of decomposed material, seven feet of hard, compact, white anhydrite or "bull plaster," exhibiting a more or less nodular structure, and breaking on the surface into small irregular fragments. Very little bedding can be detected in the mass. The other hole is in the side of the hill fifteen feet lower down, and shows on top two and a half feet of white clay, consisting of decomposed anhydrite, below which is five and a half feet of white nodular anhydrite similar to that in the other hole. This gives a thickness, almost certainly, of twenty-two feet of this rock, and it is not improbable that the hill is composed entirely of it."[2]

It is possible that this deposit when opened properly and systematically will reveal a large tonnage of some of the best grade of gypsum in the northern district.

Parts of Secs. 2, 3, 10, and 11, Tp. 33, R. VIII.

Directly to the east of this "White Elephant" a low lying ridge is encountered with a maximum relief of about 10 feet, over the surface of which there are numerous indications that at a depth of a very few inches gypsum is to be found. The character of the material in this ridge is similar to that found in the main deposit already being worked on section 26, township 32, range IX. It consists of a soft gypsite or gypsum earth on the top with soft bedded gypsum underneath. No work has been done to show the extent of the bed. A mile to the south of this, gypsum outcrops in two small mounds, which appear to be a continuation of the same ridge, although the intervening country is low lying meadows.

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[1]Can. Rec. Sci., Vol. III (1888–1889), Gyp. Dep. of Northern Manitoba, J. B. T.
[2]Can. Rec. Sci., Vol. III (1888–1889), Gyp. Dep. of Northern Manitoba, J. B. T.

Parts of Secs. 13, 14, 23, and 24, Tp. 33, R. VIII.

Another large and what will most likely prove to be a valuable deposit occurs directly east of the southern end of Gypsum lake. Here the country is very irregular, composed of a series of abrupt hollows and ridges, running in all directions and with a maximum relief of 35 feet. The overburden over the gypsum will, in most cases, be less than one foot of loam. Gypsum of a similar quality to that found at the quarry at present being operated is to be seen in numerous places over an area of half a mile by a mile and a half. This ridge is covered by a thick growth of poplar and small birch.

In many other places throughout this whole district there are indications that gypsum could be found if time were taken to thoroughly prospect the country. The deposits already described are easily noticed when travelling through the district, and the numerous caves and cracks give exposures where the gypsum can be readily seen without much work.

Rumours of the discovery of gypsum on the west shores of Lake Winnipeg are from time to time being noted in the newspapers, but so far no definite steps have been taken to prospect this area thoroughly. As early as 1888 the Indians knew of the presence of this mineral farther north than the deposits already described, as is shown by the following extract from Mr. J. B. Tyrrell's report:—

"The Indians of the Saskatchewan Band, who live on the western shore of Lake St. Martin, informed me that similar rock was to be found in several places farther north, and they have named a lake on a tributary of Warpath river, which flows into Lake Winnipeg north of the mouth of the Little Saskatchewan, Ka-Ka-wusk Sa-ka-higan (translated in English as Mica lake) from the alleged presence of selenite in its vicinity."[1]

Gypsum was also encountered in a bore-hole sunk on the Vermilion river at a distance of about 75 miles to the southwest of the above deposits. In this hole, drilled by the Manitoba Oil Company, a bed of gypsum 15 feet in thickness was encountered between 550 and 565 feet. The adjacent rock on both sides of this bed was similar in character to that found in the neighbourhood north of Lake St. Martin, so that in all probability these gypsum occurrences in this northern district belong to the same geological age.

About 15 miles to the south of Gypsumville, as the small village at the quarry is called, near Fairford on the Indian reserve, a well was sunk which encountered gypsum at a depth of 75 feet.

Gypsum deposits are, therefore, more than likely to be discovered very widely distributed throughout northern Manitoba, and as the country becomes more settled and opened by settlers, there will be several new and important deposits found.

In regard to the geological horizon of these deposits, it is difficult to make any definite statement. From a drill hole sunk through the gypsum in the floor of the quarry, a core was obtained of the rock on which this

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[1]Can. Rec. Sci., Vol. III (1888–1889), Gyp. of Northern Manitoba, J. B. T.

deposit rests. Directly beneath the gypsum lies a bed of fine grained reddish dolomite through which run numerous veinlets of crystalline gypsum. Beneath this bed, another bed of fine grained dolomite occurs of a greyish-brown colour but free from gypsum stringers. On the eastern shore of Lake Manitoba, a short distance to the west of where this drill hole was sunk, there is an outcrop of thin bedded upper Niagara dolomites, overlain by a few feet of thick-bedded massive magnesian limestone. These rocks are very similar to those found in the drill hole. Thus it is probable that these gypsum deposits lie on the top beds of the Silurian or among the lower beds of the Devonian. Mr. J. B. Tyrrell discusses this point as follows:—

"Of the exact geological age of the deposit it is difficult to speak as yet with certainty, as the strata have not been continuously traced into any others, and no beds immediately under or overlying them have been seen. There is little doubt, however, that they occupy either the summit of the Silurian or the base of the Devonian limestones. All the evidence that we have on the point has not as yet been perfectly elaborated, but it consists in the general horizontality of the beds wherever seen throughout the whole area, and in the existence of limestones holding fossils on Lake Manitoba, twelve miles distant in a south-westerly direction, and of limestones holding the fossils on Lake St. Martin, eleven miles distance in a southeasterly direction. Also reference might be made to the above-mentioned bore on Vermilion river, where the gypsum was at the base of a bed of Devonian limestone, one hundred and thirty feet in thickness. Thus these deposits are practically of about the age of the Onondaga formation of New York and Western Ontario, in which rock plaster quarries have been worked for many years. This formation also contains the great salt deposits of Ontario, and it is a significant fact that a short distance to the west of the area under consideration, around the shores of Lakes Manitoba and Winnipegosis, many brine springs are known to occur. In the State of Michigan, many of the plaster quarries are also in rocks of about the same age. In Nova Scotia, the gypsum deposits are of Lower Carboniferous age, and in Iowa they are stated to belong to a still higher horizon."[1]

These separate gypsum deposits lying in the area shown on the map have a number of common characteristics. On the surface they are all rough and hilly, and the prevailing direction of their longest axis is north and south. In so far as could be seen they are all usually stratified in rather thin beds which lie either horizontal or with low local dips. There is, however, a slight prevailing dip to the south of all the deposits. In one case, as before mentioned, massive crystalline gypsum, or selenite, was found in considerable quantities, and in odd cases throughout the beds small crystals of selenite and also crystal masses are found.

At the bottom of most of the hollows large sink holes are generally found filled up with soft mud and clay, and these holes are very characteristic of all the deposits. These sink holes are supposed to continue to the bottom of the deposits, and cause great inconvenience in handling the rock with the steam shovel, as the track, when laid over them, will stand very little weight.

In regard to the actual area underlain by gypsum, no definite estimate can be made. The depth is still an almost unknown factor, although in a drill hole in the bottom of the quarry of the Manitoba Gypsum Co. the bottom of the gypsum was reached at 40 feet. As the floor of the quarry

[1]Can. Rec. Sci., Vol. III (1888–89), Gyp. Dep. Northern Manitoba, J. B. T.

was then 30 feet below the general surface, it can be safely said that the total depth of gypsum at this part of the deposit is about 70 feet. It is probable, judging from the general regularity of each deposit, that this will be found to be an average depth for the beds. The Manitoba Gypsum Co. hold about 15 square miles of country which they are reasonably sure, from surface indications and rough tests, is underlain with gypsum, and the Dominion Gypsum Co. also holds a considerable area under similar conditions. From this it can be readily seen that even if the gypsum is only found on part of this area and extends for only a few feet in depth, a supply is available to meet the demands of the whole of the Prairie Provinces of Canada for many years to come.

EARLY HISTORY OF INDUSTRY IN NORTHERN MANITOBA.

Although the deposits in this northern country have been known for many years, it was not until the year 1901 that any active development work was carried out. In that year, the Manitoba Union Mining Company, composed of Canadian and American capitalists, staked out a large area of land supposed to be underlain by gypsum, and erected a crushing and calcining mill at the head of Portage bay on Lake Manitoba.

The deposits were worked as open quarries. The rock was transported by team over a bush road to the mill, 12 miles distant. At this mill it was crushed and calcined in the usual manner by buhrstones and kettles and shipped down the lake in the Company's steamer to be distributed throughout the western country from the station of Westbourne. The fact of having to ship by water confined the shipping season to the summer months. For the first few years the output from this mill would average, during the shipping season, about 70 tons per week. This consisted of hardwall plaster, fibre plaster, and a small quantity of plaster of Paris.

Mr. D. B. Dowling, of the Geological Survey staff, visiting these quarries in the summer of 1902, gave the following description[1]:—

> "The bedded character of the gypsum is well seen in the quarries opened by the Company. The one first worked is probably on the ridge followed by Mr. Tyrrell, and is in or near section 13. In this a quarry 55 yards long has been opened and shows an average depth of ten feet. From this, judging by the cross section of the ends, there has been removed about 1,800 cubic feet of rock. Nearby, another quarry not so well worked out, is about 40 yards long. Prospecting pits showing white anhydrite near the surface have not determined its depth, and, judging from the nodular and lenticular inclusions in the face of the quarry near, some of these prospecting holes may have touched some of the thin beds and so do not necessarily preclude the presence of gypsum beneath. Other quarries are to be opened farther to the east and north."

In a few years after operations first started, a narrow gauge tram line from the mill to the quarries was installed, thus affording easier haulage facilities for the rock.

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[1]Annual Rept. G. S. of Can., Vol. XV, p. 190A, D. B. Dowling.

In the autumn of 1904, the Manitoba Union Mining Company was purchased by the Manitoba Gypsum Company, and under this new Company operations were greatly extended. In the spring of 1906 the mill and all the Company's buildings at the head of Portage bay were burned to the ground. Plans for a new mill were immediately prepared, and by the autumn of the same year operations were again resumed with the new mill located in Winnipeg. The crude rock was shipped by steamer from the head of Portage bay and landed at the south end of Lake Manitoba at Totogan, whence it was hauled by the Canadian Northern railway to the mill at Winnipeg.

During the winter of 1910 a branch line of the Canadian Northern railway reached Gypsumville quarries, and shipments by an all rail route were commenced.

The summer of 1911 also saw the erection of a 200 ton mill by a new company, called the Dominion Gypsum Co., which has in the last couple of years obtained control of several stretches in this northern district of what may prove to be valuable gypsum properties.

Present Operations. At the present time there are two companies actively engaged in the production of the products of gypsum in Manitoba.

THE DOMINION GYPSUM COMPANY.

The property held by this Company lies on section 25, township 32, range IX, and also the property known as "The White Elephant," on sections 8 and 9, township 33, range VIII. On both these properties very little work has been done and no shipments have been made.

Mill and Plant. The mill building and plant of the Dominion Gypsum Company are situated in the western outskirts of the city of Winnipeg, at a distance of 2½ miles from the centre of the city. Sidings from both the Canadian Northern railway and the Canadian Pacific railway connect with the mill, and afford ample facilities for receiving the crude rock and for shipping the finished products.

The plant consists of the following buildings: blacksmith shop, crushing and calcining building, woodfibre plant, boarding house, stables, and office. The buildings are all of wood construction covered with galvanized iron sheeting. Plate XXV gives a general view of the mill and buildings of this Company.

The power employed is electric power supplied by the Winnipeg City Power Co. Seven motors, manufactured by T. Harding Churton and Co., of Leeds, England, having 425 horse-power, are sufficient to operate the whole plant. The fuel used for the kettles, and also for the Coles-Ruggles dryer, is soft coal obtained from Pittsburgh, Pa.

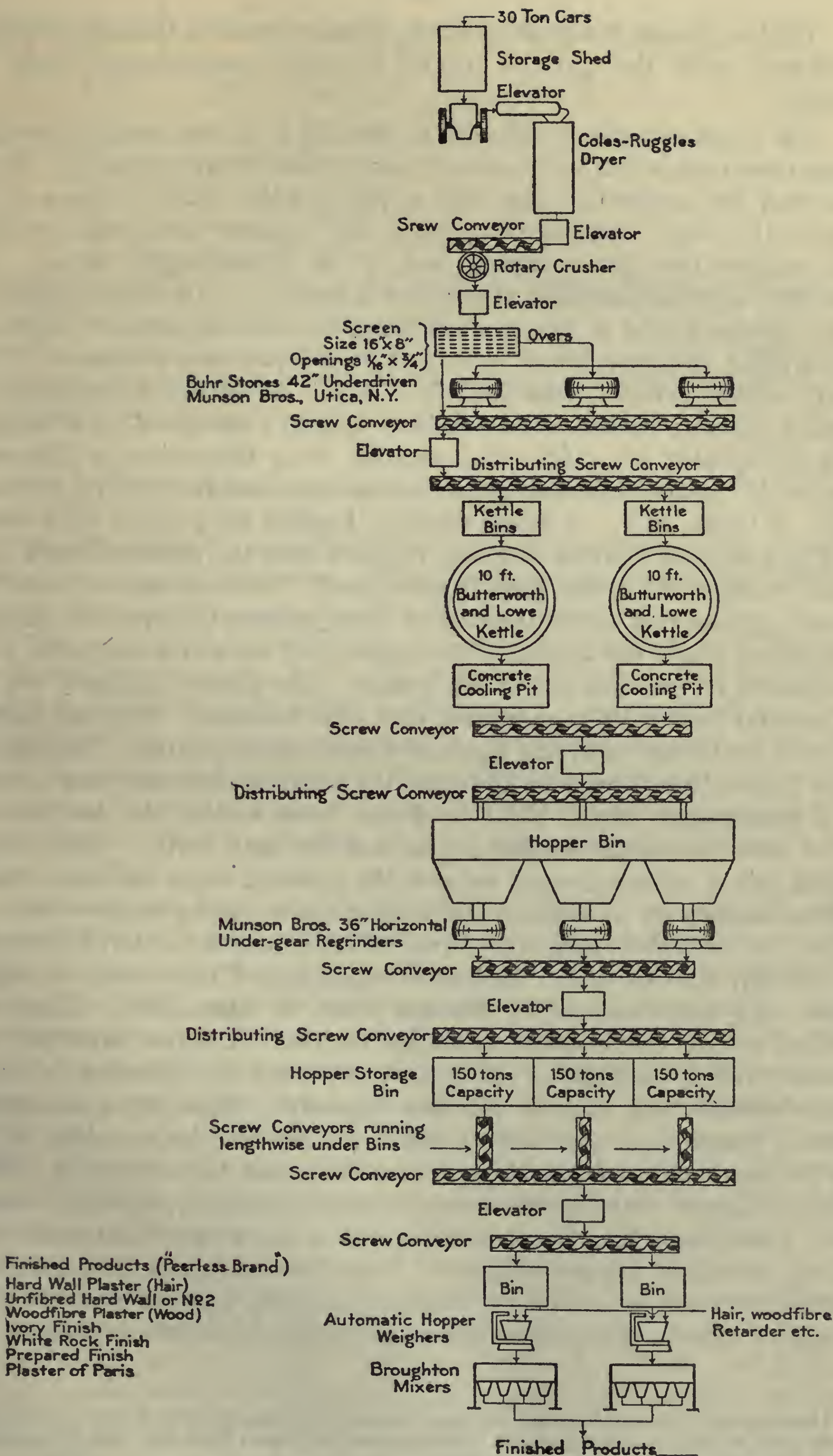

Fig. 8. Flow sheet, Dominion Gypsum Company, Ltd., Winnipeg, Man.

For the present the crude gypsum, being calcined in this mill, is being purchased until the quarries owned by this Company are ready to operate.

The crude gypsum is delivered at the mill in 30 ton standard bottom dump open cars, which are unloaded directly into the storage shed. From this shed the material is fed into a jaw crusher, which reduces it to 1″ and 1½″ size. An elevator takes the product from this crusher and empties into the receiving end of a Coles-Ruggles dryer. In this dryer all of the mechanical moisture is expelled. An elevator situated at the discharge end of this dryer elevates the dried gypsum and delivers it to a screw conveyer, which in turn empties into a rotary crusher. This rotary crusher brings the material to ½″ size. An elevator receiving the crushed material, elevates it and delivers it on to a screen 16″ × 8′ in size, with slot opening $\frac{1}{16}$″ × ¾″. The over-size from this screen is delivered to three 42″ underdriven horizontal buhrstones, manufactured by Munson Bros., of Utica, N.Y. A screw conveyer handles the product from these mills and delivers it to an elevator, together with the material which has passed through the screen already mentioned. This elevator delivers the ground gypsum to a distributing screw conveyer situated over two storage bins placed above the kettles. The capacity of each of these kettle bins is sufficient for two charges of the kettles. The kettles employed are 10 ton circular kettles 10′ in diameter, with solid bottoms. They are manufactured by Butterworth and Lowe, of Grand Rapids, Mich. The run in these kettles lasts from 2 to 2¼ hours, the calcined material being drawn at a temperature about 335°F.[1] From these kettles the hot stucco is run into two concrete cooling pits, one for each kettle. From these cooling pits a screw conveyer delivers the material to an elevator, which in turn empties on to another distributing screw conveyer placed over a hopper bin, with three hoppers. From these hoppers the material descends by gravity, into three 36″ horizontal undergeared regrinders or buhrstones, also manufactured by Munson Bros., of Utica, N.Y. These regrinders reduce the material to a fine powder. A screw conveyer, an elevator, and a distributing screw conveyer place the material in three hopper storage bins, each of 150 tons capacity. Three screw conveyers running lengthwise, one under each bin, deliver the material to a distributing screw conveyer which in turn delivers it to an elevator. This elevator empties into another screw conveyer situated over two small bins. From these bins the material is drawn and weighed automatically in two automatic hopper weighers. From these weighers it is dumped, together with hair or wood fibre, retarder, lime, etc., into two standard size Broughton mixers. From these mixers the finished products are bagged or barrelled.

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[1]Arrangements are made so that the dust carried up the flues from the kettles is collected in two dust chambers and these dust chambers are so placed that they can be emptied directly into the two bins above the kettles.

The finished products consist of the following:—

Peerless hardwall plaster (hair).
Peerless unfibred hardwall plaster (No. 2).
Peerless wood fibre plaster (wood fibre).
Peerless ivory finish.
Peerless white rock finish.
Peerless prepared finish.
Peerless plaster of Paris.

These brands are shipped in jute sacks (100 pounds) paper bags (80 pounds) or barrels holding 250 pounds.

The mill is operated for 12 hours a day, its capacity being in the neighbourhood of 200 tons. The products from this mill find a ready market throughout the whole of western Canada.

THE MANITOBA GYPSUM COMPANY.

The Manitoba Gypsum Company is the only company so far operating gypsum quarries in Manitoba. These quarries are situated on sections 26 and 35, township 32, range IX, already described.

The gypsum is quarried by the open-cut method and is loaded on the railway dumpcars by means of a steam shovel. The present size of the quarry is about 1000 feet in length with a width of 200 feet and a depth of 25 feet. A considerable part of this deposit has been cleared and the surface overburden stripped off by means of shovel scrapers, so that the gypsum beneath it is ready to be drilled, and excavated by means of the steam shovel. The overburden in most cases is very light and varies from 1 to 3 feet.

Beneath this loam and clay is about 2 feet of soft gypsum earth, finely divided, of a dull, white lustre and containing considerable moisture mechanically combined. This material at first caused great inconvenience, both in the quarry and in the mill, on account of its excess moisture. When operations were first started it was shipped separately, but since the steam shovel has been in operation and shipments are being made by an all rail route, this gypsum has been treated like the rest of the material and the whole production of the quarry shipped together. It is of a very good grade, as can be seen by a reference to the analysis given in Chapter X. Beneath this gypsum earth the gypsum rock is stratified in a series of thin beds, having little or no dip. The gypsum rock fractures readily at right angles to these beds into pieces of comparatively small size, so that no very heavy crushing is required at the mill. This fracturing is distinctly to be seen in Plate XXII B. Throughout this gypsum, which is of a dull white colour, are to be found nodular masses of varying sizes from 2″ to 12″ in diameter, consisting of a very pure white massive gypsum. These masses are quite frequent and add considerably to the quality of the gypsum.

The water table at this particular point is at present only a few feet below the present level of the floor of the quarry, and unless this can in some way be lowered, difficulty will be encountered when the workings have to be extended to a greater depth. However, as the ground has a gradual slope to the south, with a small amount of trenching, the water table could be materially lowered.[1]

Throughout this quarry a number of sink holes or funnel shaped areas appear, and these are filled with a soft clayey mud in which a stick or drill steel can be forced out of sight by hand pressure. These are supposed to continue down to the bottom of the gypsum bed. They cause considerable trouble in handling the steam shovel, for in some cases they are 25 to 30 feet in diameter, and the heavy weight of the shovel causes the track to sink when crossing them, no matter how heavily the tracks are tied. In working the shovel to clear away this waste material—it contains no gypsum—the supporting arms also have to be heavily braced else the whole shovel would upset.

Mining or Quarrying the Rock. In mining or quarrying the gypsum, the area to be worked over is first cleared of trees and all loose underbrush. Stripping is then carried on by team scrapers, after which the rock is drilled by hand and broken up by powder, to enable it to be handled easily by the steam shovel. The holes are placed 8 feet apart each way, and are anywhere from 8 feet to 15 feet in depth. The dynamite employed contains 40 per cent and 60 per cent of gelatine, the latter being used in the bottom of the holes with the 40 per cent on top.

For excavating the shattered rock and loading it into the open railway cars, a Bucyrus steam shovel, manufactured in South Milwaukee, Wis., is employed. The type can readily be seen in Plate XXIII B. The shovel has a 3 ton bucket and can cover the lateral span of 36 feet, including the railway car being loaded. When visited during the summer of 1911, a face of 20 feet, vertical, was being worked, but this varies due to the irregularities of the surface of the deposit. In a good face the shovel will load an ordinary 40 ton car in less than half an hour. The fuel used in the shovel is split poplar and birch, a good deal of which is cut when clearing the land.

A spur is run from Gypsumville into the centre of the quarry, and from here several sidings branch off so as to serve the whole quarry. These sidings are extended as required.

The Canadian Northern Railway's new branch line from Winnipeg, north through Oak Point to Gypsumville, is 170 miles in length. This was completed during the winter of 1910, and ore shipments are being made regularly three times a week to the Company's mill in the outskirts to the west of Winnipeg.

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[1]Since the writing of this report, a trench has been dug and the quarry consequently is drained to a depth 10 feet lower than when visited.

Mill buildings of the Manitoba Gypsum Company, Winnipeg, Man.

Manitoba Gypsum Company's Mill.

The mill of the Manitoba Gypsum Company is situated in the western outskirts of the city of Winnipeg. At this mill all the material quarried in the Company's quarries at Gypsumville is handled and prepared into different products for the market.

The plant consists of a group of buildings, constructed of concrete and brick and plastered with hardwall plaster. A 60 ft. steel tower supports a large water tank, and this affords efficient fire protection for the whole plant. Transportation facilities are amply provided for by spur lines from both the Canadian Pacific and the Canadian Northern railways.

A small building on the south side of the main building is employed for the manufacture of retarder, and the preparation of wood shavings for mixing with the stucco in Empire Wood Fibre Plaster. The retarder which is employed entirely at this plant is prepared according to secret formula and is mixed in a large vat. The mixture is spread and dried on large pans in a stove, after which it is pulverized and stored ready for use. It will keep indefinitely. The wood employed for fibre is poplar.

A new building has lately been erected and equipped with modern machinery for the manufacture of plaster boards, and also for preparing and mixing the stucco with sand to form a ready mixed plaster.

On account of the open method of quarrying the rock, and the fact that the water level of the district lies only a few feet below the level of the floor of the quarry, the material shipped to the mill carries a considerable amount of uncombined moisture.

The crude gypsum arriving at the mill is emptied from the bottom dump open railway cars into a small bin or elevator pit beneath the track. This bin is just sufficient to hold the boot of the elevator which conveys the material to a conveyer at the top of the building. This conveyer empties on to screens with $\frac{1}{2}''$ apertures. On account of the loosely cemented and disintegrated condition of the material from the quarries, a considerable portion of the rock passes through these screens, thus eliminating extensive heavy crushing. The oversize from these screens is run through a gyratory crusher or cracker set to crush to $\frac{1}{2}''$, and then is carried by an elevator, along with the material which previously passed through the screen, to a conveyer which empties into a Cummer rotary calciner. A rather interesting feature in this mill is that instead of using this type of kettle for complete calcination, it is employed more as a preliminary dryer with the fairly high temperature of 150° F. In this dryer the uncombined moisture is driven off and a partial calcination is also obtained, thus greatly reducing the time of the run in the kettles. A second Cummer kettle was installed in 1912. Coal is employed for heating these driers.

An elevator and conveyer handle the material from the Cummer calciners and convey it to the grinders, which consist of one No. 7 Williams pulverizer, 20 tons per hour capacity, and one of 12 tons capacity. From these grinders another elevator and conveyer handle the material to the kettles.

The kettles are three in number, two of 15 tons and one of 10 tons, of the usual type, made by Butterworth and Lowe. The fuel for these kettles is coal. At this plant the temperature in the kettles is noted at frequent intervals, with a thermometer, and any variation carefully regulated, each product requiring its own definite degree of heat at the final stage. For ordinary stucco this temperature is 310°F. while for plaster of Paris it runs up to 360°F. On account of the partial calcination which takes place in the Cummer calciners the run in the kettle is shortened to $1\frac{1}{2}$ hours, whereas an ordinary kettle run is from $2\frac{1}{2}$ to 3 hours.

From the kettles the calcined material passes into cooling bins and from there it is carried by an elevator and a conveyer to a No. 2 Newago screen. The oversize from this is passed through Sturtevant regrinders, and then by means of another elevator and conveyer is placed in the mixing bin along with the material which passed through the screens. The stucco passes from this bin into the mixing machines, where it is combined in the proper proportions with hair or wood fibre to form the marketable products known as hardwall plasters. The finished product is bagged or barrelled and shipped all over Manitoba, and the western provinces.

The following products are produced and sold at this plant:—

Plaster of Paris.
Land plaster (fertilizer).
Semi-calcined plaster (for use in oil and paint works).
Empire cement plaster (hardwall—hair).
Empire wood-fibre plaster (poplar wood-fibre).
Gold dust finish (quick setting pure stucco).
Empire finish.
Asbestos plaster (with asbestos as a binder).
Plaster board.
Partition blocks (wood-fibre).

The electric power employed for operating the kettles, mixers, grinders, etc., is delivered by the Winnipeg Street Railway Company. A total capacity of 700 H.P. is provided for in the mill.

When running at full capacity the output of the mill is 500 tons per 24 hours. In the summer of 1911, 300 tons per day were being handled, and about 105 men were employed.

The mill is arranged so that all unnecessary handling is dispensed with. Samples are taken of each kettle charge (after calcination) and these are tested so that any variation in the grade of the product is quickly detected and remedied.

A. View showing dense underbrush which has to be cleared in order to expose the gypsum deposits of northern Manitoba.

B. Face of quarry, Manitoba Gypsum Company, Gypsumville, Man. Note the bedded structure of the gypsum.

A. General view of quarry looking south, Manitoba Gypsum Company, Gypsumville, Man.

B. Steam shovel loading gypsum into cars, Manitoba Gypsum Company's quarry, Gypsumville, Man.

A. West face of quarry, with steam shovel, Manitoba Gypsum Company, Gypsumville, Man.

B. Quarry looking north, Manitoba Gypsum Company, Gypsumville, Man.

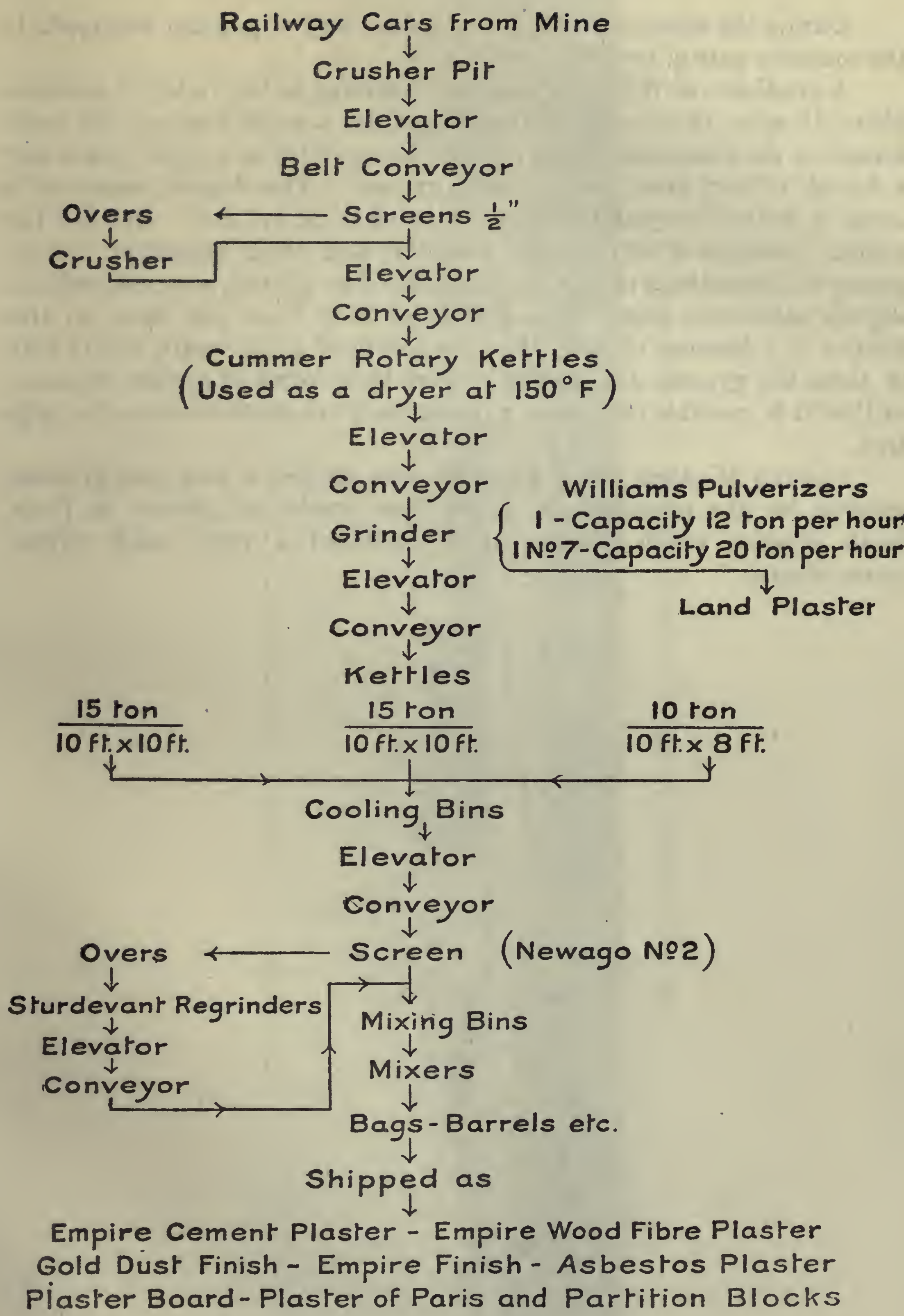

Fig. 9. Flow sheet of the Manitoba Gypsum Co., Winnipeg, Man.

GYPSUM IN SOUTHERN MANITOBA.

During the summer of 1911 a new discovery of gypsum was made in the southern part of the Province.

A syndicate of Winnipeg men, while drilling in the valley of a stream about 18 miles to the east of Dominion City, a small town on the south branch of the Canadian Pacific railway, encountered at a depth of 325 feet a deposit of very pure, massive white gypsum. This deposit consists of a series of beds of varying thickness, totalling in all 115 feet. One bed has a solid thickness of 50 feet, free from clay and other impurities. Alternating with these beds of gypsum are beds of fine grained, compact, reddish, slightly calcareous clay. Two drill holes have been put down in this district at a distance of more than one-fourth of a mile apart, and in both of these the gypsum and clay beds have been found in similar sequence, so that it is possible that these gypsum beds are continuous over a large area.

Analysis of pieces taken from the core showed a very pure gypsum, suitable for the manufacture of the finer grades of plaster of Paris. Small samples which were crushed, produced a very quick setting, strong plaster.

Mill and buildings of the Dominion Gypsum Company, Winnipeg, Man.

CHAPTER IX.

GYPSUM IN BRITISH COLUMBIA.

The gypsum industry in British Columbia is only in its infancy, although deposits of this mineral of considerable extent have been known for several years. There is a large field open for a good plaster industry in this Province, and the quality of gypsum already found is such that a plaster made from any of the deposits would readily find sale in the rapidly increasing market. During the early part of 1911 the first shipment of gypsum mined in this Province was made. This consisted of 500 sacks of crude material sent by the Industrial Finance and Development Company from Merritt, B.C., and was consigned to the Vancouver and Victoria cement works for use in the manufacture of cement. Shipments have continued steadily since then from this same deposit.

A glance at the table of imports of gypsum into this Province will give an idea of the rapidly extending market for this material.

The deposits will be dealt with in detail according to the time of their discovery.

SALMON RIVER DEPOSITS.

The presence of gypsum in British Columbia has been known for nearly twenty years. About the year 1894 several claims were staked about 11 miles east of Grande Prairie in the southern part of the Kamloops mining division. The gypsum outcrops occur on the north side of the Vernon-Kamloops wagon road, and are about 26 miles in a northwesterly direction from the town of Vernon.

Topography and Geology. The country in this district is very hilly and rolling. The valleys are mostly thickly wooded with fir, spruce, and a few pine. Numerous streams occur which flow into the Salmon river. The hills, generally with an incline of about 30°, are covered with drift and soil which supports a considerable growth of bunch grass.

Mr. James McEvoy, of the Geological Survey of Canada, made the following reference to the deposit and associated rocks of this district:—[1]

> "On the hillside north of the middle crossing of Salmon river, there is a fine deposit of gypsum, associated with grey schists and white crystalline limestone. The principal deposit, in which a tunnel twenty-five feet long has been made, is one hundred feet and over in thickness. The exact thickness could not be ascertained on account of the heavy covering of drift on the hillside. Above this is another deposit, with a thickness of thirty feet or more; still higher up are two more small deposits, one of which shows bedding. The large deposit is massive and perfectly white in some places, showing slight traces of anhydrite. The general strike of the deposits is east-and-west, true, with vertical or high northerly dip."

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[1]Extract from the Geological Survey of Canada, Vol. VIII, p. 37A.

By reference to the sketch, Fig. 10, the position of the two main outcrops may be readily seen. The district between these outcrops is covered to a considerable thickness by drift, so that without extensive

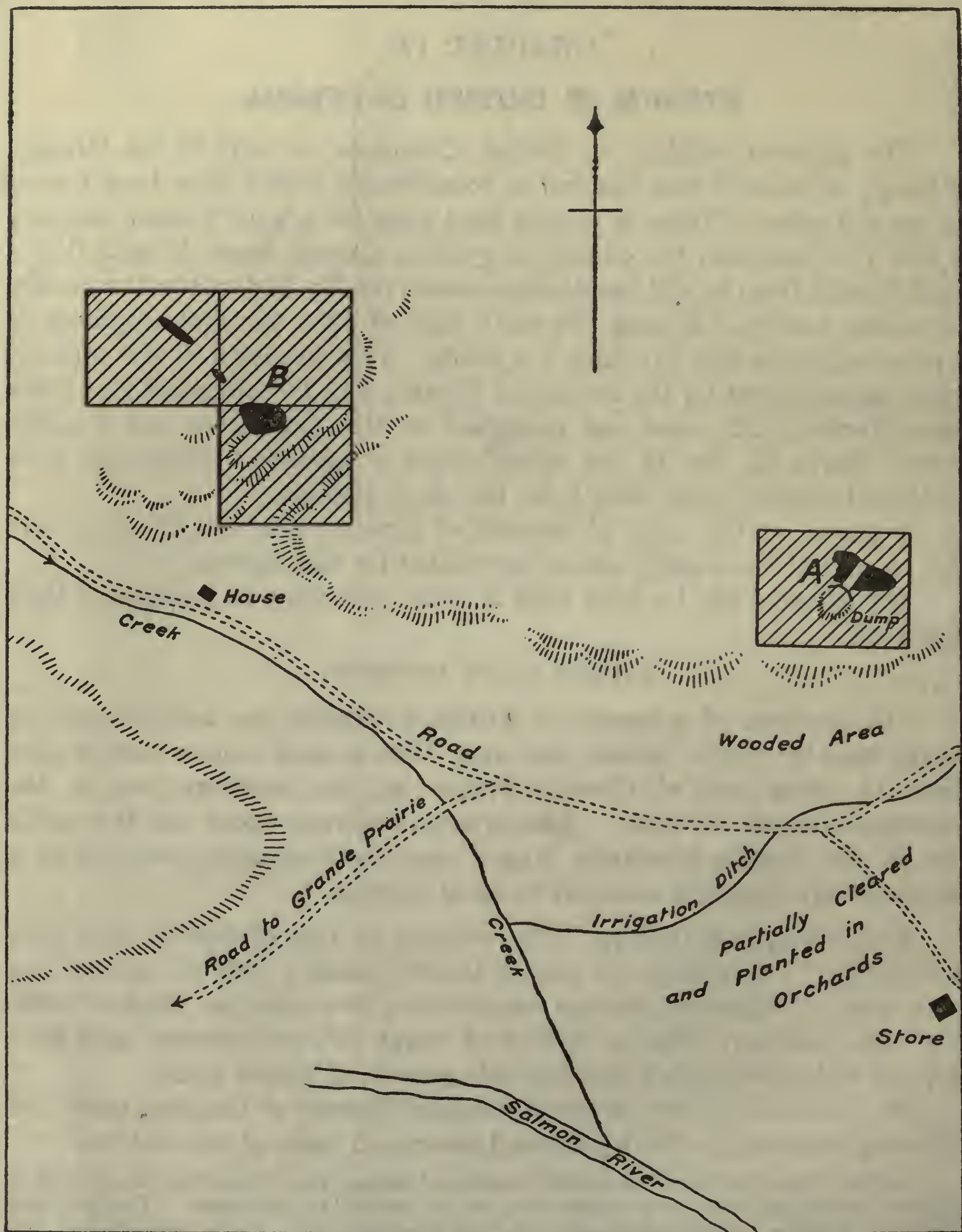

Fig. 10. Sketch showing claims on Salmon River deposits, Tp. 18, Range 12.

prospecting it could not be determined whether these two outcrops belong to a continuous deposit or whether each one was an entirely separate occurrence. Four outcrops are visible, but two are evidently only continuations of the more westerly one, and when described will be referred to as one deposit. For convenience in referring to these outcrops they have been designated on the sketch map as outcrop "A" and "B", being respectively the eastern and western showings.

Outcrop "A." This outcrop is situated on the north side of the wagon road at a distance of about one-fourth of a mile from it. Plate XXVI A gives a general view of outcrop A. The intermediate ground slopes gradually, at a pitch of about 15°, to within a hundred yards of the deposit, and is covered with a fair amount of clean timber but very little underbrush. Within a hundred yards of the deposit the ground becomes steeper, with a slope of 30° or more, and continues this grade to the summit of the ridge, which rises here about 2,700 feet above the valley. It is in the lower part of this slope that the gypsum occurs. The hillside has been eroded into a number of spurs and corresponding gullies, and it is on one of these spurs that the outcropping gypsum is visible. This slope supports a growth of bunch grass and a few trees, but the trees become fewer and more scattered as one goes up the hill. The outcrop, as far as could be seen from the surface indications, consists of a thin covering of gypsite or gypsum earth—probably due to local erosion from the main deposit—underneath which lies a large mass or bed of a very pure grade of massive white gypsum. This deposit shows nothing in the form of bedding in the main part of the deposit, but at the upper part the material shows distinct indications of stratifications, having alternate bands of white and brown material. These bands have a very steep dip to the north of from 75° to 80°. Their strike is practically east and west, and the length of this outcrop along the strike as far as could be seen was about 300 feet. The spur on which this outcrop occurs is about half a mile in length, but the rest of it is covered with waste or drift, and so it could not be determined how far the deposit extended. That it extends farther in each direction there is no doubt, as loose fragments of gypsum can be found in the soil at the foot of the slope for the whole length of the spur, in similar conditions to which it is found at the foot of the slope below the outcrop.

The deposit is exposed for a distance of 120 feet up the hillside across the strike. This includes the banded material above the white gypsum, as this has been shown by analyses to be a workable grade of gypsum. See analyses in Chapter X. Whether the deposit has any greater width can only be determined by further prospecting.

About the centre of this outcrop a tunnel has been driven into the deposit for a distance of 40 feet. This tunnel throughout its whole length is in a very pure massive rock of very even quality. The analyses made from samples taken in this tunnel show the presence of a small amount of anhydrite, but not enough to interfere materially in the manufacture of a high grade plaster of Paris. This tunnel has a bearing about N.20°E. The rock is fractured and shows many seams along which the rock has a tendency to break in mining, thus making blasting very easily accomplished.

In this deposit, as well as in all the others in British Columbia which will be described later, practically no prospecting has been done to determine the extent or size of the deposits, and no systematic tests have been made to ascertain the quality of the gypsum and its adaptibility to the manufacture of a good grade of plaster. The work that has been done has only been on a small scale, and the tests that have been made were only with small lots and carried on in the field in a general way.

Crystalline limestone outcrops appear in several places in the district, distinctly bedded and with a steep dip to the north.

Dr. Geo. M. Dawson classes the rocks of this district which are associated with the gypsum deposits as belonging to Cache Creek formation of the Carboniferous series.

Outcrop "B." The second outcrop or group of outcrops, consisting of three exposures, two of which are very small, lies about 1½ miles to the west of outcrop "A". It is at an elevation about 1,000 feet higher than outcrop "A," and shows considerable surface erosion. The outcropping of the gypsum shows very distinctly at the top of the steep side of a narrow gulley. The bottom of the gully is fairly thickly wooded and covered with underbrush, but the trees become scarcer as one ascends the hill. Bunch grass grows over most of the slope and rock exposures of limestone appear as the hillside becomes steeper. Where the gypsum occurs the slope is about 60° or more. The gypsum has a capping of badly weathered limestone.

The gypsum deposit has a vertical thickness of 40 feet or more and extends along the strike for a length of about 150 feet. The whole mass is badly disintegrated and could easily be loosened by a small hand-pick. Along the edges of the deposits residual pinnacles of limestone still remain standing, which have withstood the action of surface weathering better than the gypsum bed with which it is associated. The limestone in these masses carries minute particles of gypsum through it. Plate XXVI B gives a general view of this deposit. The gypsum in this outcrop is of a greyish-white, but clean and free from impurities and could be easily mined. On account of there being no prospecting done, it could not be determined if the rock beneath the shattered gypsum was solid.

Over the ridge of the hill two small showings of gypsum appear, similar in character.

All of these deposits or outcrops are probably of the same age, and have, most likely, been formed in a similar manner.

Judging from the appearance of these deposits and the slight amount of data which is known, this gypsum was most likely formed as a secondary mineral, due to the alteration of the limestone by the action of sulphuric acid. Whether the alteration occurred directly from limestone to gypsum, or whether anhydrite was first formed, cannot be definitely determined at present, but it is most probable that the former was the case. The lime-

A. Outcrop A. Salmon River deposits, British Columbia. White gypsum showing is material taken from tunnel which is behind tree to left of picture.

B. Outcrop B. Salmon River deposits, British Columbia. Material showing to right of photo is all gypsum. Note pinnacle of limestone to left of photo.

stone, of which there is considerable in this district, is known to be of a very pure crystalline quality. The acid would come from sulphur springs, where the sulphuretted hydrogen had been oxidized and converted into sulphuric acid.

It can readily be stated that these deposits are a very valuable addition to the mineral resources of the Province, and, if handled properly, should yield at a profit a large tonnage of the best grade of gypsum. Transportation facilities and charges, location of mill in relation to largest market, and many other minor details would have to be taken into account in opening up this property, If the proposed line of the Canadian Northern railway from Kamloops to Vernon ever materializes, the problem will be greatly simplified, as transportation facilities would then be within half a mile of the property.

SPATSUM DEPOSITS.

Two exposures of gypsum-bearing rock occur on the hills forming the west bank of the Thompson river, immediately opposite Spatsum, a station on the main line of the Canadian Pacific railway, 189 miles northeast of Vancouver. The property covering these outcrops consists of the northeast quarter of section 25, township 18, range 25, to south half of the southeast quarter of section 36, township 18, range 25, and fractions of the south half of the southwest quarter of section 31, township 18, range 24, and of the northwest half of section 30, township 18, range 24, totalling in all 450 acres. The property has a frontage on the river of about 3,300 feet.

The deposits are located about 600 feet above the level of the river, which has an elevation here of about 750 feet above sea-level. Two outcrops are plainly seen, about 2,000 feet apart. These occur on prominent bluffs, with a wide, shallow gully between them. The ground rises abruptly from the water's edge for about 200 feet vertical, and then continues in a 30° slope to the foot of the outcrop, which rises very steeply at a slope of about 50° and more. The whole mass is badly disintegrated, and highly altered. Plate XXVII A and B shows two views of the more southerly outcrop.

The rocks of the district are mostly argillaceous schists, greywackes, hydro-mica schists, and some limestone. Dr. Geo. M. Dawson refers them to the Cache Creek formation of the Carboniferous series. In referring to this formation he describes it as follows:[1]—

> "The upper part of the formation consists exclusively of limestone, which often becomes marble. The lower part contains thin beds of limestone, but is preponderantly composed of dark argillites, cherty quartzites, and contemporaneous volcanic products. The latter comprise both effusive rocks, agglomerates, and tuffs, with some beds of nearly pure serpentine. The volcanic rocks most usual are extremely decomposed diabase-porphyrites, and these, together with the argillites, frequently become schistose. . . . On both sides of the North Thompson, the Cache Creek rocks are chiefly represented by argillites, greywackes and diabases with some limestone."

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[1]G. S. of Can. Map., Kamloops Sheet, sidenote.

The appearance of these two outcrops is very remarkable. Practically no vegetation or trees of any sort appear over the whole surface of the outcrops, which stand out prominently as large, white masses against the brownish green colour of the hills around. The material is mostly a dull white or grey, badly stained in places with iron oxides, to a rusty yellow colour.

The larger and more southerly outcrop has a vertical height of about 300 feet, and a length along the strike of the beds of about 200 feet. Near the base of this exposure, and about its centre, a prospect tunnel has been driven into the hill for a distance of 25 to 30 feet, and from the end of this tunnel a winze has been sunk to a depth of 30 feet. The surface material consists of a badly disintegrated mass of mica schists, limestones and shales, with frequent nodular lumps of white gypsum of varying size. After passing through this altered material, which has been lightly re-cemented, the tunnel cuts through a band of very pure, massive white gypsum, which proved by analysis to be almost a theoretically pure gypsum. This band, however, was only 5 feet wide, with a very light grey or white highly altered hydro-mica schist, together with some altered limestone for the hanging wall, and for the rest of the length of the tunnel. This latter material showed on analysis a small amount of gypsum mixed with it. See analyses, Chapter X. The winze is also wholly in this altered limestone. The band of pure gypsum has a strike about N.25°E. and a dip to the northwest of about 40°. The tunnel is the only place where this band is to be seen, as no stripping has been done on the surface to enable one to determine whether it has any great extent. Nothing in the way of prospecting has been carried on between the two outcrops, so that no definite statement can be made as to whether they belong to the same deposit or not. Systematic development work and stripping will alone determine this. The depth to which this gypsum extends will also have to be determined before any estimate as to the value of the property can be given, and also whether any other bands of pure material exist farther up the hillside. This latter is quite probable, and a series of trenches might reveal the presence of several more of these bands of workable material.

The property was first staked about the year 1896 by a prospector named Munro, who did a small amount of development work, but allowed the lease to lapse. It was then taken up about 1906 by Messrs. Sinclair and Spencer, who staked four mineral claims, called the Hart, Flora, Mary, and Belle, and these cover both outcrops. These claims were surveyed in 1907. A slight dispute has arisen several times, owing to this property being within the railway belt, and both Dominion and Provincial Governments claim the right to issue leases.

The situation of the property for opening up as a mine is ideal. A tunnel would open up whatever gypsum is present, and an aerial cableway would convey the material across the river to the main line of the Canadian Pacific railway. In a short time also the Canadian Northern railway will be operating trains along the base of the hill in which the deposits occur.

A. Face of exposure, Spatsum deposits, Spatsum, B.C.

B. Closer view of tunnel, Spatsum deposits, Spatsum, B.C. Material on dump, principally altered limestone with occasional blocks of gypsum.

In appearance these deposits are very similar to those near Salmon river, and are most probably formed in a similar manner by the action of sulphuric acid on the limestone beds which occur in the Cache Creek formation in this district.

MERRITT DEPOSITS.

Within the last couple of years a deposit of gypsum earth has been staked and assessment work carried on by Mr. R. Henderson, of Merritt, B.C. This deposit is covered by three claims, each 1,500 feet square, called the Bauxite, the Aggatite, and the Gypsy. These three claims lie in the shape of an L, the Bauxite having the Aggatite to the east and the Gypsy to the North. The deposit is situated on the slope of the hill, at a distance of about one-half mile north of Merritt, B.C., a town on the Nicola branch of the Canadian Pacific railway.

Fig. 11. Gypsum crystals found at Merritt, B.C.

The deposit is probably the result of sulphur springs and vapours (sulphuretted hydrogen and sulphur dioxide) acting on the limestones which are associated with the rocks of the Nicola series, of Triassic age, in this district. These masses of limestone occur in isolated areas lying on top of the volcanic rocks (Nicola series) which are found in this valley. These heated vapours become oxidized with the production of H_2SO_3 and H_2SO_4, and these acids act on the limestone. The final result is the formation of gypsum with the liberation of CO_2. These reactions probably occurred underground, and the resultant gypsum so formed was carried upwards and deposited from the solutions as they passed over the surface. The gypsite, when examined under the microscope, shows distinct crystal form, but the crystals are much worn and rounded. Altered limestone is found on the hillside above the claims and cutting through the north of the Gypsy. Near this limestone several large crystals of selenite were found (see Fig. 11). The gypsum itself occurs in a very finely divided state, and the fact that the crystals are not cemented together not only facilitates handling but results in the elimination of heavy crushing. Although the crude material contains considerable vegetable matter, this fact does not appear to affect its tensile strength. It presents no difficulties as regards calcination, and forms a quick-setting, strong and reliable plaster. On account of its colour, which is a light tinge of brown, it cannot be used for very fine or finished work, where whiteness is the essential requirement; but for the manufacture of ordinary coarse stucco it fulfils all conditions. Moreover, being admirably suited for use as a retarder in cement, and as a fertilizer for certain soils, the output should command a steady market in British Columbia.

Very little stripping would be required in connexion with this deposit, the average depth of the overburden being about one foot. Owing to lack of development work, the thickness of the bed cannot as yet be accurately determined. Several prospect pits have shown a thickness varying from 3 to 8 feet. Complete and systematic stripping could be carried on to advantage, while a series of test pits would not only determine the depth of the deposit, but would also furnish data for an estimate of the quantity of gypsum available.

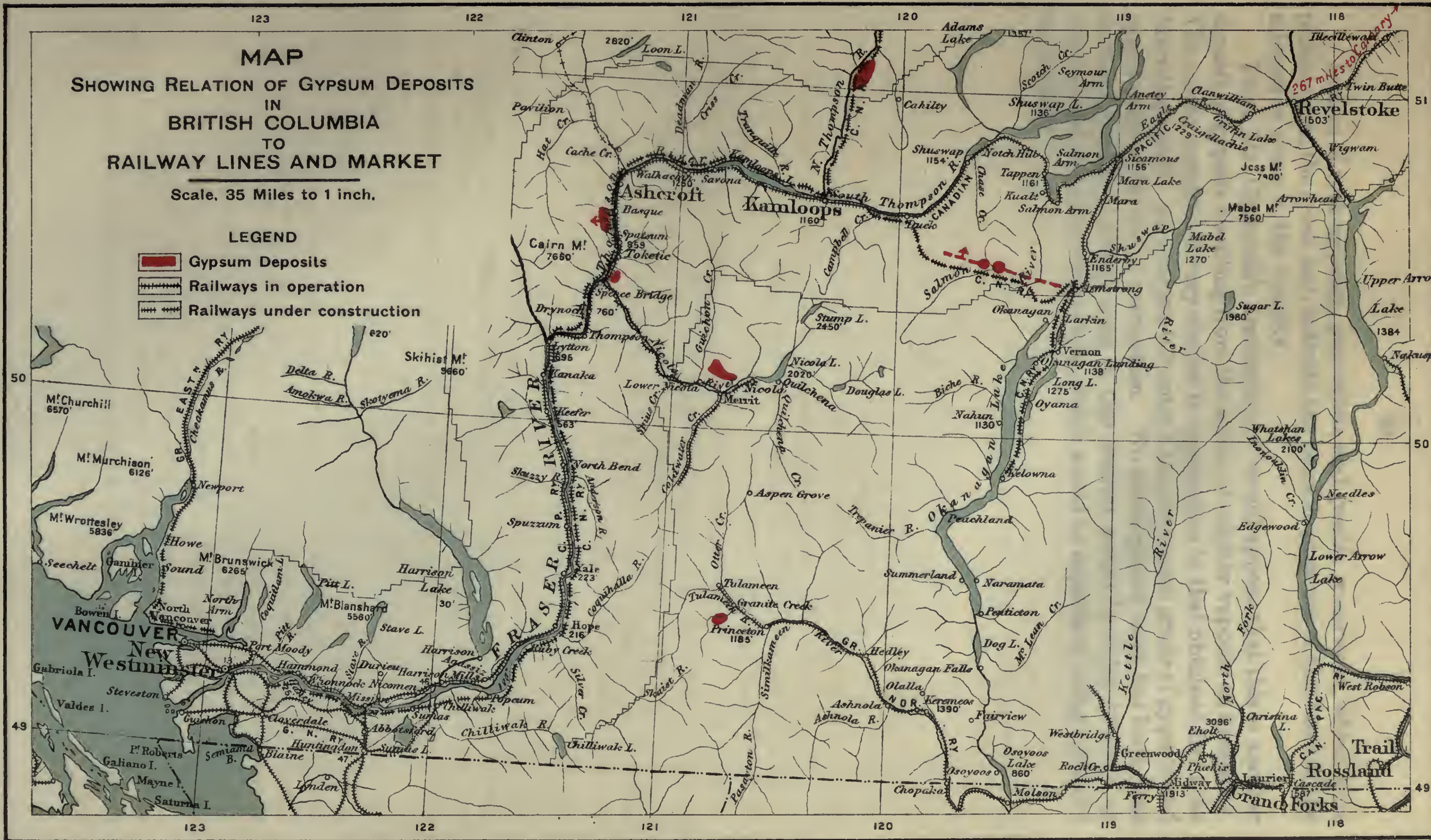
The property lies within easy access of the railway, from which a spur could connect with an incline tram line to the centre of the deposit. In a mill handling this material the preliminary heavy crushing could be dispensed with for reasons previously stated, thus allowing the product to go directly from the mine to the buhr mills.

No accurate information could be obtained as to the extent of this deposit. It is probable, however, that it extends over a width of 1,500 feet and for a distance of 1,000 feet or more up and down the hillside.

An interesting feature of this deposit is that beneath the gypsum there lies a deposit of gravel mixed with gypsum and fragments of limestone, in such proportions that when the whole mass is calcined it forms a ready mixed, coarse, cement plaster. If this gravel bed, containing gypsum and limestone in the same proportions, extends over the whole extent of the property, it could readily be utilized in the manufacture of hollow tiles, etc.

TULAMEEN DEPOSITS.

Reports of the discovery of gypsum in the Tulameen district were noted in many of the western newspapers during the spring of 1911. A deposit outcropping along the banks of Granite creek—a small tributary stream which enters the Tulameen river some 10 miles above Princeton, B.C.—has been staked by Mr. H. Churchill of Rossland, B.C. Mr. Churchill states that the gypsum earth of which the deposit consists lies on the side of the mountain which forms one of the banks of Granite creek. He has traced the deposit for a distance of half a mile along the hillside, with an average width of 20 feet.



Base map Dep[t] of Interior

Lumps of rock-gypsum, pure white and greatly waterworn, which were picked up in the creek bed, indicate the possible presence of this form of the mineral in place in the vicinity.

From Mr. Churchill's description, it would appear that this is another deposit of gypsite resulting from the action of sulphur vapours on limestone. The earthy material is very similar in appearance to that obtained from the Merritt deposit. An analysis (Chapter X) shows a good grade of gypsite and would warrant further investigation. No development work has been done on this property. Prospecting in this district would be liable to show up other properties of the same class, which would be capable of being operated successfully.

CHAPTER X.

ANALYSES OF CANADIAN GYPSUMS.

NOVA SCOTIA, NEW BRUNSWICK, AND QUEBEC ANALYSES.

The chemistry and analyses of the deposits of the Maritime Provinces and Quebec have been fully dealt with in Mr. Jennison's report published by this Branch, so will not be repeated here.[1]

ONTARIO ANALYSES.

The three analyses given below were made from samples taken from the mine of the Crown Gypsum Company, $1\frac{1}{2}$ miles below the village of York. They were taken from the top, middle, and bottom of the bed respectively at working face to the east. Three more were taken from the west working face and gave practically similar results.

	1. Top.	2. Middle.	3. Bottom.
CaO	32·34	32·70	32·49
SO_3	47·36	46·88	47·24
H_2O	20·90	20·66	20·75
Insol. mineral matter	.....	0·06	0·20
	100·60	100·30	100·68[2]

These samples show a remarkable uniformity throughout this bed, and the rock, which is of the white variety, compares very favourably with any found on this continent.

Samples were taken at the same time of the rock in the back, and also the rock composing the floor, and these were analysed. The sample taken of the back proved to be a pure dolomite with no trace of gypsum, while the one taken from the floor is also a dolomite but shows the presence of a small quantity of the sulphates. A physical examination of this rock shows that these sulphates are present in the form of minute crystals of selenite. These are probably due to secondary action and deposition from waters that have leached out the gypsum from the bed above. An analysis of this floor gave the following percentages:—

CaO.	SO_3.	H_2O.	Insol.
31·40%	16·70%	10·80%	0·66%[3]

[1] See Bulletin No. 84, Mines Branch, Dept. of Mines, Ottawa.
[2] F. G. Wait, analyst.
[3] H. A. Leverin, analyst.

This represents a percentage of 35·9 gypsum. Probably if a sample were taken from deeper in the floor, this large percentage of gypsum would decrease.

As has been mentioned before in this report, a second or lower bed of good clean, white gypsum has been discovered below the bed that is at present being worked. This bed was drilled into on two parts of the property, one when drilling for a water well and the second time when prospecting with a churn and shot drill about a third of a mile to the east of the present working. The bed in this latter case was encountered at a depth of 100 to 110 feet, and samples of the core were obtained and analysed with the following results:—

CaO.	SO_3.	H_2O.	Insol.	Total.
31·06%	42·56%	18·84%	4·70%	97·16%[1]

There is probably a small percentage of anhydrite present in this sample but not enough to be detrimental if used as a plaster.

Gypsum content = 91·13%.

The Carson mine, which is being operated by the Alabastine Company of Paris, produces massive gypsum of the white variety, of which the following is a typical analysis, furnished by the operating company:—

Sulphate of lime	71·95%
Carbonate of lime	5·17%
Carbonate of magnesia	2·26%
Silica	0·58%
Oxide of iron	0·44%
Water	19·10%
Total	100·00%

The sulphuric anhydride present in this sample is 42·32 per cent.

The gypsum rock mined from the Alabastine Company's mines near Caledonia is of the grey variety. Analyses of the rock mined from this property show more impurities than in the white rock of the Carson mine, but a good grade of hard wall plaster is made from it, and it is also well adapted for use in cement. The following analyses furnished by the Company indicate the average run of material shipped for use as a retarder in cement manufacture:—

	(1)	(2)	(3)
CaO	36·76	32·40	33·95
SO_3	36·11	39·31	36·96
H_2O	16·27	17·69	16·39
Fe_2O_3 and Al_2O_3	0·20	0·30	0·21
MgO	2·11	3·07	3·03
CO_2	6·43	4·83	7·20
SiO_2	2·12	2·40	2·31
	100·00	100·00	100·05
Gypsum present	77·67%	84·52%	79·50%

[1]F. G. Wait, analyst.

These analyses were made from samples taken from carload lots shipped to the Ontario Portland Cement Co., each analysis representing a car lot of 30 tons shipped at different times. A new seam has been opened up within the last few months and analyses of rock taken from it will average about 84 per cent gypsum.

A sample was analysed of some gypsum that had been taken from the bottom of a shaft that had been sunk on the Hudspeth property to the southeast of the town of Caledonia, and on the south side of the Grand river. This gypsum was of a bright salmon pink colour, and the result of the analysis was as follows:—

CaO.	SO_3.	H_2O.	Insol.	Total.
31·75%	45·77%	20·41%	2·30%	100·23%[1]

At one time this colour was thought to be an impurity detrimental to the grade of plaster manufactured from this rock, but of late years it has been proven, in many places, that the colour has no effect on the quality. If the gypsum could be found at this place in large quantities, a good grade of plaster could be made.

MANITOBA ANALYSES.

The deposits of gypsum of the Manitoba Gypsum Company are covered with about a foot to a foot and a half of drift soil, which is easily removed by scrapers after the undergrowth and trees have been cleared away. The gypsum is found in two conditions: gypsite, and gypsum rock. The top of the bed is composed of soft gypsite or gypsum earth and is very soft and sticky, holding mechanically considerable of the surface waters. An analysis of this material made from a sample taken systematically over the whole of the area, then stripped, gave the following results:—

CaO.	SO_3.	H_2O.	Insol.	Total.
32·60%	44·88%	20·80%	1·40%	99·68%[2]

Small quantities of $CaCO_3$ and $MgCO_3$ were found by this analysis. The sample was partially dried before being analysed, in order to drive off the excess of moisture present. This represents a good class of material for the manufacture of plaster, there being 96·4 per cent of gypsum present in the sample.

Beneath this gypsite, which averages about 2 feet in thickness, the gypsum rock is stratified and of ordinary hardness. This rock is a very light shade of grey, with occasional boulders or nodules of harder gypsum of a very pure white scattered through it. An analysis made of a sample taken from the working face in the quarry, not taking any of the white

[1] F. G. Wait, analyst.
[2] H. A. Leverin, analyst.

nodules, which would naturally increase the percentage, if included, showed a good grade of gypsum as follows:—

CaO.	SO_3.	H_2O.	Insol.	Total.
30·90%	42·52%	20·00%	3·04%	96·46%[1]

This represents 91·3 per cent of gypsum. The sample also contained small quantities of $CaCO_3$ and $MgCO_3$. Both the gypsite and the rock are shipped to the mill without any attempt to keep them separate. The high percentage of insoluble in this last sample is probably due to the presence of clay and mud from the sink holes which occur so frequently throughout the deposits.

The Manitoba Gypsum Company, in drilling to find the depth of the deposits, encountered a very soft band of material about 2 feet in thickness at the bottom of this gypsum bed. It crushed readily by hand, and when analysed, proved to be a fair grade of gypsum with a small quantity of dolomite combined with it, and also containing $MgCO_3$ and $CaCO_3$ in small quantities.

In drilling operations in the southern part of Manitoba, about 18 miles to the east of Dominion City, gypsum was encountered, and part of this core was analysed with the following results:—

CaO.	SO_3.	H_2O.	Insol.	Total.
31·72%	45·32%	20·45%	2·00%	99·49%[2]

Gypsum content is 97·30 per cent and the colour is a very pure white.

BRITISH COLUMBIA ANALYSES.

The properties on which gypsum occurs in British Columbia have so far had very little development work done on them, consequently the samples taken will only represent, in most cases, the surface of the deposits.

A sample sent in by Mr. H. Churchill, of Rossland, which he obtained from his gypsum deposits in the Tulameen district, was analysed and gave the following results:—

CaO.	SO_3.	H_2O.	Insol.	Total.
31·48%	44·32%	22·32%	Not determined.	[3]

Gypsum content = 95·14 per cent.

This sample was in the form of gypsite or gypsum earth of a light brownish shade. This is a remarkably good quality for this class of material and should prove valuable in the future if found in any considerable quantity.

[1]H. A. Leverin, analyst.
[2]F. G. Wait, analyst.
[3]F. G. Wait, analyst.

The Salmon River deposits have a tunnel driven in the gypsum in the more easterly outcrop for about a distance of 40 feet, and samples were taken from each side of this, as well as several from the western outcrop. The following table gives the results of the analyses made[1]:—

	1.	2.	3.	4.	5.	6.	7.
CaO	32·60	32·60	31·00	32·60	31·60	29·80	29·70
SO_3	46·87	46·67	45·30	46·67	45·61	39·41	38·60
H_2O	20·80	20·40	21·50	20·40	20·00	18·20	17·00
Insol	0·06	0·04	1·30	0·04	1·80	9·30	12·10
Total	100·33	99·71	99·10	99·71	99·01	96·71	97·40
Gypsum content	99·68	97·60	95·40	97·60	95·70	84·50	82·85

(1) This sample was taken from the face of the tunnel driven 40 feet into the more easterly deposit situated about 10 miles to the east of Grande Prairie, and previously described. This is an excellent quality of gypsum—pure white, massive, and easily mined. It may perhaps contain a small quantity of anhydrite, but this is so little that it would not be detrimental to the material as a plaster.

(2) The second sample was taken from the sides of the tunnel mentioned in the first sample, and 6 feet from the mouth. Anhydrite is present in this sample also, but in a very small percentage.

The tunnel for its whole length of 40 feet was driven in snow white gypsum, very uniform in texture and appearance. The two samples above mentioned will thus give a pretty fair analysis of the quality of the whole of the material showing in tunnel.

(3) The whole of the surface of this easterly outcrop is covered over with gypsite or gypsum earth to a depth of about 2 feet. This material was thoroughly sampled and an analysis made as shown above in No. 3. Throughout, this material is very clean and free from soil and clay, but small twigs and dried grass naturally get mixed with it from the small amount of vegetation it supports.

(4) This sample was taken from the more westerly of the two outcrops in this district. The surface covering was taken off in order to get as fresh an exposure as possible, and the sample was taken from an area covering the western half of this outcrop. Anhydrite is present in very small quantity.

(5) The next sample was taken from the same outcrop as No. 4, and in a similar manner, only in this case the eastern half was sampled. Anhydrite is also present, but in a very small percentage.

Both these samples are necessarily only rough estimates of the character and quality of the material in this outcrop, as no development work whatever has been done, consequently the samples had to be taken from the surface material, which, although in place, was badly disintegrated and stained by surface waters and other agents.

[1]H. A. Leverin, analyst.

(6) In the eastern outcrop, as one goes up the slope, the gypsum becomes coarser grained and banded, until it merges into what appears to be an altered banded poor grade of gypsum with alternate bands, about 1½″ wide, of brown and grey material. Above this the surface of the rock was covered with waste and soil so what lay above could not be determined. The material lying on the slope just below this banded rock was sampled and the analysis of it is shown in No. 6. Only the gypsum and insoluble were determined in this sample as well as in No. 7. The remainder will most likely be in the form of iron carbonates. This would account for the yellowish stains which occur in both samples.

(7) This sample was taken across the banded rock mentioned in sample No. 6 wherever it was exposed. The insoluble in these two samples is most likely silicates.

Although this deposit has only had a very slight amount of prospecting and development work done, it is safe to say that it can produce a large tonnage of some of the best grade of white gypsum in Canada just as soon as railway transportation facilities are afforded to the district.

The deposit opposite Spatsum and on the west side of the Thompson river has had more attention paid to it than any of the others in British Columbia, on account of its proximity to the railway, and also because it is easily visible, due to its white outcrops, for several miles either up or down the valley of the river.

There is a tunnel driven about 25 feet into this deposit on its more southerly outcrop, and at the end of it a winze was sunk to a depth of about 30 feet. Samples were taken from this winze and tunnel, and analyses gave the following results:—

	8	9	10	11	12
CaO	n.d.	n.d.	n.d.	n.d.	32·70
SO_3	3·75	13·93	5·75	2·14	46·72
H_2O	n.d.	n.d.	n.d.	n.d.	20·60
Insol	86·96	64·70	81·70	91·60	0·04
Total	.....	.....	.....	.....	100·06
Gypsum content	About 8·00%	About 29·88%	About 12·35%	About 4·60%	98·30%

(8) Rock from the bottom of the winze 20 feet below the floor of the tunnel.

(9) Five feet along the east wall of the tunnel from 10 feet in from the mouth.

(10) Five feet along the west wall of the tunnel from 10 feet in from the mouth.

(11) Grab sample over surface of the whole deposit. (Loose material).

(12) Gypsum from white band at the mouth of the tunnel.

Only one of these samples was taken in gypsum proper—No. 12—and shows a fine grade of very white rock, with a slight trace of anhydrite present. This band or bed shows right at the entrance of the tunnel, and is about 5 feet in width and dips at an angle of 70° to the northwest.

The remaining samples were taken of the wall rock and disintegrated surface material. The analyses were only partially made, to enable the SO_3 present in each sample to be determined. These rocks are in reality hydro-mica schists carrying small quantities of gypsum. The gypsum can be seen by a close examination of the samples, and the whole mass being grey they appear in place like a large deposit of grey gypsum.

In No. 11, the material was carefully taken from the whole surface of the deposit. Occasional lumps, of about 4″ in diameter, of pure white gypsum, were found, but none of these were included in the sample.

In a little gully to the south side of the deposits a small stream was coming down the side of the hill and the rocks in this stream bed were incrusted with a deposit, evidently leached out of the main deposit. A sample of this was taken and found to be alunogen, the hydrous aluminium sulphate with the formula of $Al_2(SO_4)_3.18\ H_2O$.

At Merritt, B.C., the gypsum is found in the form of gypsite or gypsum earth.

A couple of samples were taken from the deposit and analysed as follows:—

	13	14
CaO	31·90	33·80
SO_3	40·96	43·00
H_2O	19·60	20·60
Insol	1·10	0·50
Total	93·56	97·90
Gypsum content	88·20	92·30

(13) This sample was taken from a test pit sunk in the deposit about its centre and near the centre of the northern line of the Bauxite claim. The area sampled was about 10 feet square at a depth of approximately 4 feet below the surface. Half of this sample was taken and calcined, and it was found to make a very quick setting, reliable, but brownish coloured plaster.

(14) Another sample was similarly taken from a pit about 150 yards to the southeast of the previous sample.

Both of these samples were easily obtained on account of the softness of the material which is in a finely divided state. It makes an admirable material for use in cement manufacture and in the coarser grades of plaster.

The gypsums of Canada can compare very favourably with gypsum from any part of the world. The following tables show analyses taken from many parts:—

Gypsum Rock Analyses—Comparison.

	Canada.						United States.					New South Wales	Germany.		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CaO	32·11	33·00	32·93	32·70	30·90	32·60	31·80	32·94	32·04	32·20	32·00	31·10	31·87	32·44	......
SO_3	45·88	46·80	44·93	46·88	42·52	46·67	45·65	44·70	46·00	46·24	45·94	44·56	45·76	46·61	......
H_2O	20·52	20·80	20·00	20·66	20·00	20·40	20·14	19·00	20·00	20·76	20·85	20·20	19·90	20·74	......
Insol.	0·26	tr.	0·60	0·06	3·04	0·04	0·68	1·28	1·18	0·65	0·49	2·90	2·80	0·15	......
Ferric oxide and alumina	0·42	......	0·24	......	......	......	0·16	1·83	0·15	......	0·46	0·60	0·60	......	......
Magnesia	0·23	......	tr.	......	......	......	0·56	tr.	0·52	......	......	0·61	......	......	......
Carbonic anhydride	......	......	0·86	......	......	......	1·12	......	0·36	......	......	......	......	......	......
Totals	99·42	100·60	99·56	100·30	96·46	99·71	100·11	99·75	100·25	99·85	99·74	99·97	100·93	99·94	......
Gypsum content	......	......	......	......	91·04	97·60	......	......	......	......	......	......	......	......	......

Description of Samples.

Canada.

(1) *Nova Scotia.*—General average sample from No. 3 quarry, Great Northern Mining Company, Grand Etang harbour. (W. Jennison's Report, No. 84, Mines Branch, p. 44.)

(2) *New Brunswick.* Ordinary white rock from the Hillsborough quarries, Albert Manufacturing Company. (W. Jennison's Report, No. 84, Mines Branch, p. 97.)

(3) *Magdalen Islands.* An average sample taken from the vacant lands on Grindstone island, greyish-white, with compact texture. (W. Jennison's Report, No. 84, Mines Branch, p. 97.)

(4) *Ontario.* Sample taken from Crown Gypsum Company property at York. Average of working bed.

(5) *Manitoba.* Average sample of rock shipped to mill of Manitoba Gypsum Co. from quarries at Gypsumville.

(6) *British Columbia.* Average sample from tunnel in the Salmon River deposits.

United States.

(7) *Ohio.* Average sample, Sandusky. (Geol. Surv. Michigan, Vol. IX, Pt. 2, p. 145.)

(8) *Michigan.* Alabastine quarry rock, Grand Rapids. (Geol. Surv., Mich., Vol. IX, Pt. 2, p. 150.)

(9) *Kansas.* Gypsum from the vicinity of Dillon, 4 miles to the south. (Kansas Geol. Surv., Vol. V, page 16.)

(10) *Iowa.* Webster Co. upper working bed. (Iowa Geol. Surv., Vol. III, p. 291; also Vol. XII, p. 110.)

(11) *Virginia.* Saltville. (Eckel's Cements, Limes, and Plasters, p. 53.)

Australia.

(12) *New South Wales.* Lake Tank, north of Bourke. (Mich. Geol. Surv., Vol. IX, Pt. 2, p. 143.)

Germany.

(13) *Wienrode.* Hartz mountains, by Junget. (Kansas Geol. Surv., Vol. V, p. 141.)

(14) *Osterode.* Hartz mountains, by Hampe. (Kansas Geol. Surv., Vol. V, p. 141.)

PART III.

METHODS OF STRIPPING, QUARRYING, AND MINING OF GYPSUM.

TECHNOLOGY OF GYPSUM, AND GYPSUM PLASTERS.

PART III.

CHAPTER XI.

METHODS OF STRIPPING, QUARRYING, AND MINING.

The methods employed in the exploitation of gypsum deposits are generally of the simplest. The operations consist of stripping, quarrying or mining, and transportation.

There are, however, several important points that have to be taken into consideration when opening up a quarry, which, if not considered, would be liable to seriously handicap an operator in competition with his neighbour. A deposit of gypsum may be everything that is desired in the way of quality and extent, but still may not be capable of being worked economically on account of its distance from shipping facilities, ready market, and also its heavy overburden. Its location also with respect to the drainage of the surrounding country may necessitate a heavy expense in keeping a quarry free from water, so that this factor has in some cases to be taken into account. Another factor that sometimes influences the operation of a quarry is the labour market. In some of the rural districts it has been found that many of the farmers are willing to work in the quarries a part of their time, and although in that case the cost of labour is a little lower, considerable time is always lost, as the farmers will not work regularly, as they naturally have to spend a considerable time attending to their farms at some seasons of the year. Consequently the availability of a steady supply of labour is an item that should be taken into account. When steady labour is obtainable, better work can naturally be accomplished, and new and improved methods can more readily be taught the quarrymen when they are working continuously instead of spasmodically.

STRIPPING.

Methods. The amount of useless material, or overburden, resting on the gypsum beds which it is desired to exploit, has a great bearing on both the method of operating the quarry and its successful development. Where there is a rock covering over the gypsum and also a deposit of drift material, the stripping of the deposit is out of the question, and mining methods are employed, but where the overburden consists of only soft material, it is generally more economical to remove this overburden and to extract the gypsum by open quarrying. In order to remove this material, great expense has to be entailed, it costing at the present time from 20 cents to 25 cents per cubic yard to remove such material. When operations are undertaken on a sufficiently large scale to warrant the use of a steam shovel, the cost of stripping is between 15 cents and 20 cents, but where only a small quarry is to be opened, and the stripping has to be done by hand, the operator has to consider very carefully what depth of an overburden he can reasonably afford to remove, as in many cases the cost would be so excessive that a quarry could not possibly be worked at a profit.

The methods of stripping usually employed in gypsum practice come under the three following heads:—

Stripping by—(1) Hand.
(2) Horse scrapers.
(3) Steam shovel.

It is only in very small quarries, or where the material to be stripped is very light, that the work is done by hand. The work has naturally to be carried on during the summer months, as the frost would make the price during the winter months prohibitive. When the dirt is removed by hand, it is shovelled into carts and hauled to the nearest dumping ground, or else it is allowed to cave into the quarry and then sorted from the gypsum and carted away. This latter practice is greatly to be condemned, as the loose waste cannot help getting mixed with some of the white rock, impairing its value for plaster manufacture. It is a practice that is, however, very prevalent, even among some of the larger operators, and is only due to the fact that the Canadian gypsum is of such a high grade that no notice has so far been taken of it.

Horse Scrapers. A method that has been employed successfully in the deposits in northern Manitoba is to remove the overburden by horse scrapers similar to those used by railway contractors in railway construction work. The nature of the deposits there lends itself admirably to this mode of operation. The surface covering in these northern deposits consists of about 3 feet of clay and loam, loosely cemented together by gypsum, and this material readily breaks up before the scraper, and can then be hauled and dumped into any of the numerous sinkholes which are scattered through all the deposits. This has proved a very satisfactory method for the removal and disposal of the waste material.

Steam Shovel. In the larger quarries, the steam shovel is gradually coming into use for the removal of the waste material which lies on top of the gypsum. Only in late years, however, have these appliances been employed to any extent. Where the overburden is of any great thickness, the waste material is removed in benches by the steam shovel working on the top of the deposit. In that case a track is generally laid alongside the shovel, and the shovel loads directly into cars, which can then be hauled to wherever the best dumping ground is available. This method proves satisfactory to a certain extent, but considerable material is allowed to fall into the quarry, there to be removed by hand, or else by a second shovel. A second method, sometimes employed, is to remove the overburden over a bench of gypsum, to operate the shovel on top of this bench, and then clean off this bench by hand and carts. This method leaves the greater portion of the gypsum free from danger of being mixed with the waste material.

HYDRAULIC STRIPPING.

In many of the gypsum deposits of Nova Scotia and New Brunswick the overburden which rests on the gypsum is of considerable thickness. The present method of removing this waste material is, as already stated, by hand labour, horse scraper, or steam shovels, and this entails a great expense, and in many cases materially reduces the small margin of profit upon which the quarries are operated, or actually causes their shutting down. As this overburden is in all cases composed of loose material, it would seem that stripping of the gypsum beds by the hydraulic method would not only, in many of the quarries, be feasible, but would also greatly reduce the time required and the cost in handling. In order to bring this matter to the attention of the gypsum operators throughout the country, these few notes on hydraulic methods have been inserted in this report.

Conditions Required. Unlike the methods required and employed by most of the large hydraulicking companies of the west, hydraulic methods, when used for the purpose of removing the surface coverings to enable the rock underneath to be mined or excavated, have to be greatly modified to meet the altered conditions. In the first place, the wash from the monitors does not have to be saved, and hence the material can be conveyed in sluices greatly simplified from those which have to be prepared for the gold-bearing gravels. The shortest and most convenient form of sluice leading directly to the dumping ground will answer the purpose, regardless of slope (or grade) or curves.

Then, again, in most cases, when used for the stripping of gypsum, the nozzle pressure of the water would have to be obtained by means of a high pressure pump of large horse-power, and although this would be the greatest expense of the whole installation, it would do away with an extensive and expensive flume or pipe line, as the contour of the country is not such as to enable a high head of water being obtained except by this means.

The supply of water required would be one of the greatest factors in the installation, but this, in most cases, could be overcome by using the water over and over again.

The matter of a dumping ground for the waste material would be one of considerable difficulty, especially where the material was to be sluiced directly to it, but if no convenient place were available for direct sluicing, the waste material could be readily handled by a pipe line and a relay of centrifugal pumps, which would place it in any of the old abandoned quarries nearby.

In phosphate mining in Florida, hydraulic stripping is being employed to great advantage, at a cost of from 5 to 8 cents per cubic yard of material moved. In the same district, where steam shovels are employed, the cost is 20 cents per cubic yard.[1]

A modified form of hydraulic stripping is being made use of by the Nipissing Mining Company of Cobalt, Ontario, Canada (See Plate XXVIII). There it is employed to wash the surface covering of drift from the rock, in order to examine the rock closely for the small veins which sometimes would be overlooked by ordinary trenching. A turbine pump is employed, guaranteed to throw 4,800 gallons of water per minute, under a head of 415 feet, through a $3\frac{1}{2}''$ nozzle. The pumping plant consists of a 675 H.P. turbine pump connected directly to a motor. The water is piped to the point required, and is there forced through a $3\frac{1}{2}''$ nozzle at high pressure. A space is first cleared by this means, after which the ground is sluiced down in benches, thus, as soon as a certain section has been examined, it is covered over again with the tailings from the section above. The ground slopes gradually towards Cobalt lake and the water drains back again into the lake from which it is pumped in the first place.

The application of hydraulic stripping to gypsum overburden is very simple. The water is obtained from the nearest and most constant source of supply and is forced through a pipe line by an approved form of pump, so that a pressure of from 90 to 150 pounds per square inch is obtained at the nozzle of the monitor. A nozzle which delivers a stream of water at the required pressure is placed conveniently near the overburden to be removed, and the stream playing on the soft drift soon disintegrates it and it is then sluiced away by the running water to the dumping ground. If no dumping area is available near at hand, the sump method can be employed, where a sump is made in the floor of the quarry at a convenient spot and the waste material all washed into it. A series of centrifugal pumps and a pipe line are easily installed to keep the sump empty and remove its contents to the nearest permanent refuse dump.

Installation Required. The following list will cover practically all the machinery and material required for stripping by the hydraulic method:—

(1) Pumps.
    (a) High pressure pump. (b) Centrifugal relay pumps.
(2) Pipe lines.
    (a) Main pipe line. (b) Discharge pipe line.
(3) Monitor (nozzle).
(4) Sluices.
(5) Special ball and socket joint, etc.
(6) Operating motors and power.

[1]An excellent article on Florida phosphate practice can be seen in M. and M. for Dec. 1912, p. 265, by John Allan Barr.

Photo loaned for publication by A. A. COLE, Cobalt, Ont.

Hydraulic stripping, Nipissing mine, Cobalt, Ont.

In Mr. J. A. Barr's article, previously cited,[1] he gives the following paragraph descriptive of the present practice in pumping machinery in Florida for this type of work:—

"The earlier and present universal practice is to use direct acting compound or triple expansion pumps for furnishing water to the hydraulic nozzles at the mines and to the washer. The Florida Mining Company has a triple expansion pump capable of furnishing 4,000 gallons of water per minute, which it delivers at a pressure of 150 pounds per square inch. The Prairie Pebble Co. uses a somewhat similar pump made by the Worthington Company. Their pumping plant consists of three triple expansion, duplex, direct acting pumps, size 12″ × 19″ and 30″ × 17″ × 24″. These pumps have a capacity of 2,800 gallons per minute each.

The only centrifugal pumping plant that supplies water to the pipe nozzles is installed by the new French Company. This Company uses a three-stage turbine pump, direct connected to a 250 horse-power induction motor, and it delivers water to the nozzles at a pressure of 140 pounds per square inch. The experience with this pump in the field has been that when new, it was very satisfactory, but when pumping gritty water, such as must be the case in most of the mines, the pump lining soon wears, and the pump has a low efficiency.

The newest pumping stations being built contain the Corliss flywheel condenser pump. The principal advantage of this pump for this kind of work over the direct acting pump is principally its high duty, which often is at least one-third more. The duty of the direct acting pump seldom goes over 90,000,000 gallons, while that of the Corliss flywheel pump approximates 120,000,000 gallons in 24 hours. The flywheel pump is less liable to become broken by the failure of the governor to act, or by bursting of the pipe line."

Where the waste has to be transferred from a sump to a dumping ground at a distance, the pumps employed are generally centrifugal pumps of an approved type. To obviate the trouble always encountered when two or three of these pumps are operated in tandem, the best practice is now to make each pump in the relay act independently by delivering into a series of sumps from which the following pump draws its supply.

Pipe Lines. For the pipe line for the delivery of the water to the nozzles, a 10″ steel spiral pipe is being employed, and this has been found to work very satisfactorily. There is, however, no reason why other styles of piping could not be used. For the last few hundred feet of piping before the nozzle is reached, a 6″ flanged, spiral rivetted, galvanized water pipe is employed.

When the pipe line is used for removing the waste material from the sump, any approved kind of piping that will stand the wear and tear of gravel, etc., passing through it, can be employed.

Nozzles. Any of the smaller types of hydraulic monitors that are in use in gold hydraulicking methods can be employed in stripping. From $3\frac{1}{2}''$ to $4\frac{1}{2}''$ in size would suit.

Sluices. The sluices for hydraulic stripping can be of the simplest type, and in many cases no sluice is required at all, as the natural gullies in the rock will be sufficient to carry the waste material to the required dumping ground. Generally small trenches are dug, or else temporary sluices are built which very well answer the purpose.

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[1]M. and M. for December, 1912, p. 265.

Special Ball and Socket Joints, etc. In order to facilitate the easy moving and handling of the monitor from place to place, a special form of ball and socket joint is generally employed in the 6″ pipe. Several of these are placed in a length of from 400 to 500 feet, and this gives the nozzle sufficient play so as to cover a large territory. Several other special attachments are required, such as a joint to keep the pump from being broken by water hammer, and special suction pipes, etc.

Power and Motors. The question of power for operating the pumps is a matter of considerable interest. In many of the properties electric power could readily be generated, and current delivered to the motors, which are directly connected to the pumps. Where coal is cheap, steam could be used for generating this power. In some localities, water power could be obtained.

THE QUARRYING OR MINING OF GYPSUM.

The consideration of the best means of the exploitation of gypsum is a matter which up to the present time has not been a serious factor in the development of a deposit. In the Maritime Provinces, and also in the west, the largest deposits of gypsum are all comparatively near the surface, with only a covering of loose material which can easily be removed, but which would not hold up if undermined. Consequently the only method in most cases is to remove the gypsum by open quarries. This method has a number of advantages over underground mining, which have been greatly to the benefit of the gypsum operators. These advantages may be briefly stated as follows:—

(1) Easier supervision. A better idea can be obtained of the class of material that is being quarried.
(2) Better ventilation, as the men are always working in the open air.
(3) Easier handling of the gypsum.
(4) No timbering is necessary, and all the material can be extracted, as no pillars have to be left.

Its disadvantages are few, the principal one being the exposure to all the different kinds of weather, thus hindering the work, and the danger of exposure of the men to heavy rain, snow, or extreme cold.

Quarry Work. As a rule most of the quarries operating in gypsum have no regular shape, and nowhere does any systematic method seem to have been employed. It has generally been a case of taking the gypsum from wherever it occurred, without any regard to future economy in working. In consequence many of the quarries are just a series of pot holes, with no two parts of the quarries alike. Thus much time is lost by the repeated handling of the gypsum, when in many cases one handling would be sufficient.

The present practice is to obtain as high a face as possible of clean gypsum, and to break it down by caving. This is accomplished by drilling the lower part of the face with auger and hand-power drills, and then blasting the holes with a low-power dynamite, generally about 40 per cent strength. This brings down a large tonnage of gypsum, which is then broken up by hand sledgehammers to a convenient size for handling. The broken material is hand picked, so as to remove any pieces of anhydrite or foreign matter, and is loaded into small cars or dump carts and hauled either to the mill or wharf direct, or else where there is a railway line, to the nearest siding, where it is dumped into the railway cars.

In the gypsum deposits of northern Manitoba, a steam shovel is being employed successfully to handle the gypsum, thus doing away with the excessive handling which is so frequently met with in gypsum practice throughout the country. After the surface is stripped, the gypsum, which is of a soft variety, is drilled by a series of vertical holes placed regularly at 8 ft. intervals across the working face of the deposit. These holes, when blasted, shatter the gypsum sufficiently so that it can be handled by the steam shovel directly into the standard railway cars, standing on a siding beside the shovel. This method is found to be cheap and economical, and enables a large tonnage to be got out in a very short time.

In all of the gypsum quarries in Canada, the drilling is accomplished by hand power, one-man auger drills, similar to those employed in coal mining practice. They are found to work very successfully, as the gypsum is soft and drills easily. No attempt seems to have been made to install power drills of any sort.

Mining Methods. Where the overburden is excessive, and consists of a rock capping over the gypsum beds, the deposits are generally operated by underground methods. On account of the small price obtainable for the gypsum, the simplest and cheapest methods have to be employed. The present practice in Canada in gypsum mines seems to be to open up the deposit by an incline tunnel, generally at a slope of 15° to 20°. Why this special method of entrance has been adopted in preference to a vertical shaft is not clear. In the earliest gypsum operations in the country, the deposits were opened up in this manner, and the custom has been to follow the example of these first attempts.

When the bed of gypsum has been reached, main haulage ways are laid out, and the gypsum is recovered by a room and pillar system similar to that employed in coal mines. Tracks are laid to the face in these chambers, and the broken gypsum is loaded directly into cars, which are then taken by hand, or horses, to the main haulage way, where they are made up into trains preparatory to being hauled up the incline by a small hoist. Considerable loss is caused by the fact that the pillars in most cases are composed of good gypsum, which would otherwise be recovered.

TRANSPORTATION.

Transportation facilities in the quarries are of the simplest nature. In most of the operating quarries in the east, the broken gypsum is loaded by hand into single horse Scotch carts, and taken by them either to the shipping pier, or to the nearest railway siding. This necessitates a great deal of extra and useless handling of the rock before it reaches its final destination. Much time and labour might be saved if a system of radiating tracks were laid through the quarry, and the cars loaded directly at the face.

The method of transporting the loaded material from the quarry to the mill or shipping pier, is, in most cases, by narrow gauge railways, and this affords easy and cheap handling.

DRAINAGE.

Gypsum quarries, as a rule, are seldom troubled with water, but in some places, especially where the level of the floor of the quarry is near the level of the water table of the surrounding country, the problem of handling the water has to be taken into consideration. In this case a sump is located in the lowest part of the quarry, into which all the water collects, and a small duplex pump, generally stationed somewhere well protected from the blasting, is sufficient, being operated only a few hours each day, to handle all the drainage from the whole quarry. In cases where the quarry is below the drainage level of the surrounding country a larger pumping plant has to be installed.

CHAPTER XII.

TECHNOLOGY OF GYPSUM AND GYPSUM PLASTERS.

The Calcining of Gypsum.

It has long been known that gypsum ($CaSO_4 . 2H_2O$), when heated so as to drive off $1\frac{1}{2}$ parts of its water of crystallization, has the power of again taking up this water which it lost, and forming a hard, durable substance, suitable for all kinds of plaster work. This property of gypsum was known to the ancients centuries ago, and evidences of cements and plasters made in this way from gypsum are still extant on many of the old structures found in the recent extensive excavations of the ruins of ancient Egypt.

Many experiments have been carried on in regard to the action of gypsum when heated, and its resulting power to again combine with water. The most noted of these are by Lavoisier in "Academie des Sciences," 1765; Payen in "Chimie Industrielle," 1830; Landrin in "Annales des Chimie," 1874; Chatelier in "Academie des Sciences," 1887; and Grimsley in "Michigan Gypsum," Vol. IX, 1904. Quotations from all of these writers, stating their several theories, have been given in Jennison's report on the "Gypsum Deposits of the Maritime Provinces." A brief résumé, however, of the results arrived at by these writers is here given.

Gypsum, when calcined or heated, forms the hydrate $(CaSO_4)_2 . H_2O$.

When water is added in excess to this material it is partially dissolved, forming first a clear liquid, which gradually becomes turbid, due to the formation of crystals of gypsum which are gradually precipitated. The reaction which takes place is:—

$$(CaSO_4)_2 . H_2O + 3H_2O = \underset{\text{(gypsum)}}{2(CaSO_4 . 2H_2O)}$$

In actual practice, preparing the gypsum for the market consists of three operations:—

(1) Crushing and grinding.
(2) Calcining.
(3) Mixing.

CRUSHING AND GRINDING.

Opinions differ in different countries as to the advisability of carrying on crushing operations before or after calcining. The general practice on this continent is to reduce the gypsum to a flour before calcining, and, after, to sieve and repulverize all material that will not pass through a 50 mesh sieve. This method has the advantage of allowing the whole material to become uniformly calcined, but greater

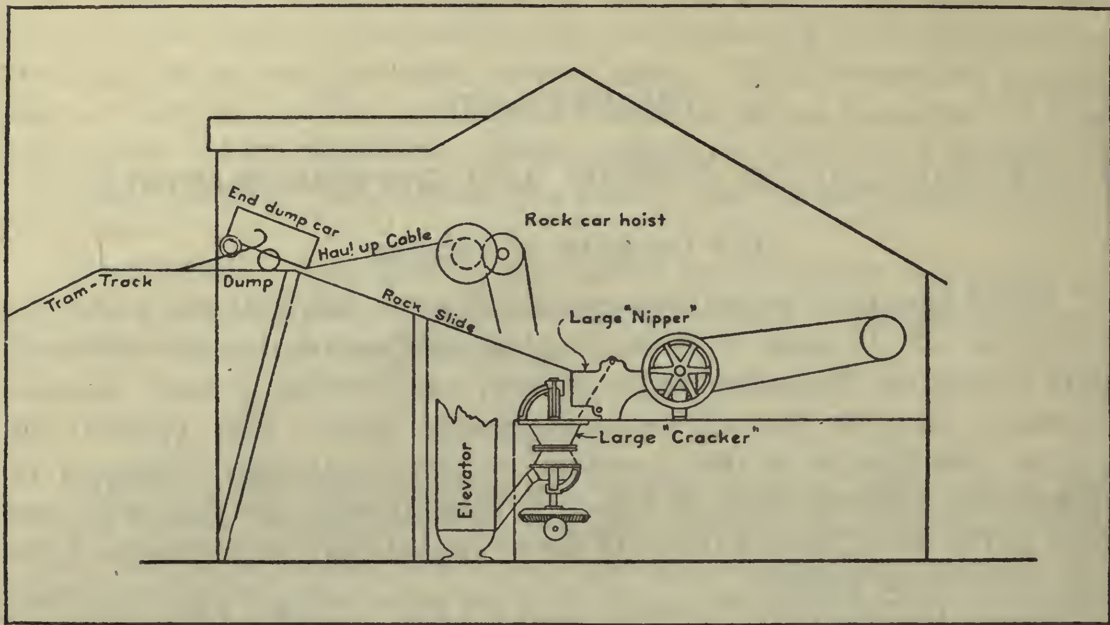


Fig. 12. Typical arrangement for a gypsum crushing mill.

power is required to crush the gypsum before calcining. In European practice, where crushing is carried on after calcination, the crude material

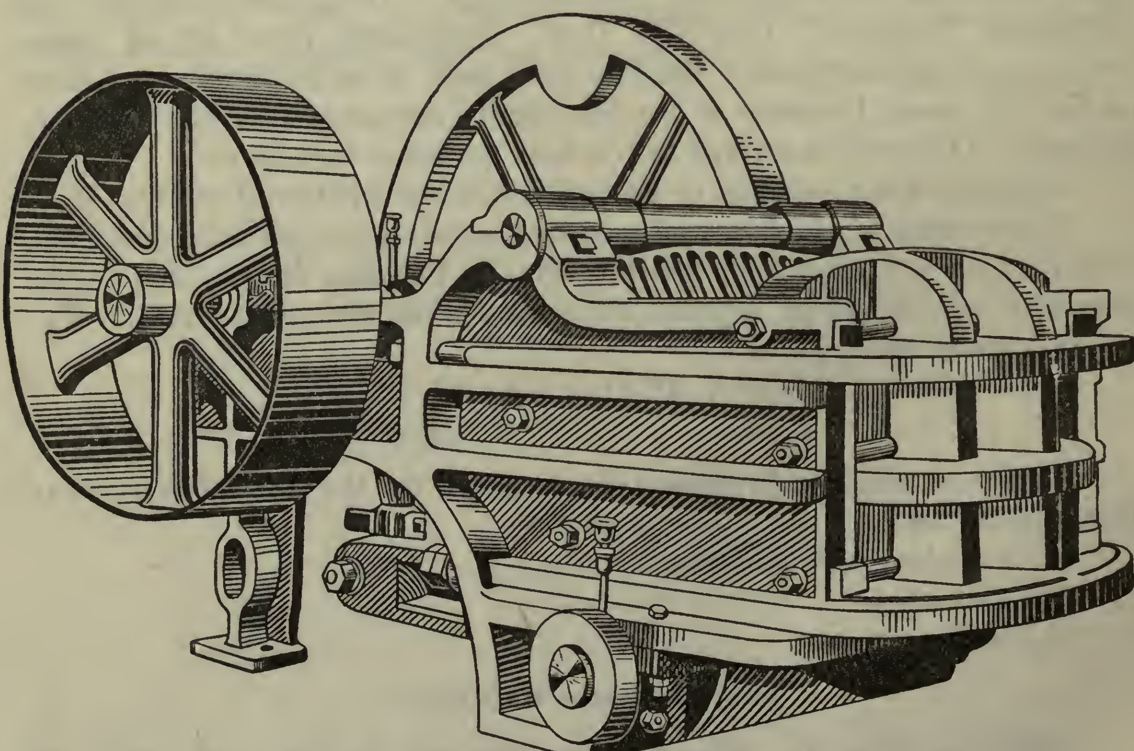


Fig. 13. Butterworth and Lowe jaw crusher.

becomes greatly shattered by the calcination, and is thus easier to crush, but the product is not so evenly calcined. Then again, in European practice calcining methods are employed which adapt themselves more readily to lump gypsum than to the powdered material, while on this continent the kettle system is the most universally employed, and this system requires a finely powdered material.

In crushing the gypsum three stages are generally required, namely, heavy crushing in large Blake jaw crushers or "nippers," as they are known to the gypsum trade, then through rotary or gyratory crushers (colloquially

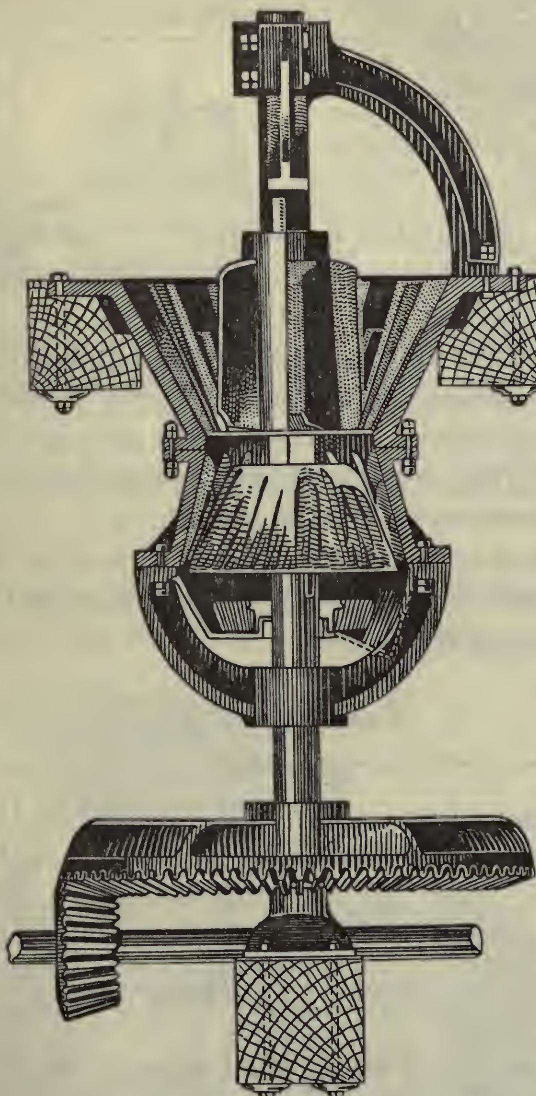


Fig. 14. Butterworth and Lowe rotary crusher.

"crackers"), and finally through pulverizers which reduce the material to a flour. In cases where gypsum earth is the material to be treated, the heavy and sometimes the intermediate stages of crushing can be dispensed with. Fig. 12 shows a typical arrangement of a crushing plant.

The gypsum rock as it is brought from the mine is dumped on a rock slide which leads directly into a large jaw crusher, similar to the one shown in Fig. 13. This consists of a jaw type crusher with corrugated jaws, in order to prevent clogging. Data regarding machines of this type are shown in the following table furnished by the makers, Messrs. Butterworth and Lowe, Grand Rapids, Michigan.

Jaw Crushers.

	Rock opening.	Shipping weight.	Hourly capacity in tons, usual dry mine run gypsum rock.	Horse-power.	List price without countershaft.
		lbs.			
Giant nipper......	20″ × 30″	11,400	36–42	14–16	$880
Large nipper......	18″ × 26″	10,300	22–30	10–12	740
Medium nipper....	17″ × 19″	6,000	8–10	4– 5	460

These crushers are equipped with pulley close on one side of frame and fly-wheel close on the other side. These crushers reduce the rock to 2″ size.

In some cases where the material to be crushed varies in size, it is well to have the rock slide composed of a series of grizzlies, or iron bars, to roughly sort out the material less than 3″ in size, and feed it directly to the rotary crusher. This, it will be found, will save a considerable quantity of power required to operate the large nipper.

From the jaw crusher the broken rock is allowed to drop automatically into the rotary crusher (See Fig. 14). The following table describes the type of machine commonly used:—

Rotary Crackers.

Butterworth and Lowe.	Rock opening.	Shipping weight.	Hourly capacity in tons, usual dry mine run gypsum rock.	Horse-power.	List price without countershaft.
		lbs.			
Giant cracker.....	For pieces up to 10″ thick....	6,500	From nipper 36–41..	19–23	$660
Large cracker.....	For pieces up to 9″ thick....	5,400	From nipper 21–25..	12–15	530
Medium cracker....	For pieces up to 8″ thick....	3,200	From nipper 10–12..	7– 9	310

If the drive gears are above the cracker with vertical shaft 10–12 feet long and rope box, add $20, $15, or $10 to above list prices respectively.

These machines are quickly adjustable for fine or coarse products. The spindle type is the most frequently employed. From the cracker the material, which has been reduced to about ¼″ size, is taken by an elevator to the top of the building and generally placed in a bin, from whence it is allowed to descend by gravity down chutes and into the pulverizing machines. Three different types are employed in gypsum mills and are shown in Figs. 15, 16, and 17.

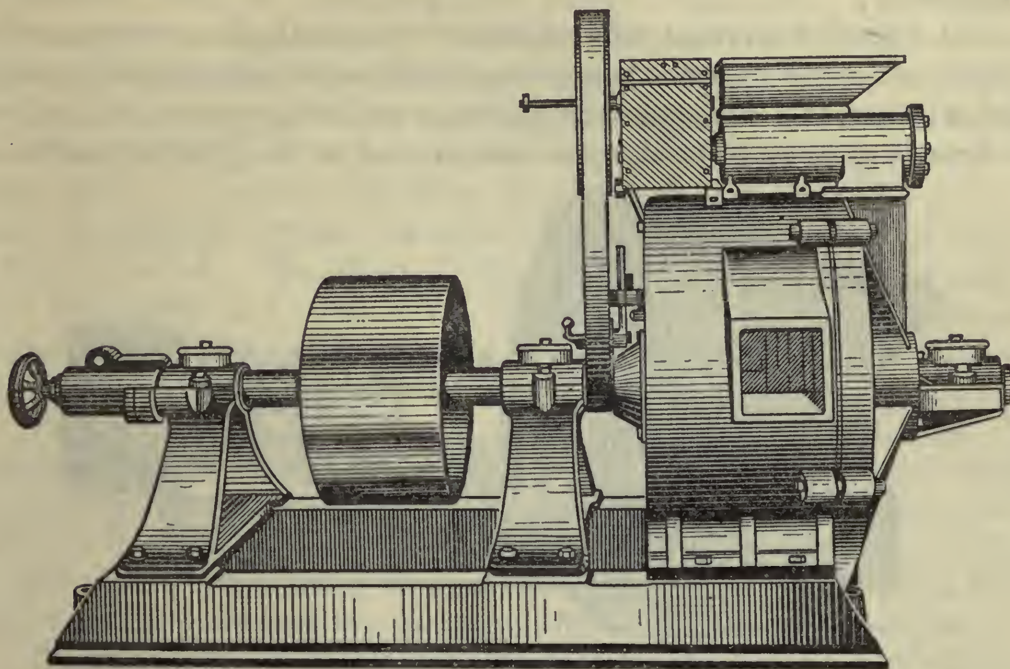


Fig. 15. Vertical buhr mill, J. B. Ehrsam and Sons.

Buhrstones. One of the oldest means of grinding gypsum is by the use of buhrstones of flour-milling practice. Some of the first gypsum

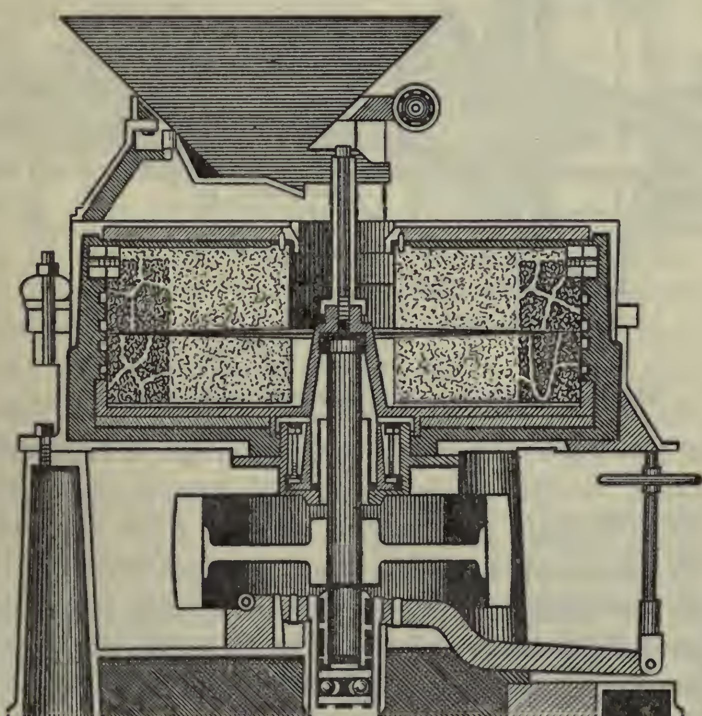
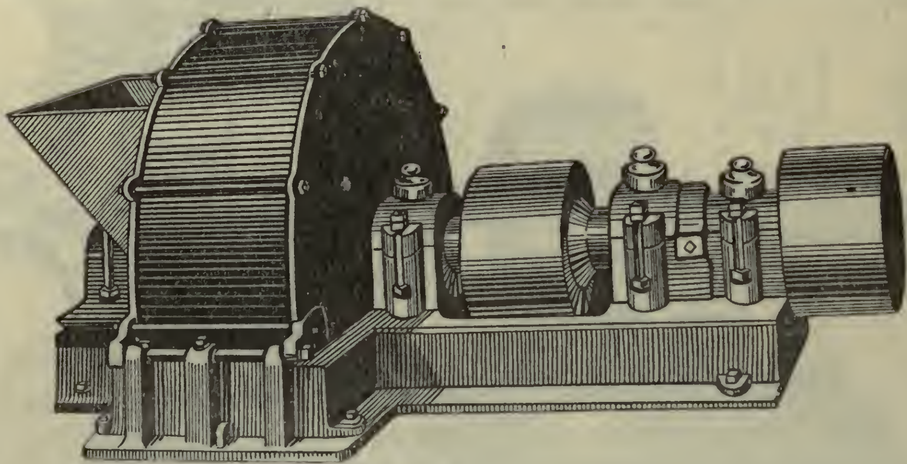


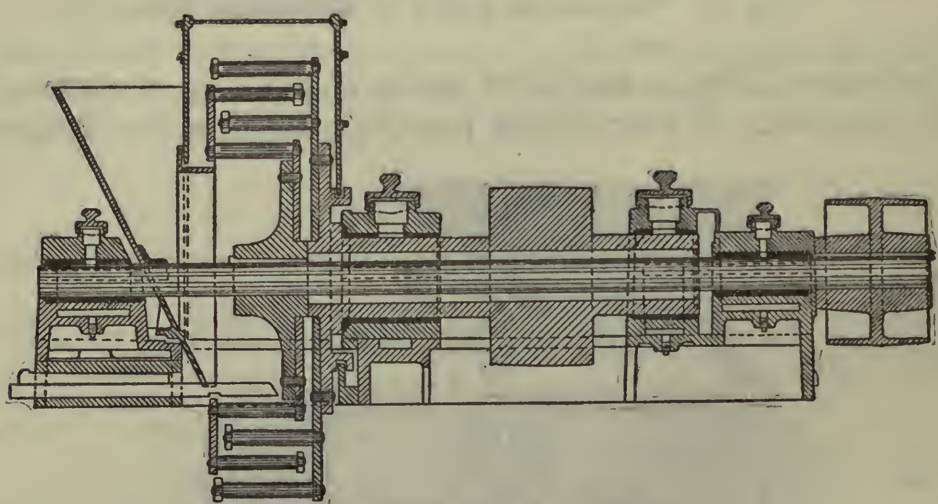
Fig. 16. Sturtevant rock emery mill, horizontal type.

mills in Canada were operated in connexion with flour mills when gypsum was used principally as a fertilizer. Naturally the fact of having the buhrstones already on hand greatly influenced their adoption into gypsum manufacture.

The French buhrstone mill consists of two rough, siliceous stone discs, of which either the upper or lower revolves concentrically against the other which is stationary. Sixteen to twenty main radiating grooves, with at least two branch grooves to each main one, are cut in the grinding surface of



A



B

Fig. 17. Holmes and Blanchard disintegrator.

each stone. In the upper stone the hole through which the material is fed will vary from 8″ to 10″ in diameter. In general practice these stones require to be dressed every two weeks. These mills are run at varying speeds, from 100 r.p.m. up to 425 r.p.m. As mentioned before, the size of the feed from the cracker is $\frac{1}{4}$″, as this is the size best adapted. The amount of gypsum these mills will crush to 60 mesh in an hour will vary greatly. An average would be about 30 tons through 60 mesh in 24 hours, the stones revolving at about 400 r.p.m. and using from 15 to 25 horse-power (See Fig. 15.)

Emery Mills. Another means employed for fine grinding in gypsum mills is a mill manufactured by the Sturtevant Mill Company or of a similar type (See Fig. 16.) These mills act on the same principle as the buhrstones, with the exception that emery replaces the quartz of the French buhr. In grinding with buhrstones it was found that the outer edges of the stones wore away much more rapidly than the central portions. To remedy this in the Sturtevant mill, the centre only is made of buhrstone, while in the concentric band around this centre are placed large blocks of emery, and slabs of sandstone or other soft rock are placed in position through the emery band to correspond to the grooves in the buhrstone. The whole of this outer band is then firmly held in place by running in molten metal, such as zinc, bronze or iron, between the buhrstone centre and the iron rim. These stones require little dressing on account of having the softer limestone furrows, which are easily kept open.

Emery mills are run as both vertical and horizontal grinders. The vertical mills can be run at higher speed and will grind material rapidly, but horizontal mills will crush much finer and more evenly, though not so rapidly. The capacity of the vertical mill working on gypsum is about 75 tons per 24 hours, using 25 horse-power, while the horizontal mill will crush from 18 to 50 tons per 24 hours with from 12 to 20 horse-power.

Disintegrators. Of late years disintegrators have come into extensive use in gypsum mills. The machine was originally invented in England, where it is known as the Carr disintegrator. Practically the same machine is known in the United States as the Stedman, and in Germany under the name of Briuk and Hübner. The machine consists essentially of several (generally four) oppositely revolving cages of iron bars running concentrically inside each other. The cages are made to run alternately left and right. The gypsum rock, when fed into the hopper of the machine, is delivered at the centre of the cages. The bars of the inner cage strike it and cause it to be thrown towards the circumference of the machine at great velocity. The rock then comes into contact with the bars of the second cage, which is revolving in the opposite direction. This tends to very quickly pulverize the material, so that when the outer cage is reached the rock is reduced to the size required. The fineness can be regulated by the speed, but this also affects the capacity. Sometimes the bars of the two inner cages are square. A typical disintegrator is shown in Fig. 17. The following table (after Eckel) gives the size, capacity, etc., of Stedman disintegrators:—

Size.	Horse-power.	Capacity in 10 hours.	Price.	Weight lbs.
30″ disintegrator, heavy pattern......	6–9	8–10 tons	300	3,000
36″ disintegrator, heavy pattern......	12–18	18–25 tons	450	5,500
42″ disintegrator, light pattern........	12–18	20–30 tons	500	6,000
40″ disintegrator, heavy pattern......	20–25	25–35 tons	600	10,000
44″ disintegrator, heavy pattern......	30–35	40–50 tons	700	12,000
50″ disintegrator, heavy pattern......	35–45	60–75 tons	900	15,000

After the gypsum has passed through one of these types of pulverizers, it is conveyed by elevators to large cylindrical storage bins at the top of the building, and from thence is allowed to flow by gravity into the calcining kettles, which are either stationary or rotary. An end elevation of a typical gypsum mill (1 kettle) is shown in Fig. 18.

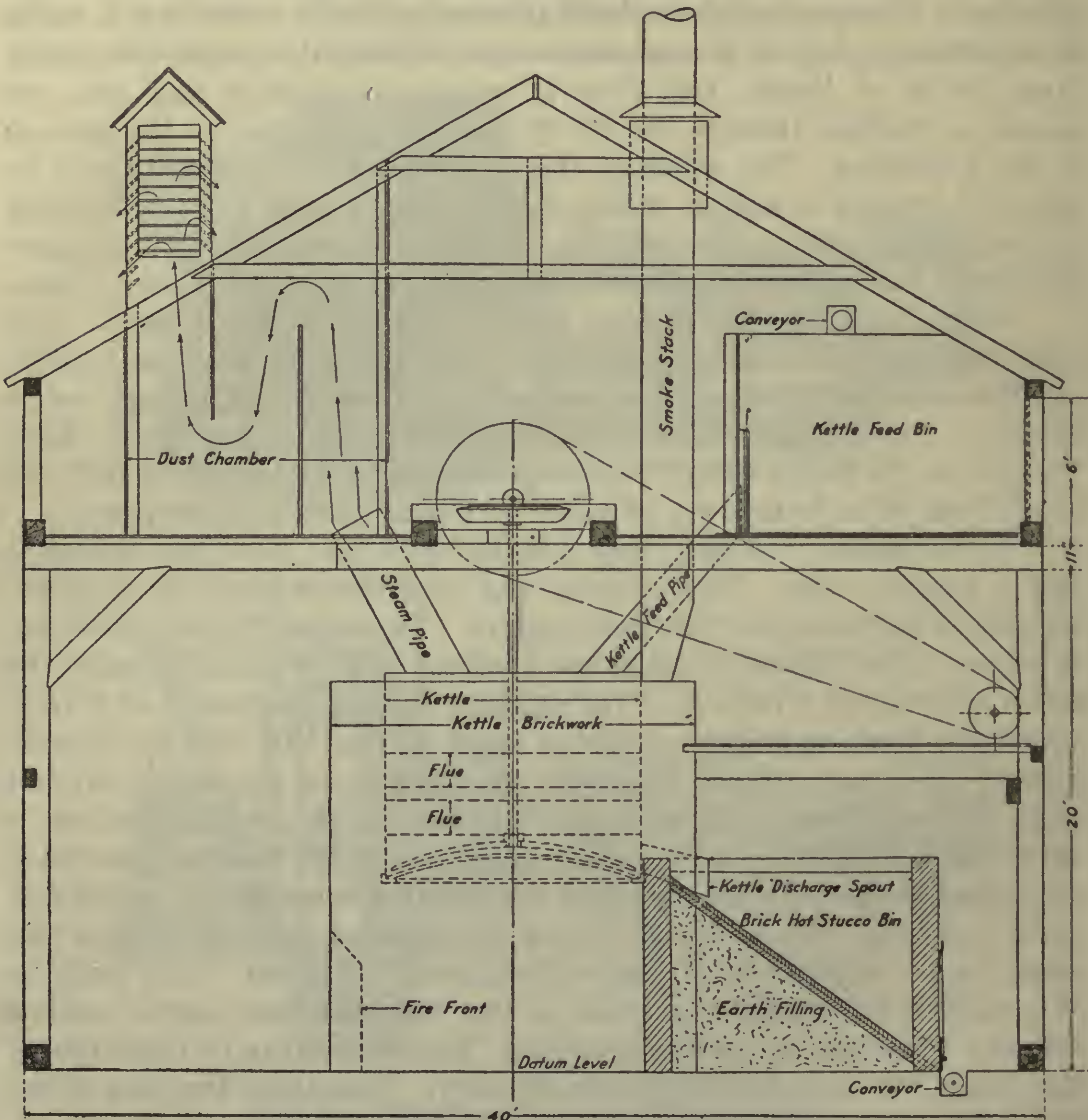


Fig. 18. End elevation of one kettle gypsum mill.

CALCINING METHODS.

When gypsum is heated to a temperature of 230° F. (110° C.) it commences to boil vigorously, due to part of the water of crystallization being driven out of the mass. On gradually raising this temperature, the mass still continues boiling until 270° F. (132° C.) is reached, when the boiling ceases, and the whole mass settles down, losing anywhere between 10 to 12 per cent of its volume. By still further increasing the heat, the partially calcined mass is again made to boil, and when the temperature reaches about 290° F. (143° C.) steam is rising freely from the kettle, and the whole mass is greatly agitated. The calcination is completed at a temperature ranging from 350° F. (177° C.) to 390° F. (199° C.), according to the quality of plaster being made. The plaster is then removed and allowed to cool. The total loss in weight is about 15 per cent.

Many methods have been tried to calcine gypsum, with more or less success, but, so far, in Canada, the kettle system is the only one in use.

Ancient Methods. In the early part of the nineteenth century, when the gypsum industry was in its infancy on this continent, the gypsum was boiled in cauldrons, which held anywhere from two to fifteen barrels each. The fuel used was wood placed under these pots. After the first boil was accomplished, the material was shovelled out on platforms beside the cauldrons, and allowed to cool. The boiling mass was constantly stirred by hand. This method was found both slow and expensive, and has been entirely replaced by either kettles or rotary calciners.

Foreign Methods. In Europe the cauldron method was also employed as well as calcining in ovens. This latter system is still used where the product required is to be of very uniform grade and high quality. It is adapted only to small quantities of very best grade of white gypsum, such as is required in the porcelain industry. Frank A. Wilder in his "Gypsum Industry of Germany" describes both individual and continuous kilns or ovens for gypsum (Iowa Geol. Surv., Vol. XII). The Mannheim system, although not yet adopted in American practice, is being employed to a considerable extent in Europe, and is described under continuous calciners.

The Kettle Method. Although the kettle method of calcining gypsum is slow and wasteful of heat, it, nevertheless, still is the commonest way employed in both the Canadian and American mills. It has the advantage of being easily watched by the operator, and produces a very even and well calcined plaster.

Several styles of kettles are employed, but these only vary in minor details. Butterworth and Lowe, Grand Rapids, Mich.; the J. B. Ehrsam and Sons Manufacturing Company, Enterprise, Kansas; the Des Moines Manufacturing Company; and C. O. Bartlett and Snow, Cleveland, Ohio, all manufacture these stationary kettles. The first kettles made were of about 5 tons capacity, but lately the tendency has been to increase this, and kettles of 15 tons capacity at one burning are quite common.

The kettle is set on a brick and masonry foundation, which encloses the fire space as shown in Fig. 19. The general size of this fire grate is about $4\frac{1}{2}$ feet by 3 feet, and is set between 6 and 7 feet below the kettle bottom. The kettle which is set on the base above mentioned is surrounded completely by a brick wall, 15 to 17 inches thick, which allows of an air space of 7 inches between the kettle and the wall. In constructing such a setting for the kettle, about 4,000 firebricks for fire pit lining, and 22,000 ordinary brick would be required.

The kettle itself consists of a hollow cylinder, made of $\frac{3}{8}''$ steel boiler plate, has a diameter of 10 feet and a depth varying from 8 to 10 feet. This kettle is placed on an iron flanged ring, which rests on the masonry, and inside of the kettle the convex bottom is made to rest on the ring. The

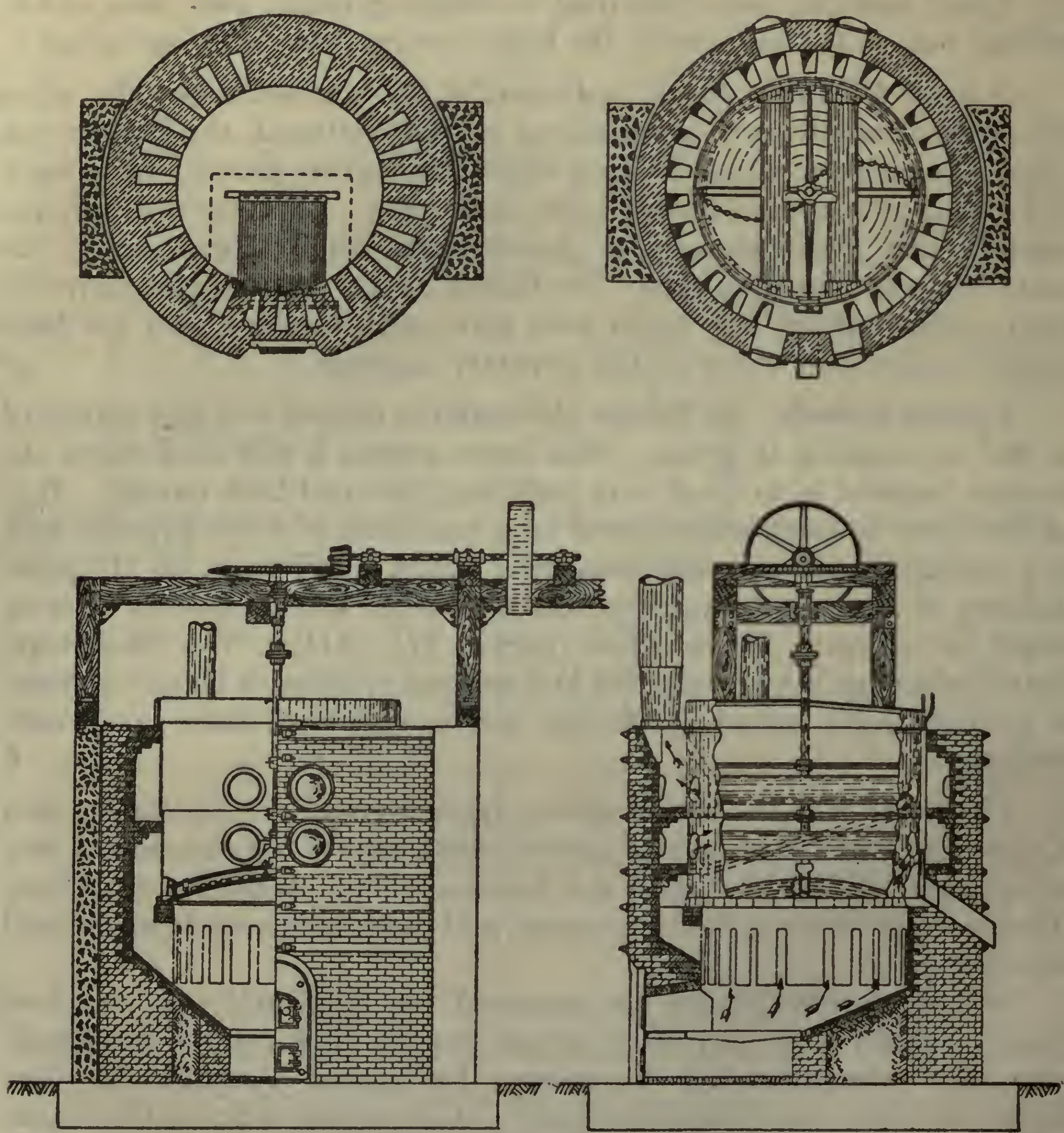
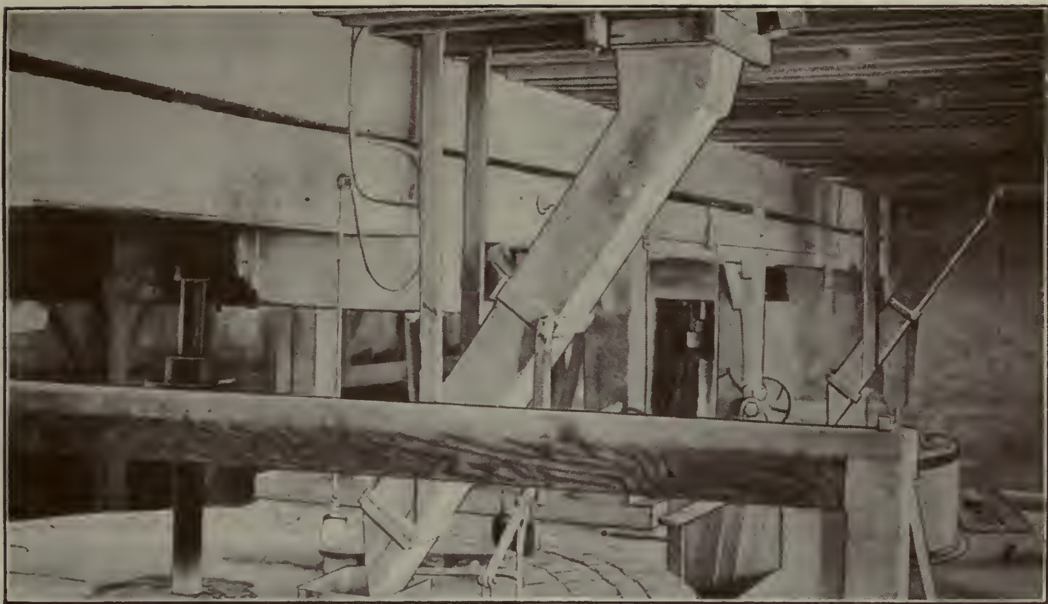


Fig. 19. Standard setting for Ehrsam's four-flue calcining kettles.

bottom is generally made of one single casting of specially chosen iron that has the lowest expansion or shrinkage when subjected to heat and cold. It is made with an arch upwards, and is firmly cemented to the ring and the bottom of the kettle with a special cement. It varies in thickness from $\frac{5}{8}''$ to $\frac{7}{8}''$. Some bottoms are made with a varying thickness, having a thickness at the circumference of $\frac{5}{8}''$ and increasing to $4''$ at the centre or crown. The great weight of these bottoms and their liability to crack



A. Front view of top of calcining kettles, Dominion Gypsum Co.'s mill, Winnipeg, Man.

B. Back view of top of calcining kettles, showing stacks, Dominion Gypsum Co.'s mill, Winnipeg, Man.

by the intense heat has led to the attempt to substitute sectional bottoms. In some districts these have been received with favour and are in constant use, but many manufacturers have not adopted them on account of the great difficulty of getting the new sections to fit with the old, due to the uneven expansion of the different sections.

The heat from the fire is allowed to play on the bottom and also on the sides of the kettle before escaping through the stack. In order to increase the heating power of the fuel and produce a quicker calcination, most of the kettles now in use have a set of flues—either two or four—running horizontally through the centre, and placed either all in one line or in sets of two placed directly beneath one another. The diameter of these flues varies according to the size of the kettle. In a small 6 ft. kettle with two flues these are made out of $\frac{1}{4}''$ plate with a diameter of 12″, whereas in a 10 ft. kettle with four flues the thickness is $\frac{3}{8}''$, and the diameter of the flue 16″. By reference to Fig. 19, the arrangement of the brickwork is seen, so that the hot gases from the fire are first allowed to heat the bottom, then pass through one set of flues, and return by the upper set before reaching the stack. The increased economy in fuel with this arrangement is quite marked.

The agitating apparatus which is used with these kettles in order to keep the material constantly in motion to prevent burning, consists of a gear-driven vertical shaft, varying in size according to the capacity of the kettle, but generally 4″ in diameter.[1] To the bottom of this shaft is attached a curved cross-arm, which supports a series of stirring paddles, which tend to force the gypsum to the centre when the shaft is revolved. Above the flues another cross-arm paddle is attached. The shaft is carried near the bottom by bearings attached to the flues. To operate this stirrer takes anywhere from 10 to 25 horse-power, according to the size of the kettle and quantity of charge. It revolves at the rate of 15 revolutions per minute.

The top of the kettle is covered with sheet iron and has loading doors and stack hole.

The fuel used is generally coal, and the consumption ranges between 400 pounds and 700 pounds per charge for each 10 ft. kettle.

The following table gives a few of the principal details of the kettles manufactured by the Ehrsam Manufacturing Company:—

Table Showing Details of the Ehrsam Calcining Kettles.

Diameter of kettle	Ft.	6	8	8	10
Height of kettle	Ft.	6	6	8	8
Number of flues		2	2	4	4
Diameter of flues	In.	12	14	14	16
Thickness of shell in kettle	In.	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$
Thickness of tubes in kettle	In.	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
Diameter of smoke stack	In.	14	20	20	24

[1]Mr. Lowe, of Grand Rapids, has noted that the presence of sodium chloride (NaCl) to any extent in the gypsum in the kettle tends to increase the power required to stir the mass. If at all noticeable in analyses, it is as well to have the stirring shaft increased to 5 inches.

Table Showing Details of the Ehrsam Calcining Kettles.—*Continued.*

Length of smoke stack................Ft.	40	48	48	48
Grate surface........................Ft.	2×3	3×4	3×4	4×5
Diameter of upright shaft.............In.	$3\frac{3}{16}$	$3\frac{15}{16}$	$3\frac{15}{16}$	$4\frac{15}{16}$
Length of upright shaft, lower section......	7′–6″	7′–6″	9′–10″	9′–10″
Length of upright shaft, upper section......	3′–6″	3′–6″	3′– 6″	4′– 0″
Number of kettle bands..................	3	4	4	6
Weight of kettle and fixtures..........Lbs.	6,000	12,000	13,000	20,000
Number of common brick above floor.......	10,000	16,000	17,000	23,000
Number of firebrick.....................	2,000	4,000	4,800	7,000
Capacity per charge................Tons	2 to 3	5 to 6	6 to 7	12 to 14
Power required on ground gypsum under ordinary conditions..............H.P.	8	15	15	25
Price................................	$450	$800	$900	$1,200

In charging the kettle, the material is allowed to run in very slowly, and is constantly agitated by the paddles. The kettle is kept at the start of a run at about 200° F. (93° C.) to 212° F. (100° C.). It takes from 1 to $1\frac{1}{2}$ hours to fill the kettle. When the kettle is full the temperature is increased, and at the end of $2\frac{1}{2}$ to 3 hours the charge is withdrawn, and allowed to cool in the fireproof brick cooling chambers beneath the kettles.

A lever beside the top of the kettle opens a trap door at the bottom which connects with a chute leading to the cooling bin.

ROTARY CONTINUOUS PROCESSES.

Many attempts have been made to adapt the continuous driers and roasters of lime and cement burning to the calcination of gypsum. Owing to the great prejudice of the actual labourers in the gypsum mills to any change in methods of calcining, the many devices which have from time to time been suggested were doomed to failure before ever they were given a fair trial. Of all these, only two, one in America and one in Europe, have obtained any headway. The natural tendency for improved methods of gypsum calcining seems to be along the line of rotary continuous processes, and if the industry is to make any material headway in the next few years, new methods will have to be adopted. In order that some idea may be obtained as to the lines along which experiments are being carried on to discover some satisfactory and economical means of continuous calcining of gypsum, a number of the more recent and important patents that have been taken out on calcining methods are briefly discussed. Two of these methods are already being employed, one in America, the other in Europe.

Cummer System.

In America, the only rotary continuous process that has made any headway is one patented by F. D. Cummer and Company, of Cleveland, Ohio, under Canadian patent No. 55,883, February 16, 1897.

Figs. 20 and 21 give a longitudinal and an end sectional elevation of a complete calciner built by this Company.

Interior view of mill of Alabastine Company, Caledonia, Ont., showing steel storage bins above kettle, and one kettle in place.

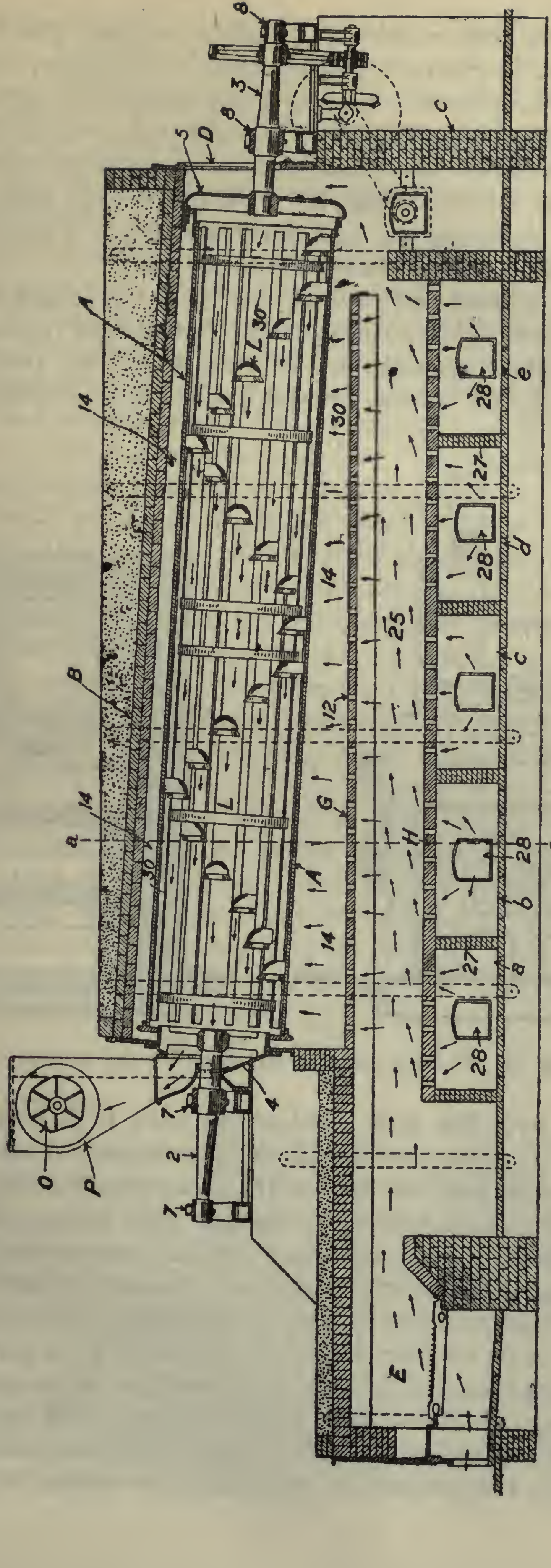


Fig. 20. Cummer calciner, side elevation.

It consists of a 30 ft. revolving cylinder A, enclosed about its side and top by a brick wall B, and at its rear by a wall C and plates D immediately at the rear of the cylinder. The calcining cylinder is supported at its ends by the extended trunnions 2 and 3, projecting from the spiders 4 and 5 at the respective ends of the cylinder, and each working in a set of bearings 7 and 8, which are wholly outside the walls of the drier and are thus free from any chance of having the dust penetrate them. The cylinder is set at a slight inclination downward from front to rear.

Beneath the cylinder and running nearly its full length is located an arch G, which is perforated with openings, 12, scattered regularly over the whole of it, and these openings are of a size which will permit a certain limited quantity of heat to pass through the cylinder or heating chamber,

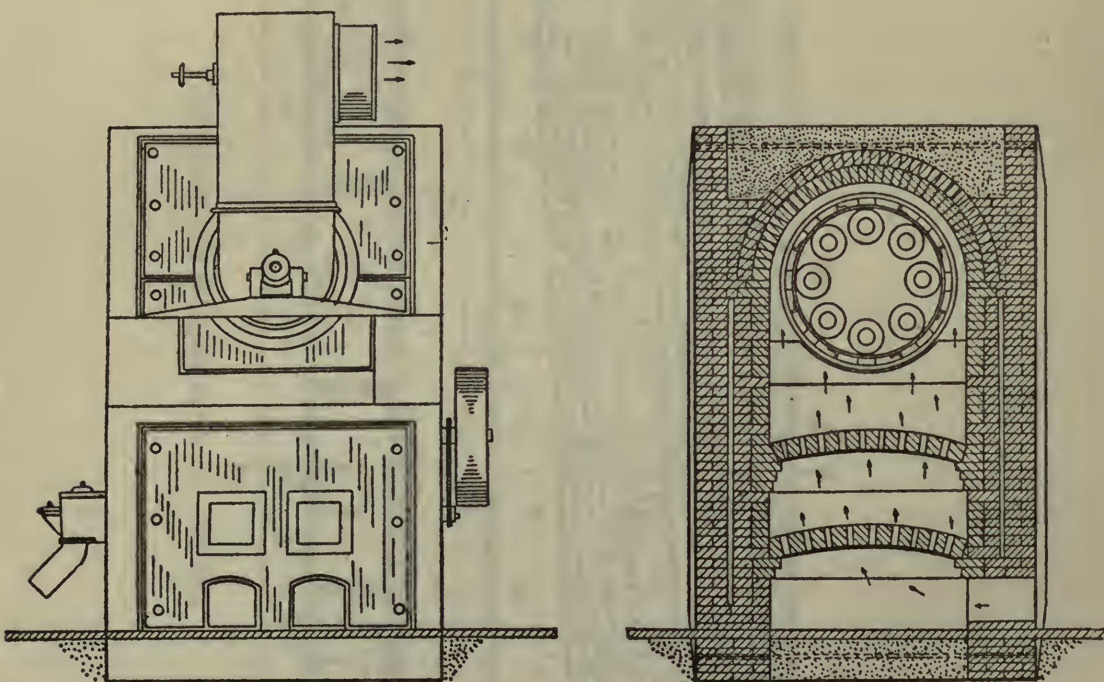


Fig. 21. Cummer calciner, end elevation and section.

14, immediately over the arch. Below the arch G is situated another perforated arch, H. This provides for the introduction of cool air into the direct shaft, 25, to regulate the heat of the gases from the furnace, E. This passageway or flue, 25, is formed by the side walls of the furnace and the perforated arches, G and H, at top and bottom, respectively, and the said arch, H, forms the covering for the series of fresh air chambers, a, b, c, d, and e, beneath the arch. Division walls, 27, separate these chambers, and each chamber has its own air inlet, 28, controlled by a suitable gate or other device to regulate the volume of air admitted, or to entirely cut off the air if necessary. One or more such chambers, with one or more air inlets each, may be used, as needed. This enables more or less fresh air to be thrown into the products of combustion or volume of heated gases from the furnace all along the line of travel, or at different points therein, as the needs of the work for the time being may demand.

A fan or blower, O, is present in the exhaust flue, P, at the front end of the cylinder, so that there is constantly present a strong suction in the cylinder and in the hooded passage leading through the cylinder.

The cylinder, A, has lifting blades, 30, longitudinally on its inside, for lifting and tossing the material.

Hooded inlets are placed in the cylinder to enable the heated gases to enter the interior. These inlets consist in a series of spirally arranged openings, 15, at suitable intervals in the cylinder between its ends and between the lifting blades, and over these inlets on the inside of the cylinder are placed the elbow shaped hoods, L. These hoods are designed as coverings and heat conductors for the openings, 15, so that the heated gases may have a free and unobstructed flow through them, notwithstanding the presence in the cylinder of a mass of tossed and travelling gypsum, which, without such hoods, would unavoidably sift out through the openings and be lost. Due to the peculiar shape of the hoods with the elbow turned towards the front of the cylinder in the direction of the draft, the material as it drops into the hoods at the bottom of the cylinder is shed or thrown off. As a further safeguard, at the base of the flaring shield, 18, there is a fine wire gauze, 20, which prevents the larger material which may come within shield, 18, from passing through the hood into the heated chamber. The heavy draft or suction is also opposed to any material leaking through the openings.

There are several advantages to be gained by this dryer. One of the main features is that the heat in the cylinder can be regulated to a fine degree, and on account of the heated air being allowed to enter the cylinder anywhere along its sides there is less likelihood of the calcined material being scattered when dropping from the end.

The Cummer dryer or calciner has found a much larger use as a dryer than as a calciner, and it is for the former use that it is being employed in Canada.

Mannheim System.

A system of rotary calcination which is worthy of attention is one which is being employed in Germany at the plant of the Rhenish Gypsum Company, located at Mannheim, in Rhenish Prussia. It is called the Mannheim system, and has been described at length by F. A. Wilder in Vol. 12, Iowa Geological Survey, pp. 213–216.

The crushing for this system is carried only far enough so that the largest pieces of gypsum will be $\frac{3}{4}''$ or smaller.

"The calciner consists of a fire box with an automatic stoker, which is placed in front of and connected with a chamber containing a rotating cylinder. Above this cylinder is a chamber called the forewarmer, through which a spiral conveyer passes, from end to end. A pipe leads from the rotating cylinder to the forewarmer, and connects at the other end with the chimney. Connected with the fire box is a fan by which a forced draft is secured.

The fire box is heated to a high temperature and the draft, forced by the fan, passes through the rotating cylinder, and then through the forewarmer. The gypsum is conveyed by bucket elevators from the crushers to a bin above the calciner and thence it flows under the influence of gravity into the forewarmer, through which it is carried by the spiral conveyer. It then falls directly into the rotary cylinder below. Shelves or buckets on the inside of this cylinder pick up the material and elevate it as the cylinder rotates. When the material nears the top the slant of the shelves is so great that it falls again to the bottom. This process of raising the gypsum and allowing it to fall is constantly repeated, the strong draft of hot air passing through the cylinder from the fire box strikes the gypsum as it falls from top to bottom and moves the fragments towards the rear with a velocity directly proportional to their size. The coarser material moves much more deliberately, and thus is exposed to the heat longer than the finer and more readily calcined particles. In this way, though the material entering the rotating cylinder varies greatly in fineness, the finer is not "dead-burned" and the coarser is sufficiently calcined. All of the heat has not been exhausted from the air in passing through the rotary cylinder, and this is for the most part saved by forcing the air, after it leaves the cylinder, through the forewarmer. In this process the heat is so completely utilized that the air and furnace gases pass to the chimney with a temperature of only 80° C. Between the forewarmer and the chimney the dust chamber is situated. Here all of the finer particles are allowed to settle and the air passes on to the chimney practically free from dust. To calcine one ton of gypsum by this Mannheim method, experience has demonstrated that on the average only 100 pounds of rather inferior bituminous coal is required. An automatic recorder indicates constantly the heat of the rotary cylinder, and this, with the mechanical stoker, insures an even temperature during the entire process of calcining. From the rotary cylinder the gypsum is again elevated to the floor above, and passes through a spiral conveyer, which is surrounded with a water jacket. Here the gypsum is cooled, and passes on to the sieves. That portion of the gypsum which does not need further grinding is separated by the sieves and the rest goes to the vertical mills."

In many ways this system has advantages, such as economy in fuel, labour, and power, and as it is a continuous process it will appeal to many, but like any other direct heat calciner it has the great disadvantage of having the gases from the fuel coming directly in contact with the gypsum, thus to a small extent injuring the calcined product by the introduction of small quantities of soot, and the fact that sulphur in the gases from the impure coal causes a reaction on the surface of the gypsum with the formation of calcium sulphide.

Bishop System of Continuous Calcining.

A rotary continuous calcining system has recently been patented in Canada by Wm. A. Bishop of Newark, New Jersey, by which he claims he is able to control the temperature in any part of the furnace to within a couple of degrees, and also that no plaster dust is lost, which in ordinary furnaces is carried off by the escaping steam. The system has several noteworthy features which may perhaps help to bring it into use. On account of its dust arrester, finely ground material can be fed into the calcining chamber. This, together with the complete means of constant mixing, enables the gypsum to become evenly and completely calcined. Another point of interest is that the material being calcined is completely enclosed throughout the operation and never comes in contact with the heating gases from the fire. This ensures a purer product than could otherwise be obtained. There is also less liability of burning out the bottom of the calcining chamber. Whether this system will be successful commercially remains to be seen. Figs. 22 and 23 show side and end elevation of the Bishop calciner. Mr. Bishop in his Patent No. 134251, July 1, 1911, describes his calciner as follows:—

"Referring to the drawings, 7 is the heat generating part of a furnace, which for purposes of illustration I have shown as a coal furnace, with the usual openings and closures for the control of the fire; oil or gaseous fuel could be used if desired.

8 is a rising forward part, 9 is a contracted intermediate horizontal part, and 10 a descending rear part of a heating flue, which continues in a depressed second horizontal part 11, and a vertical part 12, to a convenient point for entrance to a horizontal cylinder 13, and which carries the products of combustion away from the furnace.

This flue is preferably lined with firebrick throughout its length with the exception of that portion comprising parts 8, 9, and 10, the upper side of which is provided for by the under side of the trough 14 of the calcining chamber 15.

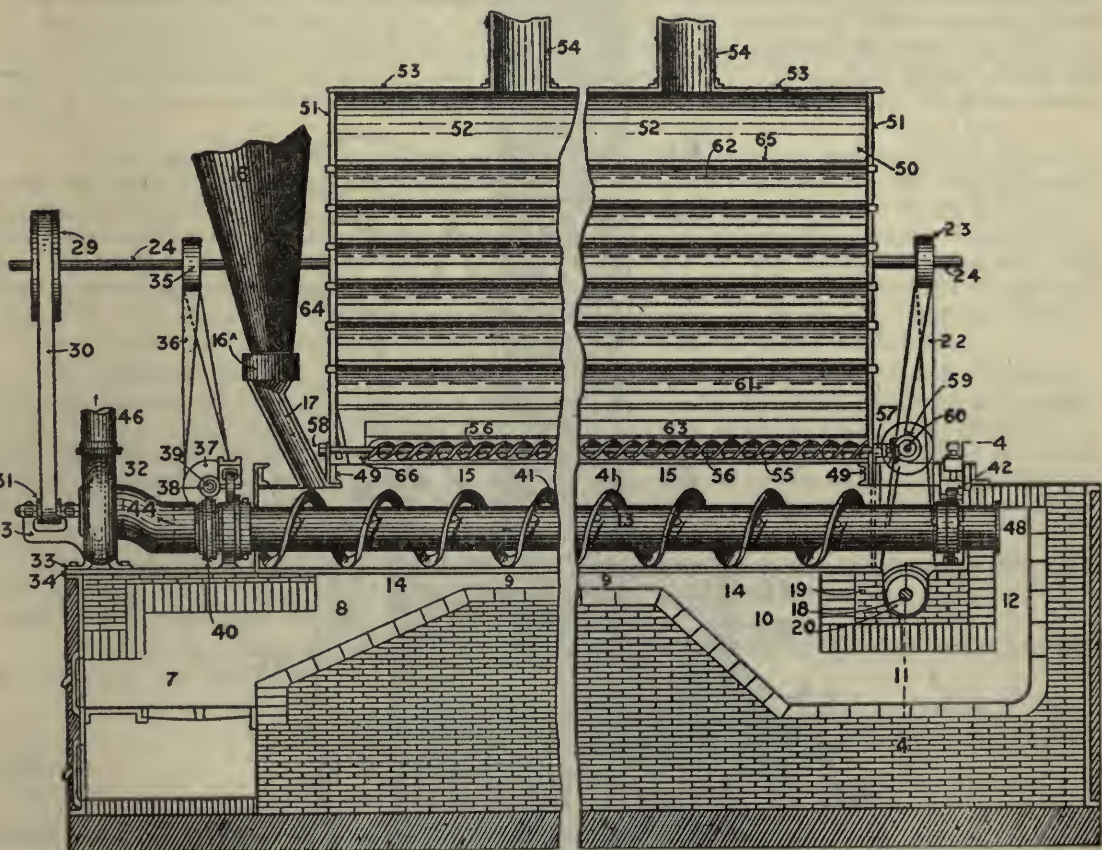


Fig. 22. Bishop rotary calciner, side elevation.

16 is a hopper provided with an automatic feed regulator 16a, from which through pipe 17 the material to be treated is fed to the calcining chamber 15, and 18 is the trough of a discharging chamber 19, which may be provided with the screw conveyer 20, operated by means of pulley 21, belt 22, pulley 23 and power shaft 24, the conveyer being mounted in bearings 25 and 26 attached to the outside plates 27 of the furnace structure, and the trough being provided with a spout 28, where the finished product is discharged from the apparatus.

29 is a pulley on a power shaft and connected by belt 30 to fan pulley 31, operating exhaust fan 32, mounted on bracket or standard 33, attached to a top plate 34 of the furnace.

35 is a pulley on a power shaft, connected through belt 36 to pulley 37, mounted on and driving a cross shaft 38, on which is also mounted a worm 39, operating a worm gear wheel 40, encircling and turning the cylinder 13, which cylinder serves on the inside as a flue to pass the products of combustion from the furnace and on the outside as the foundation for a screw conveyer and mixer 41.

The cylinder 13 is mounted on the adjustable roller bearings 42 and 43, and passes through bearing 42 to the uptake or vertical part 12 and through bearing 43 and worm gear wheel 40 into the curved connecting pipe 44, with which it has close but sliding fit, the pipe 44 being stationary, and conveying the products of combustion to the exhaust fan 32, from which they escape through exhaust pipe 46 to a stack or the open air.

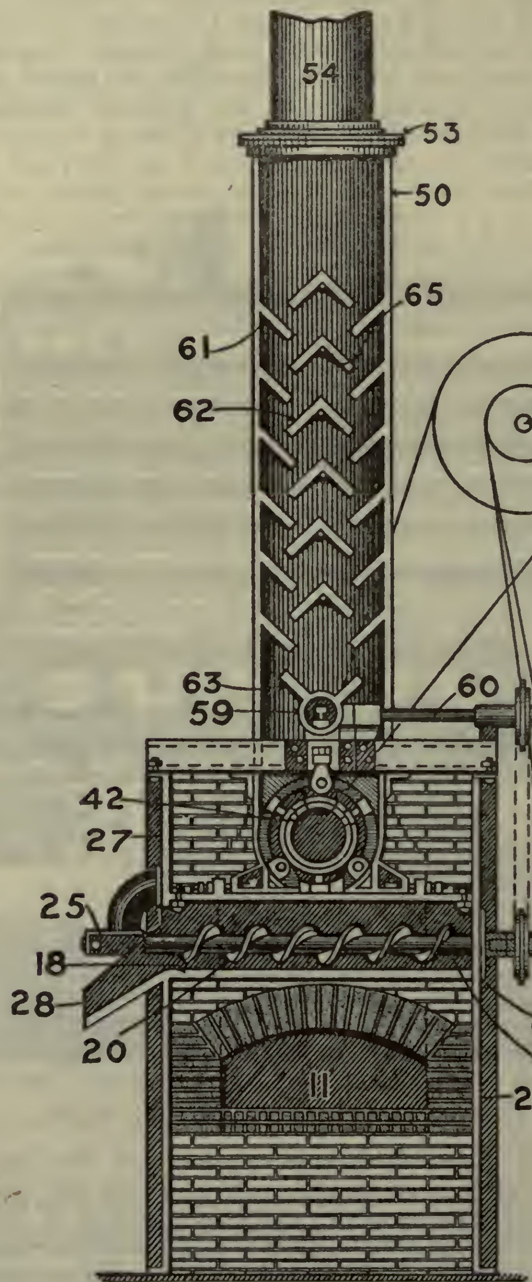


Fig. 23. Bishop rotary calciner, end elevation.

The screw conveyer and mixer 41 is comparatively narrow and is spaced from the surface of the cylinder 13 for the principal portion of its length, but widens towards the discharge end of the calcining chamber 15, until it extends practically from the trough 14 of the calcining chamber to the surface of the cylinder. By this construction the material is first passed slowly along by the narrow part of the conveyer and partly returned through the openings between it and the surface of the cylinder 13, the churning action serving to mix the material, and then, as the material becomes calcined and resolves into a somewhat fluid condition, the wider and more solid part of the conveyer retards or backs up the material, allowing it to escape only with the turning of the conveyer and the narrow space between it and the trough, whereby a too quick running-out of the material is prevented, and the proper period of treatment accorded it. The cylinder and conveyer is prevented from endwise movement through suitable thrust bearings 47 and 48.

Attached to several of the cross bracing channel bars 49 of the furnace and mounted thereon are the side and end plates 50 and 51 of a dust collecting box 52, provided with a cover plate 53 and stacks or vents 54. At the bottom of the dust-collecting box 52 is a collecting trough 55, in which a small screw conveyer 56, mounted in bearing 57 and 58 attached to the end plates 51, is operated by gearing 59 connected to power shaft 60.

Vapor and fine dust, rising from the material being calcined in the chamber, separates, the dust finding lodgment on the stationary inclined sheet-metal shelves 61, or the movable sheet-metal shelves 62, while the vapor passes upward and out of the vents 54. At intervals the accumulation of dust may be shaken down into the hopper 63 of the collecting trough 55, by a suitable shaker attached or applied to the squared ends 64 of the supporting rods 65 of the movable shelves 62, the flexible free edges of said shelves 62 engaging the free edges of the stationary shelves 61 and vibrating them. The fallen dust passed from the end of the conveyer through space 66 becomes again incorporated with the mass being treated.

By the apparatus above described it will be apparent that raw material, entering from the hopper 16 through the pipe 17, is propelled slowly through the calcining chamber 15, losing its moisture and some dust through the heat and agitation, and being well mixed through the churning action of the spaced part of the conveyer 41, recovers most of the fine dust which rises with the vapor through the action of the collecting apparatus and conveyer 56, is propelled more slowly and finally retarded by the solid portion of the conveyer 41, and passes without undue speed into the trough 18 of the discharging chamber 19, and is removed by the cross conveyer 20 to a convenient point for handling.

It is evident that, by the peculiar construction of the furnace and calcining chamber, the intense heat of the rising part of the flue is modified by the comparatively cooler condition of the products of combustion passing through the exhaust end of the cylinder 13, and that the less intense heat of the descending part 10 of the flue is offset by the comparatively warmer condition of the products of combustion in the cylinder opposite that part of the flue. These conditions may be controlled and further modified by opening the air inlets 67, closed by slides 68.

Openings 45, closed by slides 69, are provided for access to the calcining chamber 15, for the purpose of observing temperature of physical conditions of the material being treated or for cleaning out the chamber.

Openings 70, closed by slides 71, are provided in the walls of the dust collecting box for access to the shelves 61 and 62.

The brick walls of the furnace encased by plates 27 prevent undue radiation of heat.

CLAIMS.

1. An apparatus of the character described, comprising a furnace having a main heating flue, a calcining chamber having its under side forming the upper side of the main heating flue, a rotatable cylinder located within the calcining chamber and providing an auxiliary heating flue connecting with and extending forwardly from the rearward end of the main heating flue, an exhaust flue with which the forward end of the rotatable cylinder is connected, a screw conveyer and mixer secured to the rotatable cylinder, means for feeding the material to the calcining chamber, means for driving the rotatable cylinder, a dust-collecting box mounted over the calcining chamber and having vents at the top, and a collecting trough at the bottom of the dust-collecting box, having a screw conveyer discharging dust into the forward end of the calcining chamber.

2. An apparatus of the character described, comprising a furnace having a main heating flue, a calcining chamber having its under side forming the upper side of the main heating flue, a rotatable cylinder located within the calcining chamber and providing an auxiliary heating flue connected with and extending forwardly from the rearward end of the main heating flue, and exhaust flue with which the forward end of the rotatable cylinder is connected, a screw conveyer and mixer secured to the rotatable cylinder, means for feeding the material to the calcining chamber, means for driving the rotatable cylinder, a dust-collecting box mounted over the calcining chamber and having vents at the top, and provided with inclined side shelves and movable shelves between the side shelves, and a collecting trough at the bottom of the dust-collecting box, having a screw conveyer discharging dust into the forward end of the calcining chamber.

Crystallization Process.

In his experiments with gypsum, Chatelier found that when he heated a saturated solution of gypsum in a closed tube to a temperature between 266° F. (130° C.) and 302° F. (150° C.), very long, delicate, rectangular, crystal prisms were formed. These he threw into alcohol and analysed, with the following result:[1]—

	Per cent
Water	6·70
Sulphate of lime	93·30
	100·00

This agrees very closely with the formula $(CaSO_4)_2.H_2O$ where there would be:—

	Per cent
Water	6·20
Sulphate of lime	93·80
	100·00

In analyses of ordinary plaster of Paris the amount of water is about 7 per cent, so that it is a definite compound with the formula $(CaSO_4)_2.H_2O$.

The fact of the formation of these crystals of plaster of Paris has been taken into account in a process of plaster manufacture patented under patent No. 81,738, taken out in May, 1904, by Wm. Brothers, Prestwich, Lancaster, England. No commercial use seems to have been made of this patent, and whether it will work successfully on a commercial scale has yet to be proved.

The specification is as follows:—

Patent No. 81,738, May 10, 1904.
Wm. Brothers, Prestwich, Lancaster, England.
The Manufacture of Plaster of Paris.

This invention relates to the treatment or cooking of calcium sulphate (either the natural gypsum or a chemical by-product or disused plaster moulds or other form of calcium sulphate) for the purpose of obtaining plaster of Paris.

Hitherto it has been customary to roast or calcine the gypsum or calcium sulphate to drive off the water of crystallization and convert it into plaster.

I have found that by heating the calcium sulphate (in whatsoever form) in the presence of water or in an aqueous solution to a temperature exceeding boiling point, 212° F. or 100° C. that such calcium sulphate will recrystallize as the hydrate $(CaSO_4)_2 \cdot H_2O$, and may then be separated and dried without again taking up water, provided a considerable temperature is maintained.

My invention consists essentially in treating calcium sulphate (either in the natural form of gypsum, or in the powdered form of a chemical by-product, or other form) in water or in an aqueous solution (such as a solution of potassium sulphate, borax, or alum) at a temperature between 212° or 260° F. (or 100° and 130° C.) and then separating out and drying the solid product without allowing it to cool below 175° F. (or 80° C.).

When treating natural gypsum, the material is broken up into lumps, or it may be ground to powder, and is mixed with water in a boiler, pan or vat, to which heat can be applied.

[1]Michigan Gypsum, Vol. IX, Pt. 2.

When treating a waste or by-product which is in a finely-divided state, or other sulphate which has been finely ground, it is mixed with water to a thick, milky or creamy consistency and is then run into a boiler, pan or vat, to which heat can be applied to raise it to the desired temperature.

In one method steam is admitted to or passed through the mixture until it is raised to the required temperature, say about 250° F. (or 120° C.), at a pressure of about 5 lbs. to 20 lbs. per square inch.

In another method steam may be applied to a jacket or steam chamber surrounding the pan at a pressure to raise it to the desired temperature, or the boiler, pan or vat may be raised to the desired temperature by the direct action of a flame or heated gases from coal, coke, gas, or other fuel.

In the case of natural gypsum being treated when the required temperature of about 250° F. (or 120° C.) is reached, the gypsum parts with part of its water of crystallization and recrystallizes as the hydrate of calcium sulphate $(CaSO_4)_2 \cdot H_2O$.

In the case of non-crystalline calcium sulphate, when the temperature of about 250° F. (or 120° C.) is reached, it crystallizes into needle-like crystals of the hydrate $(CaSO_4)_2 \cdot H_2O$.

From the mixture, while still hot, the water is run or drained off or otherwise removed by a centrifugal machine, filter press or other apparatus, and the solid matter or crystals are completely dried at a temperature at or above 175° F. (or 80° C.), without being permitted to cool below that temperature.

The resulting product is a good plaster of Paris, which may be used in this form or ground to break the crystals, and then used in the ordinary way.

The Mixing of Gypsum.

Mixing Plasters.

When the gypsum has been sufficiently calcined it is run into cooling pits which are generally made with a concrete or brick lining. In these it is left for a sufficient length of time to properly cool. An advantage is also gained by leaving the material in these pits, as the excess heat acts on any part of the mass that has not been sufficiently calcined and brings it all to a uniform grade of calcination. From these pits it is elevated and placed in bins in the mixing part of the mill. When in this state it is called stucco, plaster, or calcined plaster. Where complete grinding has not been carried on before calcination the stucco is again fed through grinding mills and then put through screens, but where, as in Canadian practice, the material is all reduced to a flour before calcining, the stucco is screened directly and then put through the mixers. The types of screen most generally employed are some kind of revolving bolting screen, or of the shaking type, such as the Newago separator. Screens of this latter type seem to be pretty universal throughout the mills in Canada. The oversize from these screens is reground in small buhr mills.

Stucco or calcined plaster has a setting time of from five to fifteen minutes. This is altogether too fast for commercial work, so in order to increase the time for the initial set some material known to the trade as retarder has to be added. Wood fibre or hair is also added to give the material increased strength, and these materials are added together with the retarder in what is known as a mixing machine. This machine consists essentially of a hopper-shaped feeding bin into which the weighed materials are dumped, and a cylindrical chamber with a revolving paddle. When all the materials which go to make up a hardwall plaster are weighed out, a lever dumps the mixture into the main body of the mixer. This consists of a horizontal cylindrical box with a revolving screw paddle which keeps the mixture constantly stirred, thus ensuring a perfect mixing of all the materials. From the bottom of the mixer a number of chutes over which

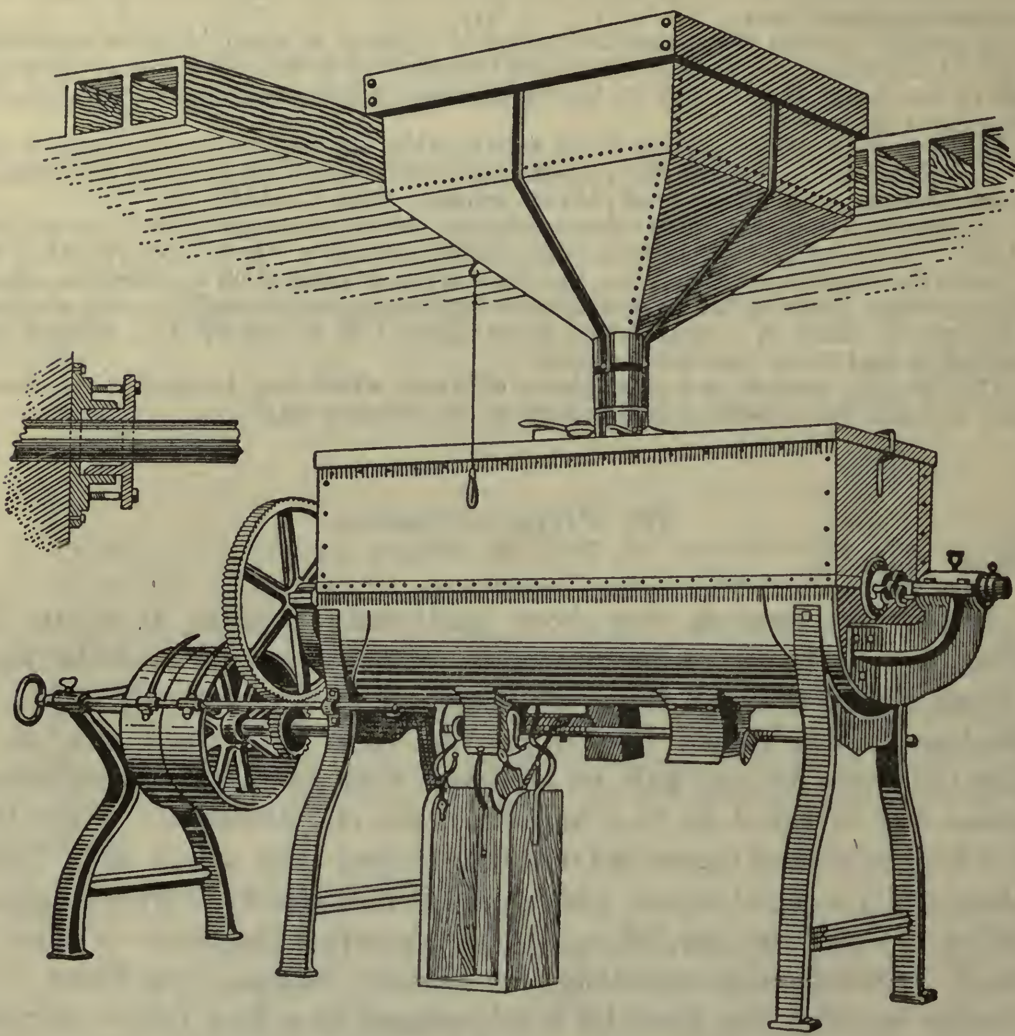


Fig. 24. Day's plaster mixer.

bags can be placed are so arranged that when the mixing operation is completed, the plaster can be dumped directly into the bags or barrels placed to receive it.

Retarders.

In nearly all the Canadian gypsum mills the material used as a retarder for the setting of gypsum is a patent retarder made from the refuse from the stock yards and packing houses. Many materials may be employed for this purpose, such as glue, glycerine, sugars of different sort, grains ground to a sufficient degree of fineness, sawdust, wood pulp, etc., and among mineral materials such materials as lime, slags, alkalis, acids, etc., are frequently employed. The action of these retarders seems to be along mechanical lines, by hindering the crystallization of the plaster and the absorbing for the time being of the water which is necessary for the complete hydration of the product. There does not seem to be any appreciable effect on the tensile strength of the plasters by the addition of a small amount of retarder.

Accelerators.

Occasionally, as in the case of a stucco made from a poor grade of gypsum earth, some material has to be added to hasten the setting qualities of the plaster. For this purpose certain salts are employed. In the better grades of fine white plaster, such as are used for dental purposes, in order that a very quick set may be obtained, either alum or borax is added and thoroughly mixed. The set in this latter case is then only about three to five minutes.

THE USES OF GYPSUM AND GYPSUM PLASTERS.

Uncalcined Gypsum.

Gypsum rock, as it comes from the mine, or when treated only by crushing and grinding, is used in many industries. For many years the principal use for it was as a fertilizer, but of late years its use in this line has been falling off, so that now the demand for land plaster fertilizer is slight. A few of the more important uses are here mentioned.

As a Retarder for Portland Cement.

Since the cement industry has grown to such a large extent, the demand for ground, crude gypsum for use as a retarder has steadily increased.

When a small amount of gypsum is added to Portland cement, the set of the cement is retarded, but apparently the tensile strength is not injured. The percentage which is allowed, according to specifications, varies in different countries. England and Germany allow only 2 per cent, while in other countries a maximum of 3 per cent is permitted.

Although larger amounts of gypsum still act as a retarder to the cement and also increase its strength, the cement, so treated, will, after a time, check and crack so as to become useless.

At one time plaster of Paris was employed entirely to retard the setting of cement, but later it was found that crude gypsum acted in a similar way, so this is the form in which it is generally used, as the cost is less than the calcined gypsum. In purchasing gypsum, the cement manufacturer purchases the sulphur trioxide content (SO_3) generally specifying 36 per cent or over, as this appears to be the main requisite in the reaction which takes place.

Basis for Portland Cement.

Many attempts have been made to substitute gypsum for limestone in the manufacture of Portland cement, and to save the sulphur content from the gypsum as a by-product. Although several patents have been issued in the United States covering processes which employ gypsum in this way, none seem to have been exploited to any extent.

Manufacture of Sulphuric Acid.

The enormous quantities of sulphuric acid which are to be found in nature in gypsum and anhydrite have led many to experiment and take out patents on processes for its recovery, but so far none of them have been commercially successful.

The first proposal was to pass steam over red hot gypsum, which was supposed to liberate SO_2, O and SO_3, leaving the CaO behind.

Another method was to pass HCl gas through a red hot mixture of gypsum and coal, forming $CaCl_2$, CO, H_2S and S.

Still another process covered by patent was to subject gypsum to an electric current within a furnace in which the gypsum was in a molten condition. By supplying an excess of free oxygen, sulphur dioxide was formed, which was conveyed into lead chambers and converted into sulphuric acid in the usual manner.

Gypsum as a Fertilizer.

The employment of ground gypsum as a fertilizer was one of the first uses made of this material. The material, commonly known as land plaster when used in this manner, is considered to have a very beneficial effect on many crops, especially those coming under the head of leguminous, such as clover, etc.

When it was first used, very little was known concerning its reactions in benefiting these crops, but of late years it is generally conceded that it is only in a limited class of soils that it proves beneficial, and there it only acts as an indirect fertilizer. It is supposed to act on the double silicate of magnesia and potash, liberating them so that they are free to act as plant food. The action of gypsum on soil is stated briefly by Aikman in Manures and Manuring, p. 463, as follows:—

"The true explanation of the action of gypsum is to be found in its effect on the double silicates, which it decomposes, the potash being set free. Its action is similar to that of other lime compounds, only more characteristic. As a manure, therefore, its action is indirect, and its true function is to oust the potash from its compounds. Its peculiarly favorable action on clover is due to the fact that clover specially benefits by potash, and that adding gypsum practically amounts to adding potash. Of course, it should be borne in mind that the soil must contain potash compounds, if gypsum is to have its full effect. Now, however, that potash salts suitable for manuring purposes are abundant, it may well be doubted whether it is not better to apply potash indirectly. Further, it must be borne in mind that gypsum is applied to the soil whenever it receives a dressing of superphosphate of lime, as gypsum is one of the products formed by treating insoluble phosphate of lime with sulphuric acid."

Another use to which land plaster is adapted is as a retainer of ammonia in barnyard manure. If applied freely around the stables on the floor and manure pile it acts as a disinfectant, and also retains the ammonia, so that this valuable product is saved to the farmer when he puts the manure on the land.

Of late years the use of gypsum as a land plaster in Canada has greatly decreased. It has been found that it is not adaptable to all classes of soil, and hence has been given a strong set back. It is possible that if used when recommended by the Department of Agriculture in the western provinces, where the soil is high in potash, a beneficial result might be obtained.

Body for Paints.

The uncalcined, finely ground gypsum is sold in considerable quantities to paint manufacturers, where it is employed as a body for several grades of paint. For this use it is also sold in a semi-calcined condition.

Flux.

In connexion with the smelting of certain nickel ores mined in New Caledonia, crude gypsum is used as a flux. Thus, in smelting this ore, coke and gypsum are added to the charge, the latter furnishing the sulphur necessary for collecting the metal into a matte. It also acts as a base to counteract and slag the siliceous gangue.

In Germany it has been used as a flux for many years in the concentration of lead-copper matte in the reverberatory furnace.

In the Carmichael-Bradford blast-roasting process dehydrated gypsum is added as flux to galena concentrate.[1]

Crayon Manufacture.

White and coloured crayons used in blackboard and other work are now extensively made from gypsum. The uncalcined gypsum rock is very finely ground in a disc pulverizer and combined with several other ingredients, principally as a binder, and the mixture is then pressed into required shapes and dried before packing.

Filler for Cotton.

As a filler for cotton, the crude gypsum of purer quality, very finely ground, is sometimes used.

Asbestos Packing Gaskets.

In the manufacture of asbestos packing and gaskets, gypsum is mixed with asbestos and other ingredients, and gives body to the packing. In steam pipe coverings gypsum is also used to a considerable extent.

Imitation Marble and Onyx.

Many endeavours have been made to harden gypsum blocks, so that they will resist exposure to the weather, and also to represent the colourings and markings of marble, onyx, or any other of the decorative building stones.

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[1]U.S. Patent No. 705,904 (July 29, 1902).

Several patents in the United States cover this process, but the industry has not, so far, been developed in Canada.

Mr. Geo. W. Parker, of Grand Rapids, Michigan, under U.S. patent No. 459,151 (1894), describes his "Process of Treating Gypsum Rock to Imitate Chalcedony," as follows:—

"The crude gypsum rock is first shaped in any desired form and is then freed from the water constituting one of its constituent elements. It is next coloured in accordance with the desired effect, and then it is treated to the action of hardening chemical solutions.

To carry my process into effect, the gypsum rock from the mines having been given the desired configuration, as stated, is submitted to the drying action of hot air for twelve hours (more or less) until all the moisture has been eliminated. The material is now calcium sulphate, porous from surface to centre, and capable of absorbing sufficient chemical solution to produce the desired effect of the rock and colours.

To the surface of the dehydrated rock are now applied the mineral colours—such as, for an illustration, solution of copper nitrate and aqua ammonia or a solution of sulphate of iron, nitric acid, or other mineral colours. After colouring, the rock is immersed in a solution of aluminium sulphate ($Al_2(SO_4)_3$), for about fifteen hours, or until the pores of the rock are completely filled. The material is then removed and exposed to the open air for a few hours at a low temperature, and then polished."

Specimens were seen in Winnipeg by the writer during the summer of 1911, of plates of gypsum which had been treated by some similar process. In these specimens, however, only the surface of the gypsum had been treated with the colouring material, still leaving the centre of the block white.

Terra Alba.

Under the name of terra alba uncalcined gypsum is ground to a flour and sieved, after which it is sold in bags and sacks to the public for many purposes, chiefly as an adulterant in flour, sugar, baking powders, etc. The analyses made of these several articles in connexion with the operation of the pure food laws in a number of the states have been the means of detecting a wide range of such illegitimate use.

Terra alba, or gypsum flour, when mixed with a pure grade of wheat flour, is called Corine flour, and is used in dusting moulds for metal casting in foundries.

To the water used for brewing purposes, gypsum flour is sometimes added, as it enables the water, so treated, to dissolve the albuminous matter in the malt more effectually. Some wells in England are especially prized for brewing, on account of the water of these wells having passed through the gypseous deposits through which the wells are bored.

Many other uses are found for ground, uncalcined gypsum, such as a base for mixing with Paris green or other insecticide, and as a drug, etc.

Sculpture Work.

When large blocks of clear gypsum can be obtained in the form known as alabaster it is highly prized by sculptors and artists for statuary and other forms of art decoration.

CALCINED GYPSUM.

Plaster of Paris.

Plaster of Paris is the name given to all gypsum which has been only partially dehydrated and to which no impurities have been added either before or after calcination. Its use is very varied and extensive, and it is constantly being employed in new industries as its applications become known. Several of the more important uses will be described.

Dental Plaster.

Plaster of Paris enters to a large extent into the work carried on by dentists, in the forming of plaster casts for plate work. For this work the gypsum has to be ground exceedingly fine, and special care is taken in calcining, in order to obtain a uniform product. Only the whitest and purest of gypsum can be employed for dental plaster.

Modelling.

In artists' modelling, plaster of Paris is used to take casts from the original piece of work, in order to reproduce it either in bronze or other suitable material.

Moulds.

For moulds of every description plaster of Paris is extensively employed. The uses to which this material is put in the line of moulds, etc., are practically limitless, but only a few of the more prominent will be mentioned.

Plate Glass Moulds for Polishing.

The calcined gypsum, of which so much is employed in the plate glass industry, needs to be very finely pulverized and especially free from grit, in order not to scratch the polished surface of the glass when embedded in it. The process is briefly as follows: the rough plates of heavy glass, after coming from the kilns, are placed on large heavy, circular tables, up to 24½ feet in diameter, which have been covered with a coat of plaster of Faris. As the plaster sets, the plate of glass becomes firmly embedded in it, thus holding it rigid for polishing, and also relieving it from any strain it may be put to while being polished. When the first side is polished, the plaster is broken away round the edges and the plate removed. The table is then thoroughly cleaned, and a fresh coating of plaster spread over its surface, and the plate again placed on it, with the polished side down.

At many of the glass factories the old, set plaster, as it is scraped off the tables, is taken and recalcined in small kettles. The product thus obtained is mixed with new plaster and used only when polishing the first side, as it is considered too liable to contain grit, which would scratch the polished side if embedded in it.

A ton of 2,000 pounds of plaster is sufficient to embed about 910 square feet of glass.

Pottery Moulds.

Large quantities of plaster of Paris are employed in the manufacture of moulds for various pottery designs. It is especially adapted to this use, on account of the porous nature of the gypsum moulds, which permits the ready evaporation of the moisture from the clay, while the surface of the ware is not exposed to dangerous drafts.

Hat Moulds.

In the manufacture of most of the hats used, the blocks on which they are shaped are made of calcined gypsum.

Foundry Work.

For special castings and for castings of babbit in many foundry shops plaster of Paris is used extensively, on account of its porosity.

Moulds for Rubber Stamps, etc.

In mouldings for rubber stamps of all descriptions calcined plaster is made use of, on account of its readily taking sharp imprints.

Interior Decorations.

One of the larger industries to which calcined gypsum is adapted is the decoration of public buildings, principally interior work. Although it is sometimes used in outside decoration, where buildings are erected which are only for temporary use, such as were the buildings at the World's Fair at Chicago, it will not withstand the exposure to air and rain. A few years will cause it to crumble and go to pieces, if not protected by some method of glazed, waterproof coating.

For interior decoration or relief its use is extending each year. The mouldings, cornices, etc., to be seen in public buildings, are now made from this material. The interior of the new Grand Trunk Railway station at Ottawa, Canada, gives a good idea as to what extent it can be employed.

Mr. G. P. Grimsley gives a good description of the method employed in the manufacture of these reliefs. He says:—

"In this manufacture the design is modelled by the artist in clay, and then a mould is made of gelatin glue. A mixture of stearic acid and coal oil is used to oil the mould and prevent the cast from adhering. Into this mould is thrown a mixture of plaster of Paris and fibre, and finally, on the outer surface pure plaster. The whole is worked into the mould with the fingers, or in large designs it is pressed into the proper form by means of a wooden die or scraper, with its edge cut to the proper shape. The plaster is allowed to set and is then removed from the mould. Large pieces are moulded over a steel frame, which can be fastened in place by screws or staples. These designs are left in pure white or are painted in desired tints. Before painting, they are coated with shellac."[1]

[1]The Gypsum of Michigan, Geo. Surv. of Mich., Vol. IX, Part 2, p. 220.

Surgical Casts.

The medical profession employs plaster of Paris in considerable quantities for casts around broken limbs, etc. On account of its ready setting qualities, firmness when set, and the fact that it is not affected by moisture, heat, or cold, it is especially adapted for this purpose.

Plaster Ornaments and Casts.

In the finer art work, plaster of Paris plays a considerable part. Statuettes and all kinds of ornaments for home decoration are made of this material, as well as many of the casts and busts seen in public buildings.

Manufacture of Match Heads.

Calcined gypsum is employed by the match companies in the form of a good grade of plaster of Paris. It enters into the composition of match heads.

Safe Construction.

A considerable quantity of plaster of Paris is used each year in Canada by the manufacturers of steel safes. The use to which it is put is to fill in between the hollow walls of the safe.

It is claimed that a mixture of plaster of Paris and alum forms the best known filling for safes, as an external application of heat is certain to liberate a large quantity of water, which is transformed into steam, thus ensuring safety to the contents of the safe.

Jewelry Manufacture.

Jewelry manufacturers use considerable quantities of the finer grade of calcined gypsum, in which they set gold, silver, and precious stones to engrave or polish them.

Filler for Paper.

Calcined gypsum, or plaster of Paris, is used as a filler in nearly all the finer grade papers. For this use it has to be of a very white and pure quality, ground exceedingly fine.

Mr. G. P. Grimsley describes its use as follows:—

"The bleached pulp in the manufacture of paper is drawn out in fine fibres on the beater rolls and is then loaded with some mineral material, consisting usually of china clay or fine gypsum. When this is added in moderate quantities, it closes up the pores of the fibres and enables the paper to take a better finish. It is used especially in writing and printing papers."[1]

Gypsum Paint.

Calcined gypsum is used extensively as a whiting or whitewash paint. The finely ground gypsum is calcined and carefully screened and then set in blocks. When thoroughly dry, these are reground and screened and sold as a substitute for true linseed oil whiting.

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[1]Michigan Gypsum, Mich. Geol. Surv., Vol. IX, part 2, p. 216.

Geological Use.

A small and rather original use is made of plaster of Paris by geologists in excavating some of the larger and fragile fossil remains of the mammals, etc., of prehistoric ages. These remains, as they are uncovered, are gradually covered with cotton soaked in paste, on top of which plaster of Paris is cast in crossed ribs to give strength, so that the specimens can be brought with greater safety to the museums, where the plaster and cotton is carefully removed and the fossils mounted.

CEMENT PLASTERS.

When gypsum (which either contains certain impurities before calcining or to which special materials have been added after calcining), is partially dehydrated at a temperature not exceeding 400° F., the resultant product is known to the trade as cement plaster. This material is now being used almost exclusively in building construction, in preference to lime plaster. Although slightly more expensive at present than lime plasters, its greatly superior heat resistance, such as is required in all modern fireproof buildings, and its lasting qualities, are quickly overcoming the prejudice against its price, and as cheaper methods are being constantly employed in its manufacture, its use will soon become universal. The fire resisting qualities of plaster of Paris were discovered early in the history of its use, and many of the wooden beams in the houses in Paris which had been covered with a thin coating of plaster were found, after the great Paris fire, to have entirely escaped destruction. In several large, recent fires in modern buildings, where this cement plaster had been employed on the interior walls, it has been noticed that the exterior walls had been ruined by the flames from the window openings, while the interior of these same walls had escaped, due to their protecting coating of plaster.

In certain climates and in certain countries this plaster has a phenomenal lasting and preserving quality, notably in the moderate climate of southern Europe and Egypt, and portions of ancient buildings which had been coated with plaster are in a far better state of preservation than the rocks and masonry which were unprotected in this way.

In ordinary plaster of Paris, the setting time is very rapid—from 5 to 15 minutes. In order to enable easier manipulation and to give time for the plaster to be moulded and handled properly on the walls, certain materials known as retarders are added. Their composition and action have been described elsewhere.

To form a binder and strengthener to the cement plasters several materials, such as wood fibre, hair, etc., are employed, the material so used generally giving to the product the name by which it is commonly known to the trade. For the preparation of the wood fibre cottonwood or common poplar has been found to be very serviceable, and is employed in most of the Canadian mills. The logs are cut into lengths of about 24 inches and have an average diameter of 12 inches. These are placed horizontally in a fibre machine, which is very similar to a lathe in its action, the poplar block being revolved and a series of toothed circular plates being revolved and pressed against the block. These circular plates are keyed on a shaft lying parallel to the length of the block. One fibre machine will cut enough fibre in a shift of 10 hours to make 50 tons of wood fibre plaster.

The hair picking machine generally consists of a toothed drum (see Fig. 25) revolving at a fairly high speed of 600 to 700 revolutions per minute. Into this machine the baled hair is fed by hand. One of these machines will usually pick from 5 to 8 bales per hour.

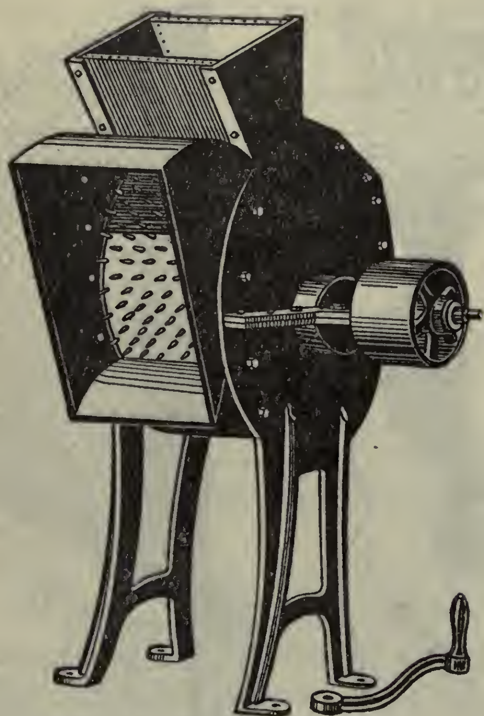

Fig. 25. Day's hair picker.

When wood fibre plaster is manufactured, the following proportions are generally used. These vary considerably, according to the quality of the plaster, and also the practice in different mills.

1,000 lbs.	Calcined plaster.
3 lbs. to 5 lbs.	Retarder.
10 lbs. to 12 lbs.	Lime (CaO).
30 lbs. to 70 lbs.	Wood fibre.

A plaster such as described above will require from 2 to 24 hours to set.

When hair is used as a binding material, the same proportions are employed as for wood fibre plaster, with the exception that picked hair is substituted for wood fibre. The quantity of hair added is generally from $1\frac{1}{2}$ to $4\frac{1}{2}$ pounds for every 1,000 pounds of plaster. Unlike lime plaster the plaster manufactured from gypsum does not act on the hair and eat it away. Other materials are sometimes substituted in place of the wood fibre or hair, such as asbestos fibre or manilla fibre, but although they form a very good binding material their use has not become very extensive.

This cement plaster is known to the trade under many different names. Each manufacturing company places its material on the market under its special name, such as Empire Cement Plaster, Paristone, Pulpstone, Gypstone, Empire Wood Fibre Plaster, etc.

In Germany this cement plaster is mixed with a small percentage of carbon and sold as Tripolite. The strength seems to be increased by this addition, but the colour is affected so that it cannot be used for white work. The method of applying gypsum plaster to metal lathing is shown in Fig. 26.

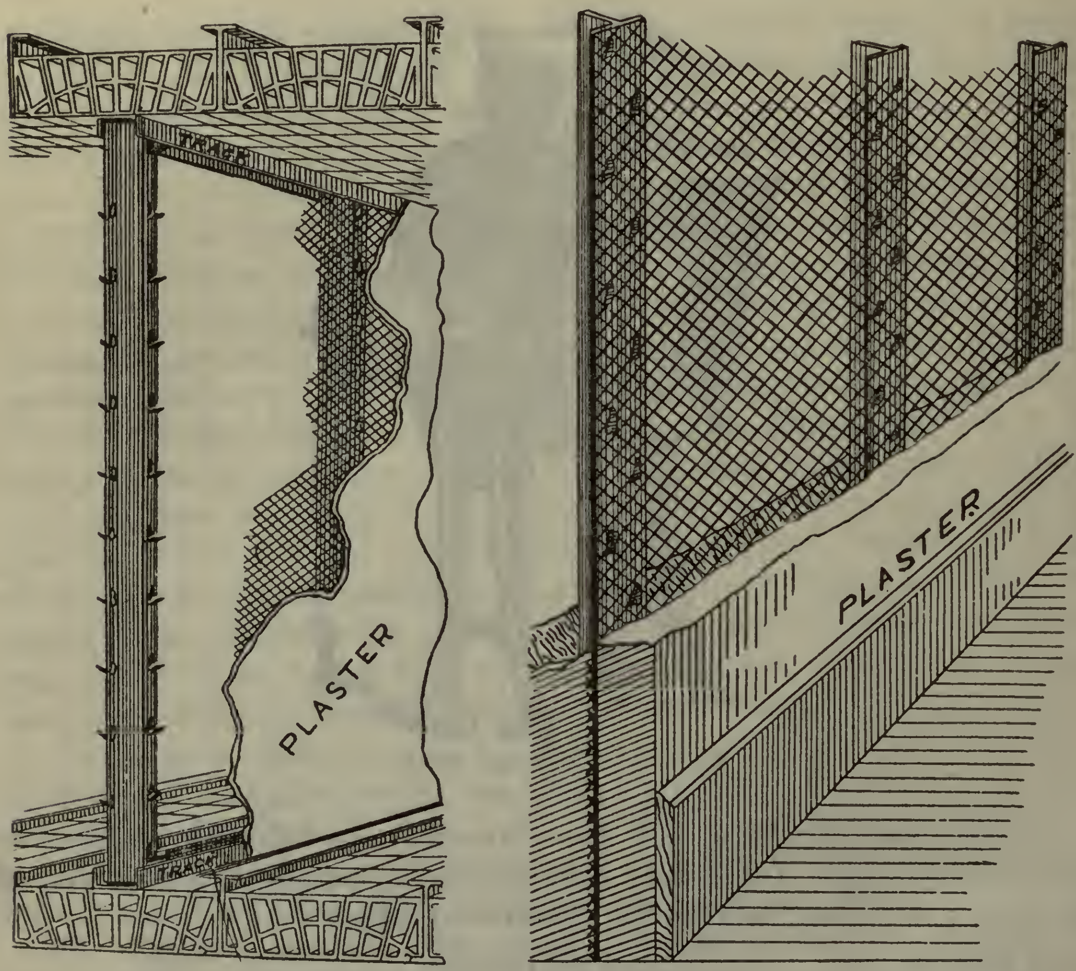

Fig. 26. Illustration of use of plaster on wire partition walls.

FLOORING PLASTER.

A type of plaster which, so far, has had little attention in this country, but which will be sure to gain favour, is already extensively used in Germany and on the continent under the name of flooring plaster. This plaster is produced by the complete dehydration of pure gypsum at a temperature over 400° F., but the material is not dead burned. The German name for this material is "Estrickgyps," or "Estrick gypsum."

Its manufacture differs a little from ordinary cement plaster in that a special vertical kiln is employed, and the material is calcined in small lumps at a temperature of about 500° F.

The special use that is made of this material in Germany is, as its name implies, for flooring plaster. It sets very slowly, but becomes exceedingly hard and forms a strong, durable, cheap flooring for ordinary purposes.

HARD FINISH (WALL) PLASTERS.

When gypsum is calcined at a red heat, or over, and certain substances (usually borax or alum) added, and then heated again, the resultant plaster is known as hard finish plaster. It is slower in setting than ordinary plaster, but attains a greater degree of hardness. This increased hardness is supposed by Landrin to be due to the reaction of sulphate of alumina and potash on the plaster rock, converting nearly all the carbonate of lime into gypsum. Several different methods have been employed to produce these plasters, and the plasters so obtained are known under such names as Keene's cement, Parian cement, Martin's cement, etc.

Keene's Cement. The best known and most prominent of these cements was first manufactured many years ago under English patents—since expired—under the name of Keene's cement. Until the last few years, all of this material employed in America was imported, but it is now being successfully manufactured on a small scale in the United States, and the prospects are that Canadian manufacturers will also produce a similar plaster in the near future.

The calcination of the gypsum in the manufacture of this product is carried on in small, vertical kilns, somewhat similar to those used in burning lime. The gypsum, which is generally calcined in small lumps, is brought to a red heat, after which it is treated with a 10 per cent solution of alum, and allowed to dry. Calcination is carried on after this to a dull red heat, but no further. The product is finally ground to flour in emery mills.

Mack's Cement. Another hard finish plaster, known under the name of Mack's cement, is composed of flooring plaster (dehydrated gypsum), to which has been added a small quantity—0·4 per cent—either of dehydrated sodium sulphate (Na_2SO_4) or potassium sulphate (K_2SO_4). Unlike Keene's cement, this is a very quick setting material and has great adhesive qualities. On account of its surface being but slightly porous when set, it absorbs very little oil when painted.

Parian Cement. Parian cement is obtained in a similar manner to Keene's cement, with the exception that the saturating solution is composed of borax instead of alum. The time of the set can be regulated by the strength of the borax solution in which the calcined gypsum is treated; the stronger the borax the slower the set.

Many chemicals have been tried, with more or less success, as a hardener for calcined gypsum, and the products sold under such names as Martin's cement (solu. K_2CO_3), Magand's cement (solu. sulph. of zinc, sulph. of iron or sulph. of copper), and numerous other varieties.

MISCELLANOUS USES.

Alabastine. Alabastine is a wall tint, made with pure, white, calcined gypsum, to which colouring material has been added. Patented in 1875 by Mr. M. B. Church, of Grand Rapids, Mich., its use has gradually extended over the whole of Canada and the United States.

It is manufactured and put up in 2½ and 5 pound packages, ready for use upon the addition of cold water. One 5 pound package of the material will cover an average of 450 square feet, if the walls are not old and badly stained, or too rough. Alabastine can be applied not only to plaster walls, but also over wood, burlap, and any other material which will take ordinary paint. It is claimed to be very sanitary and germ-proof, and insect pests will not remain upon walls coated with it. It cements crevices and prevents vermin from entering.

Lieno. Another wall tint very similar to alabastine is known under the name of Lieno. It is manufactured by the United States Gypsum Company, and the name is taken from the inventor's name, O'Neil, spelt backwards. The tints that can be produced with these colours are very soft, and it is claimed that they can be applied by inexperienced hands with as complete effect as if applied by professionals. A specialty is made of Lieno in use for relief work. It is sold in 5 pound packages and larger sizes. Unlike alabastine, this material requires warm water for mixing.

Flooring Blocks or Plaster Board. Flooring blocks are being manufactured in Canada and the States for use in floors and walls. Special machines are used in which this material is made. The calcined gypsum, finely ground, is mixed with excelsior or sawdust, and moulded into blocks or boards, after which it is allowed to dry by natural heat. These boards can be cut and nailed on walls, etc., as required.

Asbestos is sometimes used in preference to sawdust or excelsior. It makes a practically fireproof material, and thus is adapted for many purposes.

Some firms manufacture this board by spreading a thin layer of plaster, on top of which paper is placed, and then another layer of plaster. If a coarse grade of paper is employed, the plaster will penetrate it and the whole will form a solid mass.

Partition Blocks. Many attempts have been made, with varying success, to cast gypsum into bricks for interior building purposes. One of the most satisfactory forms in which these blocks are made is the hollow block with two square holes. They find a ready use in cellar linings, etc.

Selenitic Lime. Selenitic lime, or, as it is better known, Scott's cement, has for its essential constituents lime (CaO) and a small percentage of sulphur trioxide (SO_3). The sulphur trioxide can be added to the lime in several ways. The earlier patents taken out by Scott provided for the manufacture of this product by reheating to bright redness, lightly calcined, grey chalk lime in shallow kilns with perforated floors, beneath which were placed pots of burning sulphur. The reaction supposed to take place when the sulphurous acid fumes rose from the sulphur among the red hot lime, was the convertion of the lime (CaO) into calcium sulphite ($CaSO_3$), which in turn became oxidized into calcium sulphate ($CaSO_4$). Only a small amount of sulphurous acid was absorbed by the lumps of lime—about 2 to 3 per cent— and then only the surface coating of the lumps was altered, but this was thoroughly distributed throughout the whole mass by regrinding.

Further experiments showed that the same material could be obtained by either adding a little sulphuric acid to the water when mixing with the lime in preparing the mortar, or by the addition of ground plaster of Paris to the powdered lime.

Scott's final specification called for the manufacture of a cement which he named selenitic cement, which was composed of calcined hydraulic lime, to which 5 per cent of plaster of Paris had been added, and the whole mass ground to a flour, and thoroughly mixed.

The following table by Eckel gives the results of tests made on selenitic limes by Grant in 1880:—

Tensile Strength of Selenitic Limes.

	1 Lime: 3 Sand.		1 Lime: 4 Sand.		1 Lime: 5 Sand.		1 Lime: 6 Sand.	
	dry	wet	dry	wet	dry	wet	dry	wet
A. Grey lime, not selenitic	50	68	44	57	30	45	21	28
A. Grey lime, selenitic	128	141	65	139	55	87	40	65
B. Lias lime, not selenitic	48	95	49	59	32	47	23	27
B. Lias lime, selenitic	79	131	63	99	44	72	52	80
C. Selenitic lime	123	148	80	129	72	83	58	74
D. Selenitic lime, Rugby	91	151	59	102	33	77	29	66
E. Selenitic lime, Aberthard	128	204	83	147	71	123	....	76

In order to compare the tensile strength of the selenitic lime, two tests, A and B, carried out with the lime before the addition of the plaster of Paris, have been included in the above table. The results given are in pounds per square inch, and the tests were made after the briquets were kept one year, the dry being exposed to the air, while the wet were kept in water during the whole time.

Lime cements prepared in this way set very rapidly, but the best results are obtained when limes that are only slightly hydraulic are employed.

By reference to this table the gain in strength can be readily seen, but in this country, where natural cements are common, it has not been employed to any extent.

APPENDIX A.

LIST OF GYPSUM OPERATORS IN CANADA.

APPENDIX A.

LIST OF GYPSUM OPERATORS IN CANADA.

Product .... Gypsum.
Operator .... Victoria Gypsum Mining and Mfg. Co.
Owner .... Keystone Materials Co.
Head office .... Chester, Pa.
Mine office .... Quarry St. Ann, N.S.
Incorporation .... April, 1890, Nova Scotia.
Capital stock .... $100,000.
Province .... Nova Scotia.
Date .... 1910.
Name and location of property ..... St. Ann mine, St. Ann, C.B. rear of Goose cove.
County .... Victoria co.
Mine manager .... W. Clarence Lodge, Quarry St. Ann.
Products shipped .... Crude gypsum.
Shipping station and transportation service .... Connected by railway to shipping pier at Munro point, St. Ann harbour.
Destination of shipments .... Chester, Pa.

Product .... Gypsum.
Operator .... Newark Plaster Co.
Head office .... 17 Battery Place, N.Y.
Mine office .... McKinnon Harbour, N.S.
Province .... Nova Scotia.
Date .... 1910.
Name and location of property ..... McKinnon Harbour, Ottawa Brk., Eastmore.
County .... Victoria co.
Mine manager .... John Y. Gillis.
Products shipped .... Crude gypsum.
Destination of shipments .... Newark, N.J., U.S.A.

Product .... Gypsum.
Operator .... Great Northern Mining and Railway Co., Ltd.
Mine office .... Eastern Harbour, Cheticamp, C.B.
Secretary .... Paul Leclerc, Quebec, Quc.
General manager .... Hubert Anconi, Eastern Harbour, N.S.
Province .... Nova Scotia.
Date .... 1910.
Name and location of property ..... Bellemarche, Eastern Harbour.
County .... Inverness.
Mine manager .... N. V. Grandin.
Products shipped .... Ground gypsum and plaster of Paris.
Destination of shipments .... Montreal and Quebec.

Product .... Gypsum.
Operator .... Albert Parsons.
Head office .... Walton, N.S.
Province .... Nova Scotia.
Date .... 1910.
Name and location of property ..... Cheverie quarry and Walton quarry.
County .... Hants co.
Mine manager .... Albert Parsons.
Products shipped .... Crude gypsum.
Destination of shipments .... New York, Boston, and Baltimore, U.S.A.

Product . . . . Gypsum.
Operator . . . . Nova Scotia Cement and Plaster Co.
Head office . . . . 9 Toronto St., Toronto, Ont.
Mine office . . . . Port Hastings, N.S.
Secretary . . . . R. P. Ormsby.
Manager . . . . N. Lowery.

Preparatory work 1909, none since.

Product . . . . Gypsum.
Operator . . . . Windsor Gypsum Co.
Head office . . . . Windsor, N.S.
Mine office . . . . Newport Station, N.S.
Province . . . . Nova Scotia.
Date . . . . 1910.
Name and location of property . . . . . Newport, near Windsor.
County . . . . Hants co.
Mine manager . . . . Thos. A. Mosher.
Products shipped . . . . Crude gypsum.
Shipping station and transportation service . . . . Connected by siding with Dominion Atlantic Ry.
Destination of shipments . . . . Newburg, N.Y.

Product . . . . Gypsum.
Operator . . . . Windsor Plaster Co., Ltd.
Head office . . . . Windsor, N.S.
Secretary . . . . J. P. Smith.
Province . . . . Nova Scotia.
Date . . . . 1910.
Name and location of property . . . . . Brooklyn, N.S.
Products shipped . . . . Ground gypsum and plaster of Paris.
Destination of shipments . . . . Canada.

Product . . . . Gypsum.
Operator . . . . Maritime Gypsum Co., Ltd.
Head office . . . . New York, 381 4th Ave.
Mine office . . . . Amherst, N.S.
Incorporation . . . . Oct. 1905, Nova Scotia.
Capital stock . . . . $49,000.
President . . . . D. L. Haight, Pres. Rock Plaster Co., New York.
Vice-president . . . . H. J. Logan, Amherst.
Secretary . . . . H. W. Soutar, 381 Fourth Ave., New York.
Province . . . . Nova Scotia.
Date . . . . 1911.
Name and location of property . . . . . Amherst point.
County . . . . Cumberland.
Mine manager . . . . Arthur T. Avard, Amherst.
Products shipped . . . . Crude gypsum.
Shipping station and transportation service . . . . Intercolonial Ry. shipping pier $1\frac{1}{2}$ miles from quarry by rail.
Destination of shipments . . . . United States.

Product . . . . Gypsum.
Operator . . . . Newport Plaster Mining and Mfg. Co.
Mine office . . . . Windsor, N.S.
Secretary . . . . John Bungay.
Province . . . . Nova Scotia.
Date . . . . 1910.
Name and location of property . . . . . Avondale, N.S.
County . . . . Hants.
Mine manager . . . . Daniel Munro, Box 225, Windsor.
Products shipped . . . . Crude gypsum.
Destination of shipments . . . . New Brighton, Staten Island, and New York, U.S.A.

Product	Gypsum.
Operator	Wentworth Gypsum Co., Ltd.
Owner	J. B. King and Co.
Head office	Windsor, N.S.
Mine office	Wentworth, N.S.
Incorporation	May 19, 1891, Nova Scotia.
Capital stock	$200,000.
Secretary	John Bungay, Windsor, N.S.
General manager	E. N. Dimock.
Province	Nova Scotia.
Date	1910.
Name and location of property	Fraser and Eagle swamp.
County	Hants.
Township	Wentworth.
Mine manager	Geo. Shay, Wentworth ,N.S.
Products shipped	Crude gypsum.
Shipping station and transportation service	Shipped from pier on St. Croix river.
Destination of shipments	New York.

Product	Gypsum.
Operator	Noel Plaster Co.
Head office	Noel, N.S.
Province	Nova Scotia.
Date	1910.
Name and location of property	Noel, N.S.
County	Hants co.
Mine manager	Selwyn A. O'Brien, Noel, N.S.
Products shipped	Crude gypsum.
Destination of shipments	Red Beach, Maine, U.S.A.

Product	Gypsum.
Operator	The New Brunswick Gypsum Co.
Mine office	Hillsborough, N.B.
Province	New Brunswick.
Date	1910.
Name and location of property	Lake Maringouin.
County	Westmorland.
Mine manager	C. J. Osman.
Products shipped	Crude gypsum.
Destination of shipments	United States.

Operator	The Iona Gypsum Co., Ltd.
Office	309 Charlotte St., Sydney, C.B.
Name and location of property	Iona, C.B.
Secretary and treasurer	D. J. O'Connell, 309 Charlotte St., Sydney, C.B.

Product	Gypsum.
Operator	Kennedy Stinson—The Stinson-Reeb Supply Co.
Head office	Montreal, Que.
Province	New Brunswick.
Date	1911.
Name and location of property	Plaster Rock, N.B.
County	Victoria.
Mine manager	E. W. Stinson, Plaster Rock, N.B.
Products shipped	Crude gypsum.
Destination of shipments	Montreal and Hull, Que.

Product	Gypsum.
Operator	Hillsborough Plaster Co.
Owner	Wentworth Gypsum Co. (J. B. King and Co.).
Head office	Windsor, N.S.
Mine office	Hillsborough, N.B.
Secretary	John Bungay.

Province.........................New Brunswick.
Date.............................1910.
Name and location of property.....Hillsborough, N.B.
County...........................Albert co.
Township.........................Hillsborough.
Mine manager.....................James Blight.
Products shipped.................Crude gypsum.
Shipping station and transportation service.........................Conveyed to Gray Island wharf by Salisbury and Albert Ry.
Destination of shipments..........New York, U.S.A.

Product.............................Gypsum.
Operator.........................Albert Manufacturing Co.
Incorporation....................1854, New Brunswick.
Capital stock....................$300,000.
Secretary........................C. J. Osman.
Province.........................New Brunswick.
Date.............................1910.
Name and location of property.....Hillsborough.
County...........................Albert co.
Township.........................Hillsborough.
Mine manager.....................C. J. Osman.
Products shipped.................Crude and ground gypsum, plaster of Paris, hard wall plaster.
Shipping station and transportation service.....................Three miles of private railway connect quarry with pier.
Destination of shipments..........Crude to United States; most of manufactured gypsum sold in Canada.

Product.............................Gypsum.
Operator.........................John E. Stewart.
Mine office......................Andover, N.B.
Province.........................New Brunswick.
Date.............................1910.
Name and location of property.....Plaster Rock, Tobique river.
County...........................Victoria co.
Mine manager.....................John E. Stewart.
Products shipped.................Crude gypsum and ground gypsum.
Destination of shipments..........New Brunswick and Quebec.

Product.............................Gypsum.
Operator.........................Alabastine Co., Ltd.
Head office......................Paris, Ont.
Mine office......................Caledonia, Ont.
Incorporation....................1885.
Capital stock....................$50,000.
President........................M. B. Church.
Secretary-Treasurer..............R. E. Haire.
Province.........................Ontario.
Date.............................1912.
Name and location of property.....Caledonia mine and Carson mine.
County...........................Haldimand.
Mine manager.....................R. E. Haire, Paris, Ont.
Method of working................Mining.
Treatment of ore, etc.............Crushing and calcining and mixing.
Products shipped.................All grades of crude gypsum and calcined plasters—alabastine.
Shipping station and transportation service.........................Grand Trunk railway.
Destination of shipments..........Ontario and Central Canada.

Product . . . . Gypsum.
Operator . . . . Brown Gypsum Co., Ltd.
Head office . . . . Lythmore, Ont.
Mine office . . . . Box 14, Caledonia, Ont.
Sales office . . . . 24 Yonge St. Arcade, Toronto, Ont.
President . . . . Whitney G. Case.
Vice-Pres. and general manager . . . . . H. J. Brown.
Secretary . . . . Chester W. Fell.
Sales manager . . . . O. A. Cole.
Province . . . . Ontario.
Date . . . . 1912.
Name and location of property . . . . . Mine at York, Ont., mill at Lythmore, Ont.
County . . . . Haldimand.
Township, range, and lot . . . . (See Chapter VII.)
Mine manager . . . . John A. Nelles.
Mill manager . . . . J. H. White.
Method of working . . . . Mining.
Treatment of ore, etc . . . . Milling and mixing.
Products shipped . . . . All grades of crude gypsum and calcined plaster.
Shipping station and transportation service . . . . Michigan Central railway.
Destination of shipments . . . . Ontario and Quebec.

Product . . . . Gypsum and products.
Operator . . . . Toronto Plaster Co., Ltd.
Owner . . . . Toronto Plaster Co., Ltd.
Head office . . . . 1062 King St. W., Toronto, Ont.
Mine office . . . . Cayuga, Ont.
Incorporation . . . . Sept. 15, 1911, Ontario.
Capital stock . . . . $150,000.
President . . . . John Kennedy, Guelph, Ont.
Vice-president . . . . H. W. Calkins.
Secretary-treasurer . . . . D. E. Kennedy.
Manager-director . . . . H. W. Calkins.
Fiscal year ends . . . . April.
Annual reports published . . . . April.
Province . . . . Ontario.
Date . . . . June, 1912.
Name and location of property . . . . . Cayuga.
County . . . . Haldimand.
Mine manager . . . . Robt. Wilds.
Method of working . . . . Mining.
Treatment of ore, etc . . . . Ore mined and shipped to mill at Toronto, where it is calcined and prepared into standard grade of plaster of Paris.
Products shipped . . . . Plaster of Paris.
Shipping station and transportation service . . . . Cayuga, Wabash, and Grand Trunk railways.
Destination of shipments . . . . Toronto.

Product . . . . Gypsum.
Operator . . . . Manitoba Gypsum Co.
Head office . . . . 504 Trust & Loan Co. Bldg., Winnipeg, Man.
Mine office . . . . Gypsumville, Man.
Incorporation . . . . 1904.
Capital stock . . . . $450,000.
President . . . . Wm. Martin.
Vice-President . . . . Hugh Sutherland.
Secretary . . . .
Treasurer . . . . } A. Gough.
Sales manager . . . .
Manager . . . . T. Brommel.
Province . . . . Manitoba.
Date . . . . 1912.
Name and location of property . . . . . Gypsumville quarries.

County............................Northern Manitoba.
Township, range, and lot..........(See Chapter VIII.)
Superintendent....................J. R. Spear.
Method of working.................Quarrying.
Treatment of ore, etc.............Milling and mixing.
Products shipped..................All grades of crude gypsum and calcined plaster.
Shipping station and transportation
service.........................Canadian Northern railway, and Canadian Pacific railway from mill.
Destination of shipments..........Manitoba and western Canada.

Product.............................Gypsum.
Operator............................Dominion Gypsum Co., Ltd.
Head office.......................Winnipeg, Man., 407 McArthur Bldg.
Mine office.......................Gypsumville, Man.
Incorporation.....................Dec. 1910, Manitoba.
Capital stock.....................$200,000.
President.........................W. Armstrong.
General manager...................W. Armstrong.
Province..........................Manitoba.
Name and location of property.....Gypsumville, Man.
Mine manager......................D. C. McArthur, Gypsumville, Man.
Products shipped..................Crude and calcined gypsum.
Destination of shipments..........Manitoba and western Canada.

Product.............................Gypsum.
Operator............................Industrial Finance and Deb. Co.
Head office.......................220 7th Ave. W., Vancouver, B.C.
President.........................Dr. Schumacher.
Province..........................British Columbia.
Date..............................1912.
Name and location of property.....Merritt, B.C.
Mine manager......................H. O. Peters.
Method of working.................Quarrying.
Products shipped..................Crude gypsum.
Shipping station and transportation
service.........................Canadian Pacific railway.
Destination of shipments..........Portland Cement Co., Vancouver and Calgary.

APPENDIX B.

BIBLIOGRAPHY.

CANADA AND THE UNITED STATES.

Table I.—Arranged according to Provinces and States, etc.
Table II.—Arranged according to Authors.
Table III.—General references.

APPENDIX B.

BIBLIOGRAPHY.

TABLE I.

Provinces and States.

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APPENDIX C.

GYPSUM DEPOSITS OF THE MARITIME PROVINCES.

W. F. Jennison.

EXPLANATORY NOTE.

In preparing the Bulletin on the Gypsum Resources of Canada, it was impossible, in the time available, to visit all the localities in eastern Canada where gypsum is known to occur. It was, therefore, considered advisable to include in this publication, as an appendix, certain chapters of the report on the Gypsum Deposits of the Martime Provinces, prepared by Mr. W. F. Jennison, for the Mines Branch, Department of Mines, in 1911, and published as Bulletin No. 84 (now out of print). These chapters[1] deal very fully with all the gypsum areas in Nova Scotia, New Brunswick, and the Magdalen islands. They have been edited to correct typographical and other errors which appear in the original bulletin. The chemical analyses have all been checked back to the originals on file in the Mines Branch office; and some necessary references and descriptions added.

(Signed) **L. H. Cole.**

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[1]Chapters IV and V, Bull. 84.

GYPSUM DEPOSITS OF THE MARITIME PROVINCES

BY

W. F. Jennison, M.E.

Gypsum Deposits of Nova Scotia.

For many years the gypsum deposits of Nova Scotia, as well as those of New Brunswick and the Magdalen islands, were considered as belonging to the Permian age. It was not until Lyell, Dawson, and others had made a careful study of the fossils belonging to these measures, that they were placed in their true stratigraphical position, forming part of the lower Carboniferous.

The lower Carboniferous measures of this Province are made up of grey and red sandstones, conglomerates, arenaceous and argillaceous shales, limestones, gypsums, and marls, the various members predominating in different districts, but following no regular order. The following section, as measured by Dr. Gilpin[1] in Pictou county, N.S., is characteristic:—

	Ft.	In.
Red fissile shales	15	0
Compact bluish limestone	4	6
Grey marl with nodules of limestone	21	4
Grey laminated sandstone	6	0
Gypsum with a few layers of arenaceous matter	17	3
Brown marl with veinlets and crystals of gypsum	30	6
Arenaceous limestone, fossiliferous	3	10
Gypsum	8	0
Calcareous fissile sandstone	11	5

The gypsum deposits are not confined to any particular horizon in these measures, but are always found associated with limestone and marl.

At Cheticamp, Inverness county, they occur near the base of the lower Carboniferous, but farther south in the same county, and on Boularderie island, they occur only a few feet below the Millstone Grit. In Cumberland county they occupy a position about the middle of the series. At the Inverness coal mines, gypsum is found immediately underlying the coal beds; in fact, in one of the slopes of this mine, 1,500 feet from the surface, a block of gypsum was found embedded in the coal seam, but here the whole series has been faulted and cannot be considered a guide to the proper position of the gypsiferous formation.

[1]Gypsum of Nova Scotia, by Edwin Gilpin, F.G.S., 1881.

The best illustration of the irregularity of the occurrence of these deposits will be seen in the lower Carboniferous measures of Hants county, which is one of the largest areas seen in the Province, and has been subjected to less disturbance by faulting or upheavals than any other.

By referring to a geological map of Nova Scotia, it will be seen that the lower Carboniferous, beginning on the west side of the Avon river and crossing on an eastwardly course its northern boundary, follows the Devonian rocks in a tortuous course to the Shubenacadie river, and continues on an eastwardly course through Colchester county. The southern edge we find has for its boundary granites, Cambrian slates and quartzites, and Devonian slates. This area has an extreme length, as described, of about 60 miles, with an extreme width of 12 miles. The following rivers running through this area give good opportunities to study sections; the Avon on the west, with its tributaries; the Ste. Croix, Kennetcook, and Cogmagun; the Walton and Tennycape rivers cutting in from the north, and the Shubenacadie and its tributary; the Fivemile river, on the east. The whole of this area is not considered gypsiferous, but wheresoever the marine limestone occurs there will the gypsum be found. It will be noticed that many of the deposits occur in close conjunction with the contact of these measures and the various members of the older series. Not only do they occur at that point, but it will be noticed that on all the rivers, sometimes miles from the contact, important deposits are found. The Wentworth gypsum quarries on the St. Croix river are from 1½ to 2 miles from the nearest point of contact. The Newport Plaster Mining and Development Company, Limited, has quarries at Avondale, which is five miles from the nearest point of contact.

It will, therefore, be seen that, although gypsum in Nova Scotia and New Brunswick always occurs in the lower Carboniferous measures, and that it is always associated with marine limestone as members of the lower Carboniferous group, yet it is not confined to any particular position, and is liable to occur at the contact, or at any intermediate point.

ASSOCIATED LIMESTONE

The limestones of the lower Carboniferous measures are of the marine formation, and present almost every grade of composition, varying from the highly arenaceous and argillaceous to the almost chemically pure. By some writers it has been said that many of them show a high percentage of magnesia. The late Mr. Fletcher, of the Geological Survey of Canada, procured two samples from near the gypsum bed of Judique, Inverness county, which showed 15 and 21 per cent of magnesia carbonate. The writer's experience of these limestones, with one exception, is that where immediately associated with the gypsum they are particularly free from magnesia. The exception is the recent analysis of samples taken from the limestone belt dividing the gypsum beds of Cheticamp (see Analyses, page 190) which shows 16·83 per cent magnesia. From over fifty of these deposits in different parts of the Province, examined by him, samples by analysis showed less than 2 per cent carbonate of magnesia. This, however, is not true where the limestones are immediately associated with the manganese deposits, which are oftentimes in close proximity to the gypsum.

The limestone associated with the manganese deposits in Pictou county, showed as high as 10·15 per cent carbonate of magnesia, while those of Colchester gave 28·03 per cent, and at Tennycape, Hants county, some show as high as 35·44 per cent of magnesia carbonate.

It seems probable that, as the manganese often occurs within a few hundred feet of the gypsum, the samples furnished by Mr. Fletcher may possibly have been associated with manganese, rather than gypsum. The gypsum, particularly in Cape Breton island, is very free from this element, with the exception of those samples which were taken nearest the limestone belt above referred to, which showed small quantities of magnesia (See Analyses, page 190). In over fifty samples taken from different parts of the island, only one showed even a trace of magnesia.

DESCRIPTION OF DEPOSITS.

The deposits present much variety of colour and texture. The greater part, in texture may be classed as compact or crypto-crystalline, with lesser quantities of granular or saccharoidal. In some places considerable quantities of selenite occur, showing folia, sometimes a foot or more across and transparent throughout, and the fibrous varieties are seen in many places associated with the gypsum and marls. Crystals of selenite are often found disseminated irregularly through the gypsum beds, usually in groups of bunches, sometimes in veins of importance.

Anhydrite often occurs in extremely variable proportions in many of the deposits, with great irregularity, and the occurrence of this mineral, which is practically valueless, with the gypsum, often interferes with the economic operation of the quarries.

The following brief description of the gypsum deposits of Nova Scotia, with analyses furnished by Mr. F. G. Wait, chemist for the Mines Branch of the Department of Mines, is intended to give essentially the conditions of most economic importance, rather than to deal at length with the geological conditions of each deposit, which are very similar and have been referred to in the foregoing pages.

For convenience of description and future reference, the following table will show the division of Nova Scotia into gypsum districts and the counties included in each district.

Table, Gypsum Districts of Nova Scotia.

Gypsum District.	Counties.	Name of Localities.
A	Inverness and Victoria	Pleasant bay, Aspy bay, Ingonish, Cheticamp, Margaree, N. E. Margaree, Broad Cove marsh, S. E. Margaree, Ross section, Inverness, Mabou, Smith island, Middle Bridge, Denys river, Malagawatchkt, McKinnon harbour, Nyanza, Port Bevis, Island Point, St. Ann, Saunders cove, East bay, Tom river, Black river, Madame island, Askilton.
B	Guysborough and Antigonish.	Madame island, Askilton, Tracadie, Pomquet harbour, Antigonish harbour.
D	Pictou, Halifax, and Colchester.	Westville, Bridgeville, East Mountain, Shorts lake, Shubenacadie river, Elmsdale, Gay river, Musquodoboit, Stewiacke river, Newton mills.
E	Hants.	Shorts lake, Shubenacadie river, South Maitland, Noel, Walton, Cheverie, Avon river, Clarksville, Ninemile river, Elmsdale, Gay river.
F	Cumberland.	Malagash, Pugwash, Philip river, Springhill mines, Nappan, Parrsboro.

Pleasant bay, Inverness county.

Here a small gypsiferous area occurs, but it and a small area at St. Lawrence bay in Victoria county, which also has outcrops of some importance, are, owing to their situations on the exposed coast of the Gulf of St. Lawrence, without harbours, and, therefore, practically inaccessible, and may be considered at present of no commercial value, except for local purposes.

Aspy bay, Victoria county.

Extending from the Atlantic ocean, inland about six miles, in a somewhat triangular shape, occurs one of the most important gypsiferous areas on the island of Cape Breton. Its occurrence, comprising nearly 8 square miles, is in comparatively low lands surrounded by hills of the older Pre-Cambrian rocks, often 1,000 feet in height, and it is practically all underlain with gypsum.

Two rivers, the North Aspy river and the Middle river, run through this area, exposing cliffs having a height from 40 to 70 feet, and their meadows make a very easy gradient from the deposit to the sea.

The exposures are extensive. The rock is white, and mottled white and grey, compact crystallization showing some little anhydrite, which carries petroleum in small (pea size) cells at the base of exposure.

The following analyses, from average samples taken from the exposures, will serve to show the composition of the rock:—

	I	II	III
	%	%	%
Lime	41·30	33·62	32·97
Sulphuric anhydride	57·91	45·28	46·16
Water, loss on ignition	0·82	21·06	21·00
Insoluble mineral matter	0·07	0·05	0·15
Bitume	0·08	....	....
	100·08	100·01	100·28

No. I. Anhydrite showing cells of crude petroleum.
No. II. Sample from the McPherson property.
No. III. Sample from the McLeod property.

At present the deposits are inaccessible for want of a harbour. The natural outport would be North pond, at Dingwall. This pond, which has sufficient depth of water for shipping purposes, has been separated from the ocean by the washing of sand and gravel up from the ocean bed, forming a narrow bar across the entrance, and thus closing to navigators one of the best harbours on the coast.

Ingonish, Victoria county.

On the north side of Ingonish harbour a small area of 2,871 acres occurs, and although this area is small, the quality and quantity of the gypsum, together with the accessibility of the deposit, gives it commercial importance. The greatest exposures, from 30 to 70 feet in height, occur at the water's edge on the north side of the harbour, where a ship might easily moor to the rock and have sufficient depth of water for loading purposes. The entrance to the harbour is somewhat silted up, and at present will not give sufficient depth of water for modern transportation.

The gypsum is a pure white compact variety, free from any exposures of anhydrite, or other detrimental substances.

Analysis:—	Per cent.
Lime	33·12
Sulphuric anhydride	45·88
Water, loss on ignition	21·10
Insoluble mineral matter	0·22
	100·32

Cheticamp, Inverness county.

In this district will be seen a gypsiferous belt, skirting the metamorphic hills from the mouth of the Cheticamp river on the north to well below Friar point on the south, a distance of over 13 miles, and at no place a greater distance than 2 miles from the sea coast. Its width varies from about 600 feet to over 2,500 feet.

The principal outcrops occur on the southeast side of Aucoin or Mill brook, about 3 miles from the northern extremity, and at Grand Etang harbour, about the same distance from the southern extremity.

Between these two points, and their extensions both north and south, the gypsum is mostly concealed, but is traceable by the characteristic sink holes and hummocky ground, under an overburden of clay.

The northern exposures, on the east side of Aucoin brook, are composed of a series of precipitous cliffs, from 60 to 180 feet high, about the level of the brook, and forming a narrow plateau parallel to and at no great distance from the base of the great plateau of northern Cape Breton.

The southern exposure occurs near the head of Grand Etang harbour, where the high cliffs of white compact gypsum outcrop near the water's edge.

The northern exposures have been developed by the Great Northern Mining and Railway Company, who have established a plaster mill near the face of the cliff. This area alone contains very extensive deposits of gypsum, made up of different beds interstratified with limestone. The first or lower bed, overlying the metamorphic series, consists of a compact variety of snow-white and white gypsum; resting on this is a bed of carboniferous limestone having an average thickness of about 100 feet; above the limestone is a very extensive bed of grey and white selenitic gypsum. The valley of the Mill brook is all underlain with gypsum, and covered with from a few inches to a few feet of red clay; on the western side the gypsum again crops out with considerable prominence.

The high bluff of selenitic grey and white gypsum is often cut by vertical veins of pure transparent selenite, running parallel to the strike, with veinlets or stringers cutting off horizontally. One of these veins has a width from 8 to 20 feet, and may be traced for at least half a mile.

The following analyses will show the results of average samples carefully taken from different parts of this property:—

——	I	II	III	IV	V	VI	VII	VIII	IX
Lime	32·17	32·10	32·11	32·42	32·23	32·36	32·96	32·80	28·76
Magnesia	0·08	0·40	0·23	tr.	......	tr.	......	......	16·83
Ferric oxide and alumina	0·18	0·24	0·42	0·20	0·18	0·14	......	......	1·56
Sulphuric anhydride	46·07	45·74	45·88	46·51	45·91	45·80	46·20	46·32	0·50
Carbonic anhydride	......	0·84	0·78	......	tr.	0·60	......	......	40·92
Water, loss on ignition	20·75	20·03	20·52	20·70	20·60	20·75	20·98	20·92	0·80
Insoluble mineral matter	0·16	0·46	0·26	0·26	0·86	0·38	......	......	10·88
	99·41	99·81	100·20	100·09	99·78	100·03	100·14	100·04	100·25

No. I. General average from No. 1 quarry.
No. II. Sample from the cave, greyish white rock.
No. III. General average from No. 3 quarry.
No. IV. Sample of the selenite rear of mill.
No. V. Sample of the selenite northwest of mill.
No. VI. Sample from adjoining property.
No. VII. General sample white rock from No. 2 quarry.
No. VIII. Sample from 8 ft. selenite vein.
No. IX. Sample from the limestone vein running through the property.

Margaree, Inverness county.

In the valley of the Margaree river occur several unimportant gypsiferous areas, which will be known as Margaree, 1·41 square miles; Northeast Margaree, 8·60 square miles; Southwest Margaree, 3·55 square miles; and Ross section, 1·6 square miles.

In the Margaree area all the gypsum is concealed by an overburden of clay, except a small outcrop on the shore near the mouth of the river. The above is also true of Southwest Margaree, small outcrops occurring on Allen brook and Upper Margaree.

In the Northeast Margaree area, outcrops occur at Levis farm, Hogsback hill, and on the west side of the river. The most important of these is that at Hogsback hill, where a good white compact gypsum outcrops in considerable prominence, and at Munroe brook, where the gypsum forms a cliff 75 feet high, and the brook flows through it to the Margaree river.

In the Ross section the principal outcrop occurs on the west side of Northeast Margaree river, near where the Munroe brook disappears in the gypsum cave.

Although much of this is of very good quality, yet it is not at all probable it will become of great commercial value, being inaccessible to transportation facilities. It should have some value for local purposes, such as a fertilizer, as the soil of the Margaree valley is particularly adapted for its use, and it would give excellent results on clover and leguminous crops.

The following are analyses taken from this territory:—

——	I	II	III	IV	V
	%	%	%	%	%
Lime	33·20	33·00	30·80	32·80	33·20
Ferric oxide and alumina	....	....	0·60	0·30	....
Sulphuric anhydride	44·68	45·64	40·80	45·72	46·32
Carbonic anhydride	....	....	1·85	....	....
Water, loss on ignition	21·04	20·96	19·80	20·62	20·92
Insoluble mineral matter	0·30	0·30	5·64	0·80	....
	99·22	99·90	99·49	100·24	100·44

No. I. Sample from Levis' farm, Hogsback hill, Northwest Margaree.
No. II. Sample from north side of Margaree river, Munroe brook.
No. III. Sample from Grier farm, Northwest Margaree.
No. IV. Sample from Grier farm, Northwest Margaree.
No. V. Sample from Grier farm, Northwest Margaree.

Broad Cove marsh, Inverness county.

In this section occur three small gypsiferous areas. The most prominent is on the seashore about a quarter of a mile north of the mouth of McLeod brook, and although narrow it extends northwardly nearly 2 miles. This, together with the other two lying between the road leading to Southwest Margaree and the road to Inverness, make up a total area of 214 acres. These are also, at present, unimportant for commercial enterprise, being inaccessible to shipping facilities.

Analyses:—	Per cent.
Lime	32·80
Ferric oxide	
Sulphuric anhydride	46·20
Water, loss on ignition	20·92
Insoluble mineral matter	
	99·92

Inverness, Inverness county.

Here, having the advantage of the Inverness and Richmond railway, and its probable extension, and their close proximity to the coal mines, the deposits again become more important. At Broad Cove chapel, outcroppings at the seashore are extensive cliffs, consisting in the greater part of a white compact variety, with some little grey associated; and limestone encased in gypsum, is seen. This deposit has an area of 84 acres.

In the rear of this, about three-quarters of a mile back from the shore and extending inland nearly to Loch Ban, is another area of 488 acres. This has practically no outcrops, being covered almost entirely with a heavy overburden of clay.

Two and one-half miles from the town of Inverness the third area in the section occurs, containing 614 acres.

In this some very prominent outcrops can be seen. Just below the big trestle, at a point known as the Laurie quarry, the outcrop has a height of 45 feet above drainage level. The rock is a white compact variety, mixed with a dark grey shaly variety having rusty stains. Above this about one mile, on the McIsaac lot, an outcrop shows more even texture and colour, principally white and compact.

The following are analyses of samples from this section:—

—	I	II	III
	%	%	%
Lime	33·00	32·20	33·00
Ferric oxide and alumina	....	·20	....
Sulphuric anhydride	46·56	46·00	46·60
Water, loss on ignition	20·90	20·60	20·69
Insoluble mineral matter	....	·90	....
	100·46	99·90	100·29

No. I. White compact from Laurie quarry.
No. II. Dark grey shale from Laurie quarry.
No. III. White compact, McIsaac lot.

Mabou, Inverness county.

In this section there are numerous gypsiferous areas which are more or less available for commercial purposes. They comprise a total area of 6·55 square miles.

At Finlay point, on the sea coast, and about one mile north of Mabou coal mines, occur cliffs of excellent white compact gypsum from 35 to 50 feet in height. This area extends along and borders the sea coast for nearly 3½ miles. The exposures here are large, and every indication points to an extensive deposit of gypsum of a quality suitable for all ordinary manufacturing purposes, but the sea coast is rugged, and very little protection could be given to shipping. To operate this deposit it would, therefore, be necessary to make the shipping point at Mabou harbour, a distance of 3½ miles over a rather difficult pass.

At Mabou harbour the most important deposits are located, and known as the Col. Snow property, and the Beaton property.

The rock is exposed in cliffs from 45 to 60 feet high, and consists almost wholly of a white compact gypsum, with smaller quantities showing microscopic crystals of selenite. Small quantities of anhydrite may be seen at the base of the cliffs.

Following east to Hillsborough, and south to Southwest Mabou, large gypsiferous areas occur, but consist in the greater part of concealed measures. Large outcrops of a very soft, grey, and dark grey, granular gypsum, suitable only for land plaster, occur at Hillsborough. At Southwest Mabou the rock is similar in texture, and has associated with it fine crystals of selenite.

The following analyses of samples from these different deposits will show the composition:—

—	I	II	III	IV	V	VI
	%	%	%	%	%	%
Lime	32·80	32·80	33·88	32·92	33·40	33·00
Sulphuric anhydride	45·90	46·20	44·36	46·24	46·28	45·61
Water, loss on ignition	20·85	20·85	20·87	20·87	20·45	21·20
Magnesia	....	....	....	....	trace.	....
Insoluble mineral matter	0·40	0·30	0·50	....	....	....
	99·95	100·15	99·61	100·03	100·13	99·81

No. I. Sample from Hillsborough, light grey, with heavy red incrustation.
No. II. Sample from Hillsborough, dark grey, soft granular.
No. III. Sample from Beaton property, white compact variety.
No. IV. Sample from Col. Snow property, white compact, with crystals of selenite.
No. V. Sample from Finlay point, white compact, and free from selenite.
No. VI. Sample from Southwest Mabou, very soft, granular, with selenite crystals.

Smith island, Inverness county.

In this locality occur three small gypsiferous areas consisting of 212·8 acres. The largest and most important of these is that of 148·8 acres, on Smith island.

This island is situated about one mile from the mainland, and opposite Port Hood. Its topography is low, and the exposures, which in the greater part are on the exposed side of this island, appear as extensive beds associated with shales and carbonate of lime, and may be traced from shore to shore by broken land and pits or sink holes.

The gypsum occurs in alternating layers with the carbonate of lime and marls, the latter carrying extensive quantities of fibrous gypsum.

At Ragged point, and at Cape Susan, at one time, was an area of considerable importance, which has been, by erosion of the sea, divided into two, having a total area of 64 acres. The occurrence here, like Smith island, has few outcrops, and the gypsum and limestone are closely associated. Large quantities of marl are also prominent.

The close proximity of these areas to the railway and coal fields makes them desirable for manufacturing purposes.

Middle Bridge, Inverness county.

On the southwest Mabou river, and on the Mill river, small isolated gypsiferous areas occur, comprising a total area of 155 acres. They are practically all concealed, and like Smith island, are associated with carbonate of lime and reddish marls, and these, like the similar deposits at South Glencoe, are not considered commercially important.

Denys river, Inverness county.

Practically joining the Washabuck Peninsula district on the east and the Malagawatchkt area on the south, there is a section known as the Denys River section. It comprises a total gypsiferous area of 16·41 square miles.

The greater part is made up of concealed measures, and can only be traced by surface indications. The outcrops are few, the principal being near and below Munroe Bridge, where the cliffs rise from 10 to 45 feet above the sea level, consisting of a grey and light grey, white and mottled white rock. Associated with it is seen a dark grey Carboniferous limestone. In texture it is about equally divided between compact and granular.

Its composition is shown in the following analysis:—

	Per cent
Lime	33·17
Sulphuric anhydride	45·42
Water, loss on ignition	20·63
Insoluble mineral matter	0·93
	100·15

The evidence in other parts of the area where covered, is in favour of a good white compact rock being concealed, but this can only be proved by a series of test pits or bore holes.

The position of the whole area on the border of the Bras d'Or lakes is so desirable, that it is considered important, and worthy of complete investigation.

Malagawatchkt, Inverness county.

On the south side of Denys basin is a narrow gypsiferous area skirting the shores of the Bras d'Or lakes from McKenzie brook on the northwest to about half a mile southwest of Mathesons wharf, and continuing southwest by numerous small islands and peninsulas to West bay. In this area of 6·44 square miles, including that portion of the Washabuck Peninsula district southwest of Denys basin, numerous outcrops of gypsum are seen as at Plaster island, and on the River Denys road, George island, Green island, and Floda island.

Many of these outcrops are of little importance, being low and having but small quantities above sea-level. Several, however, have sufficient prominence to be considered as available supplies. The exposure on Donald McKinnon's farm, River Denys road, has a height averaging 50 feet, with a length of 275 feet. This deposit, and its extension $2\frac{1}{2}$ miles northwest to Plaster island, shows probably the most important deposit in the whole area. At Plaster island the exposure is from 10 to 40 feet in height on the shore, and covers an area of 4 to 5 acres.

In texture and colour, this rock is a soft white compact variety, having some anhydrite associated with it.

The following analyses are the result of average samples—No. 1, from the McKinnon outcrop, and No. 2, from the Plaster Island outcrop:—

——	I	II
	%	%
Lime	33·33	33·70
Sulphuric anhydride	45·00	45·25
Water, loss on ignition	20·75	20·78
Insoluble mineral matter	0·33	0·04
	99·41	99·77

Washabuck peninsula, Victoria county.

This area includes the deposits at McKinnon harbour, Ottawa brook, Washabuck river, Nineveh, Little Narrows, Maciver point, Deadman point, McKay point, Boulaceet harbour, Lieutenant pond, Iona, Jamesville, Red point, and south side Whycocomagh bay. The total area is 25·54 square miles. Here all varieties of texture and colour may be found. The exposures are many and large. Anhydrite occurs frequently, outcropping in large irregular masses. This is especially true at Nineveh, and at Washabuck, the former showing a perpendicular face of 60 to 80 feet and a length of over 800 feet. At the latter place it shows on a road leading from Washabuck river to Little Narrows, for nearly a mile in width.

At Ottawa brook, the Newark Plaster Company, of Newark, New Jersey, U.S.A., started operations in 1908. They have opened up several deposits, and built a railway connecting them with their shipping pier, constructed on the north side of Great Bras d'Or lake.

The rock at some of the points opened up, although a soft white compact variety, shows much disturbance, being badly fractured and folded; due to local pressures— probably the conversion of anhydrite into gypsum. At another point, only a few hundred feet distant, a dark carbonate of lime is seen graduating into gypsum. The lower left corner shows the lime, with streaks of snow-white gypsum. The right and upper side is a soft white compact variety of gypsum, showing very little disturbance. The composition of these two associated rocks is seen in the following analyses:—

—	I	II
	%	%
Lime	33·50	51·27
Magnesia	....	0·46
Ferric oxide	....	0·30
Sulphuric anhydride	45·32	0·04
Carbonic anhydride	....	40·73
Water, loss on ignition	21·15	0·86
Insoluble mineral matter	0·10	6·34
	100·07	100·00

At Little Narrows (south side), on the properties of M. J. McAskill and widow McAskill, very large exposures are seen. At the latter the face is about 100 feet high and over 600 feet long; the rock is an excellent quality of soft white compact variety with but few irregularities. It is situated on St. Patrick channel, about one mile from the shipping point, to which a practically level route could be secured.

Composition is shown by the following analyses:—

	Per cent.	Per cent.
Lime	33·30	33·67
Sulphuric anhydride	46·00	46·00
Water, loss on ignition	21·16	20·70
Insoluble mineral matter	0·24	0·20
	100·70	100·57

On the north side, at Little Narrows, the measures are concealed by an overburden of clay.

From Maciver point to Deadman point the deposits are not considered, at present, to be of any commercial value. This is also true of the greater part of the Washabuck river. East of Boulaceet harbour, although no exposures are seen, the indications on the surface are rather encouraging, and further investigations may develop a property of considerable commercial value.

At Lieutenant pond, and at Iona, exposures are seen near the seashore, of sufficient area to make them of considerable value. The greater part of the rock is a soft white compact variety, with smaller quantities of granular texture, also some grey and blue rock are perceptible. Anhydrite also occurs with some prominence. The following analyses show the results of samples from this rock:—

—	I	II
	%	%
Lime	33·20	40·16
Sulphuric anhydride	45·60	55·60
Water, loss on ignition	21·06	4·52
Insoluble mineral matter	0·15	0·13
	100·01	100·41

At Jamesville, high precipitous cliffs of gypsum and anhydrite occur, which are in structure and colour very similar to those at Iona. The Intercolonial railway crosses this deposit and separates the greater part of it from water shipment. Just in the rear, and in close contact with the gypsum, stands a perpendicular wall of Carboniferous limestone, which has been quarried for commercial purposes.

At the south side of Whycocomagh bay, bounded on the northwest by the St. Patrick channel, and on the southeast by Denys basin, is situated a gypsiferous area of 6·78 square miles.

The surface indicates that the greater part of this is underlaid by gypsum, and that it is covered by an overburden of clay of varied thickness. Several exposures are seen in this area, the greater part of which is composed of a white compact variety, with lesser quantities of granulated white and grey, with some crystals of selenite.

Very little anhydrite is shown. An attempt was made about 40 years ago to operate a deposit here, known as "The Boom," and one cargo of good white rock was quarried and shipped, but the unfortunate loss of the ship and cargo before reaching its destination caused the discontinuance of further operations.

Analyses of average samples show:—

—	Granulated.	Compact.
	%	%
Lime	33·33	33·73
Ferric oxide and alumina	....	tr.
Sulphuric anhydride	45·72	46·20
Water, loss on ignition	20·85	20·85
Insoluble mineral matter	0·19	0·06
	100·09	100·84

At McKinnon harbour, the measures are nearly all concealed. About 1½ miles east of the harbour there is an exposure showing a face of good white compact rock, 30 feet in height. The samples from this show the following composition:—

	Per cent.
Lime	33·13
Sulphuric anhydride	46·04
Water, loss on ignition	20·70
Insoluble mineral matter	·36
	100·23

On the south side of Red point and between McKinnon point and Oyster pond, occurs, in the bluff of the shore, a mixture of gypsum and limestone, associated with selenite, having large transparent plates or crystals, covered with a very plastic smooth red clay. The colour of the rock varies from a dark grey and mottled, to a pure white, having a compact texture. The clay carries small particles of gypsum, and might be classed as gypsite.

The following are the results of analyses of samples taken from this deposit:—

——	I	II	III	IV
	%	%	%	%
Lime	51·88	38·20	33·67	33·67
Ferric oxide and alumina	0·43	tr.	tr.	....
Sulphuric anhydride	0·96	42·16	44·77	45·44
Carbonic anhydride	40·76	2·49	....	....
Water, loss on ignition	0·57	20·83	20·80	20·92
Insoluble mineral matter	5·40	1·60	0·40	0·07
	100·00	100·28	99·64	100·10

No. I. Dark grey with particles of selenite.
No. II. Grey mottled.
No. III. Pure white.
No. IV. Selenite.

Nyanza, Victoria county.

This section, together with Middle river and Baddeck river, comprises a total gypsiferous area of 14·60 square miles. With the exception of three points, the whole is devoid of outcrops, and has an overburden of clay of varying thickness.

At the rear of Alex. McGregor's house, a small outcrop of white granular rock appears, having a height of face from 10 to 20 feet, and an elevation 60 feet above the sea-level. On the road near Baddeck Bridge small hummocky outcrops are seen, having a belt of Carboniferous limestone running through the centre. On James McGregor's farm, near Baddeck river, another outcrop of a few acres occurs, but both this and the preceding outcrop have so little elevation above the sea-level that they are considered of little commercial value, beyond the fact that they may be used for local manufacturing. In the concealed gypsum areas of both the Middle and Baddeck rivers, high elevations might develop deposits of great value.

The composition of samples taken from the exposures are shown in the following analyses:—

——	I	II
	%	%
Lime	32·99	33·17
Sulphuric anhydride	46·60	46·28
Water, loss on ignition	20·88	20·96
Insoluble mineral matter	....	....
	100·47	100·41

No. I. From near Baddeck Bridge.
No. II. From James McGregor's farm.

Port Bevis or Big harbour, Victoria county.

From Baddeck bay on the west to St. Ann bay on the east may be considered as one continuous gypsiferous bed, having an area of 15·83 square miles.

It contains many important outcrops of both gypsum and anhydrite. On the shores of the Great Bras d'Or lake, west of Port Bevis, extensive cliffs of anhydrite occur. Another cliff is 70 feet high and 650 feet long. The prominence of this mineral is greater on or near the shores of the lake, and again at the contact of these measures with the older rocks, and may be a conversion from gypsum by metamorphic action.

The farther it is possible to get from these points the freer the deposit seems to be from anhydrite. Thus, it is seen that the best exposures of gypsum are found at the head of Baddeck bay, about 1 mile from deep water shipping, where very little disturbance is apparent. These exposures occur in a valley where there are extensive outcrops of soft, white, compact gypsum, without any appearance of anhydrite.

At the rear of Margaret McKenzie's grant, and about 1 mile from McDonald point, similar conditions are seen; also on the farm of Alex. McKenzie, near his house, where a large bluff covered with clay has been tested to a small extent, and although only about 100 yards on the east from an exposure of anhydrite, and from a similar exposure about one-quarter of a mile to the west, this particular bluff, which shows but little disturbance, has evidence of being a good variety of gypsum, and no evidence of anhydrite. Extensive outcrops are also seen at South Gut, 2 miles, and 2½ miles west of South Gut; also at North Gut; but associated with these are some prominent exposures of anhydrite.

At Port Bevis a few years ago the Victoria Gypsum Mining and Manufacturing Company carried on extensive operations, but owing to increasing occurrence of anhydrite at depth, the place was abandoned. This is also true of a point west of Plaster mines, where a small quarry was operated many years ago (1875) by Mr. Duncan MacDonald, of Montreal, who exported annually about 5,000 tons. It has been noticed that both of these quarries are in the region of most disturbance.

The following analyses will show the composition as a fair average from this section:—

—	I	II	III	IV
	%	%	%	%
Lime	32·80	33·77	38·10	33·60
Sulphuric anhydride	46·08	44·63	53·16	45·45
Water, loss on ignition	21·07	21·05	8·72	20·70
Insoluble mineral matter	0·18	0·27	0·26	0·20
	100·13	99·72	100·24	99·95

No. I. Sample from rear of Alex. McKenzie's house.
No. II. Sample from Margaret McKenzie grant.
No. III. Sample from a face 70 feet high and 650 feet long, east of Alex. McKenzie's house.
No. IV. Sample from near South Gut.

Island point, Victoria county.

One of the most picturesque spots in all the gypsiferous districts is that on the south side of Boularderie island, and known as Island point, comprising an area of 232 acres. The point is about 2 miles long, and projects into St. Andrews channel, with good natural shipping facilities.

The deposit is made up of gypsum and carbonate of lime outcrops, the gypsum having greater prominence. The rock is white and snow-white in colour, with some grey intermixed, all a compact soft variety.

The following analyses show the composition:—

—	I	II
	%	%
Lime	32·24	33·33
Ferric oxide and alumina	tr.	....
Sulphuric anhydride	46·08	45·93
Water, loss on ignition	20·85	20·82
Insoluble mineral matter	0·50	....
	99·67	100·08

On the northern side of Boularderie island, at Sutherland point, another small gypsiferous area occurs, but it has small commercial value.

St. Ann, Victoria county.

In this section, at Goose cove and at Oregon, 4½ miles from the mouth of North river, occur small gypsiferous areas. At Oregon there are 134 acres; at Goose cove two areas, having a total of 230 acres. At the former place the measures are all concealed; at the latter large exposures from 40 to 60 feet in height are seen. One of these has been opened up and operated for several years by the Victoria Gypsum Mining & Manufacturing Company. It is situated 3½ miles by rail from their shipping pier at Munroe point. The rock in colour is white, light grey, and mottled white, the white having prominence. The outcrops indicate a soft compact variety, and operations prove this to be true to a depth of 30 to 40 feet; but during the summer of 1908, while sinking on the floor of the quarry, anhydrite was discovered in considerable quantities. The following analyses show the composition:—

—	I	II	III
	%	%	%
Lime	42·80	33·20	32·87
Ferric oxide and alumina	tr.	....	....
Sulphuric anhydride	56·16	46·08	46·14
Water, loss on ignition...	0·73	20·68	20·73
Insoluble mineral matter	0·80	0·30	0·02
	100·49	100·26	99·76

No. I. Sample from floor of quarry.
No. II. Sample of mottled white.
No. III. Average sample from stock pile.

Saunders cove, Cape Breton county.

On the south side of Boularderie island, and 11 miles northeast of Island point, occurs a gypsiferous area of 299 acres. The measures are well exposed on the shores, and are made up of white granulated gypsum, between 15 and 20 feet thick, succeeded by greenish marls, mixed with streaks, veins, and nodules of pink and white gypsum and selenite; and much of it may be classed as gypsite. The limestone at this point occurs both above and below the gypsum.

East bay, Cape Breton county.

On the north side of East bay and skirting its shores are several small deposits of gypsum, comprising a total area of 281 acres. The exposures are small, and varied in colour, comprising white, grey, dark grey, blue, black, and pink. This great variety of colour deteriorates the value, except for fertilizer purposes.

Situated about 2½ miles from deep water shipping, at the head of East bay, there is a gypsiferous area comprising 2·40 square miles of much importance. It is easily accessible, and shows an exposure from 20 to 60 feet high over a large portion of its area. The greater part of the rock is a very pure compact white variety, with lesser quantities of soft white granular, with no evidence of anhydrite.

The following analyses show the results of average samples taken from these deposits:—

———	I	II	III
	%	%	%
Lime	32·87	33·10	31·62
Sulphuric anhydride	46·07	45·95	42·96
Water, loss on ignition	20·89	20·85	20·44
Insoluble mineral matter	0·12	0·07	3·60
Ferric oxide	....	....	0·95
	99·95	99·97	99·57

Nos. I. and II. From the large deposit at the head of East bay.
No. III. Analysis of the dark variety from north side of East bay.

Tom river, Richmond county.

On the southeast side of Great Bras d'Or lake is a gypsiferous area of 2·7 square miles, comprising Campbell cove, Hay cove, and McNab creek, in which occur several outcrops of gypsum. Some of these outcrops consist of a very excellent, snow-white, compact variety, resembling alabaster; while others, especially at Tom river, show an excess of lime. It is free from all evidence of anhydrite, and is easily accessible to water shipment.

The following analyses show the average quality of the rock:—

———	I	II	III
	%	%	%
Lime	32·95	34·04	33·02
Sulphuric anhydride	46·64	44·28	46·68
Water, loss on ignition	20·93	21·07	20·91
Insoluble mineral matter	0·13	0·67	0·26
	100·65	100·06	100·87

No. I. Hay cove, Richmond county, N.S.
No. II. Tom river, Richmond county, N.S.
No. III. Sample "B" Tom river, Richmond county, N.S.

Richmond county, N.S.

At Black river, south side of West bay, occurs a gypsiferous area of 1·81 square miles. This is reasonably accessible to water transportation and may be considered as a property having commercial value. The outcrops are prominent and are principally on the banks of the river, about 1 mile, and 2½ miles from its mouth. The greater part of the rock is a white compact variety. Small quantities are coloured with the oxide of iron.

The following analysis shows the results of an average sample taken from the exposures:—

	Per cent.
Lime	32·11
Magnesia	tr.
Ferric oxide and alumina	0·44
Sulphuric anhydride	45·82
Carbonic anhydride	0·34
Water, loss on ignition	20·35
Insoluble mineral matter	0·48
	99·54

Madame island, Richmond county.

This area comprises not only the deposits of Madame island, but of Port Richmond, on the north side of Lennox passage, and a very small deposit near Pirate harbour in Guysborough county, making a total gypsiferous area of 6·57 square miles.

The most important of these deposits is that on the north side of Madame island, and the south side of Lennox passage, where there is a large gypsiferous area of 3·77 square miles. The outcrops of gypsum in this area having most prominence are situated about 1½ miles west of Lennox Ferry landing, and about 1 mile from the shore. At this point the exposures cover many acres in area, and have a height of from 30 to 70 feet. Here, years ago, H. C. Higginson, of Newburgh, New York, operated a quarry, and exported large quantities of the crude material to the United States. The gypsum is a white compact variety; but it has, irregularly associated with it, much anhydrite. The occurrence of this mineral, no doubt, had much to do with the closing of the quarry, although there still remain large quantities of good gypsum. This, together with excellent natural shipping facilities, and the increasing demand for the product, should be an impetus to reopen and operate this extensive area.

Analysis:—

	Per cent.
Lime	33·33
Sulphuric anhydride	45·32
Water, loss on ignition	20·92
Insoluble mineral matter	0·22
	99·79

Other small exposures occur on Evans island, and Freeman island; also at Carlton head, and north of Port Richmond, but these have little prominence, and evidence of anhydrite gives them little commercial value.

A smaller area, but having more prominent exposures, occurs about 2½ miles east of the town of Arichat. Here a white compact variety of gypsum is seen in the side of a high hill, which would give a working face of about 75 feet in height. Associated with this there is a small quantity of blue anhydrite, which diminishes somewhat the commercial value of the deposit.

Analysis of gypsum from Arichat:—

	Per cent.
Lime	32·86
Magnesia	0·13
Ferric oxide and alumina	0·14
Sulphuric anhydride	45·47
Carbonic anhydride	0·96
Water, loss on ignition	20·00
Insoluble mineral matter	0·08
	99·64

Askilton, Inverness, and Richmond counties.

In this section we have what may be known as the Hastings area, of 75 acres, at Port Hastings; the Beaver Dam Lake area of 1·6 square miles on the border line of Inverness and Richmond counties, and about 4½ miles east of Point Tupper; the Askilton area of 1·8 square miles, at Askilton, 3½ miles from the Intercolonial railway, or about 6 miles east of Port Hastings. Also a small area about 1½ miles south of Askilton, of 302 acres, on Inhabitants river.

The Inhabitants River area, and the Beaver Dam Lake area have very little importance, being situated in low ground. The Beaver Dam lake is only traceable by the pits or kettle holes, and hummocky ground. In the banks of Inhabitants river small outcrops are seen, but both areas seem to be covered heavily with clay.

The Hastings area is small. The greater part seems to have been eroded by the sea, and now forms a small inlet or cove having a floor of gypsum. The greater part of what remains is in outcrops from 30 to 60 feet high, showing a variety of colours and texture with considerable anhydrite.

The Askilton area is the most important in this section from all points of view. It has large outcrops, some as high as 70 feet above drainage level, and the greater part is an excellent white compact variety, with smaller quantities of granular.

The Straits of Canso, the natural outport for the deposit—being an open port all the year—makes this deposit desirable, especially to those who export large quantities of crude rock, as it is the nearest deposit to a winter port in the Province.

The following analyses from samples of the different deposits will serve to show the average composition of this rock:—

——	I	II	III	IV	V
	%	%	%	%	%
Lime	40·48	33·80	33·20	34·20	33·20
Sulphuric anhydride	55·48	46·08	46·32	45·92	45·84
Water, loss on ignition	3·90	19·86	20·85	20·65	20·60
Insoluble mineral matter	0·44	....	0·14	....	0·90
	100·30	99·74	100·51	100·77	100·54

Nos. I and II. Average samples, Hastings area.

Nos. III and IV. Average samples of white compact, Askilton area.

No. V. Sample of the granular, Askilton area.

GYPSUM DISTRICT "B."

Tracadie harbour, Antigonish county.
Pomquet harbour, Antigonish county.
Antigonish harbour, Antigonish county.

The gypsum deposits in this district, although for convenience shown on three map sheets, are all included in one gypsiferous area, consisting of over 125 square miles, and practically continuous. It is, therefore, deemed advisable to consider them together.

Referring to this district, Dr. Honeyman[1] says:—"Succeeding the conglomerates of Antigonish mountains, and reposing directly upon them, we have limestone of considerable thickness. Succeeding these limestones, we have an enormous bed of gypsum. Its length is nearly equal to that of the associated limestone. It appears at the forks of James river and the Ohio river which it passes over nearly parallel to the course of James river until it reaches within one hundred paces of the limestones; its mountain side runs parallel with the limestones, Braley brook running between and along the bottom of the abrupt and lofty gypseous wall for about 3 miles. After parting with the brook the gypsum pursues its course until it reaches Right river, nearly a mile north of the town. After an apparent break of 2 miles, it again appears on the east side of the Sugar Loaf, and proceeds onwards into St. George bay; its land terminus being Ogden's lofty cliff."

In the above we have the description of the northern boundary, about 16 miles in length. Its breadth varies from 2 to 6 miles, or more, and is made up of alternating beds of gypsum and Carboniferous limestone. It stretches southwardly through the harbour, and up the west side of South river, and continuing southwardly may be traced by sink pits and conical mounds, under the town of Antigonish, and thence to West river, where it again outcrops, and terminates against the metamorphic hills on the west side of the river.

Coming back to South river, these measures branch off more southerly to St. Andrews and Glenroy, and thence eastwardly, following closely the contact between the lower Carboniferous measures and the metamorphic rocks, to Barrie head, east of Tracadie harbour.

Although large quantities of gypsum are found in the southern and western part of the district, which at some future date may be considered important, yet those nearer the east and the northeast, particularly in the vicinity of Antigonish harbour, are much superior; in fact it is very difficult to find exposures better both in quantity and quality, many of them being over 100 feet high, some twice this height, and covering an extensive area. Much of the rock is the very best white compact, having the appearance of alabaster.

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[1]United States, Institute of Natural Science, Vol. I (old series), Part 4, p. 115.

It is regrettable that, while the area contains practically inexhaustible quantities of gypsum of the very best quality, it is inaccessible to transportation facilities.

The principal harbour (Antigonish)—like those described on the east coast of Cape Breton island—has sufficient depth of water for shipping, but is silted up at its entrance by sand that prevents water transportation; while the long rail haul by the Intercolonial railway, which passes through part of the district to the Strait of Canso, makes transportation by it prohibitive, especially for crude material. The distance to Mulgrave, the nearest port, is about 40 miles.

GYPSUM DISTRICT "D."

Westville, Pictou county.

In this section two small gypsiferous areas occur, comprising a total area of 517 acres. The larger is about one mile north of the Pictou coal fields. It is cut by the Intercolonial railway (Pictou Town Branch), and the Intercolonial Coal Company railway connecting their mines with their shipping pier at Granton. This area, together with the smaller one, 2½ miles farther west, consists principally of concealed measures, made up of alternating thin beds of Carboniferous limestone, gypsum, and marls; their value consists in being accessible to shipping facilities and their close proximity to the coal fields for manufacturing purposes.

Bridgeville, Pictou county.

On the Nova Scotia Steel Company's branch railway, 6 miles south of Ferrona Junction, on the Intercolonial railway, a gypsiferous area occurs, consisting of 4·32 square miles. The exposures are more prominent than those on Sheet No. 30, but they are 18 miles by rail from a shipping port.

The rock consists of a compact white and pink variety, showing considerable anhydrite.

East Mountain, Colchester county.

In this section, 1¾ miles from the railway, are four small isolated areas known as the S. Roode area, comprising 20 acres, and consisting of a soft grey gypsum, which has been utilized to some extent as a fertilizer; and the George Thompson area, 90 acres, the exposures consisting principally of a translucent anhydrite. There is, however, some evidence of alabaster being here, but so much of the measures are concealed that it is difficult to make any exact determination. This deposit is 2½ miles from the railway; the James Clifford area, 65 acres, measures all concealed, 1¾ miles from the railway; and the Elisha Archibald area, 55·2 acres. The rock here consists of a snow-white compact variety, with some smaller quantities showing granular crystallization, also some alabaster. It is 1¼ miles from the railway, and if the alabaster proves to be a prominent constituent it may be considered of commercial value.

——	I	II	III	IV
Analysis:—	%	%	%	%
Lime	33·12	41·20	32·80	33·20
Magnesia	....	....	....	0·15
Sulphuric anhydride	46·68	58·36	45·92	45·44
Carbonic anhydride	....	....	....	0·17
Water, loss on ignition	20·63	....	20·04	20·55
Insoluble mineral matter	....	0·28	0·92	....
	100·43	99·84	99·68	99·51

No. I. Geo. Thompson: associated with large quantities of pure white anhydrite.

No. II. Geo. Thompson; pure white anhydrite, associated with No. 1.

No. III. E. Archibald: white compact.

No. IV. Samuel Roode: greyish-white.

Shorts lake, Colchester county.

In this section there is a large, tortuous, gypsiferous area of over 15 square miles. It is the eastern extension of the lower Carboniferous measures described on page 185, which extends westwardly across the Shubenacadie river and through Hants county. The topography at this particular location is generally low and level, and although there are some outcrops of prominence, very much the greater part consists of concealed measures. Beginning at the northwest corner of this sheet, on the farm of John Irwin and the adjoining properties situated about 3½ miles east of the headwaters of the Cobequid bay, occur some small outcrops. Here the gypsum varies much in colour and texture, and shows an excess of carbonate of lime in its composition. As far as could be observed it is only suitable for fertilizer purposes. Following the line of contact eastwardly at Hilden, 2 miles west of the Intercolonial railway, outcrops of blue and white, of both granular and compact varieties, show considerable prominence on the estate of James Morgan. Continuing southwardly and eastwardly, and crossing the railway near Brookfield, we have numerous outcrops of more or less prominence, on the farms of Leonard Carter, James Lockhart, Alonzo Lockhart, John McCulloch, and J. J. Snook. The gypsum here is more regular in quality and texture, but where it occurs close to the contact it usually shows considerable anhydrite.

About 1½ miles south it again crops out on the property of Robert Benjamin; and at Upper Pleasant valley also, south and west of Shorts lake; and again at Little river, east of the railway; on the Stewiacke river; and near Ramsey post-office, on Wallace brook.

Unless, by testing, some superior variety of gypsum should be discovered, as, for instance, snow-white or alabaster—which is quite probable—this section can only be considered commercially valuable for a manufacturing industry for local purposes.

The following analyses show the average composition of the different deposits sampled:—

——	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
	%	%	%	%	%	%	%	%	%	%	%	%	%
Lime	38·20	39·88	33·00	33·00	33·80	31·28	31·60	32·88	32·60	34·00	33·00	33·08	33·00
Magnesia	1·06	......	......	......	......	......	......	......	0·20	1·08	......	......	......
Ferric oxide alumina	......	......	......	......	0·56	1·80	1·00	......	......	......	......	......	......
Sulphuric anhydride	53·80	51·28	46·20	45·72	42·04	42·44	42·64	45·52	45·88	46·72	45·76	45·92	46·08
Carbonic anhydride	1·17	1·81	......	......	3·44	trace.	......	......	......	......	......	......	......
Water, loss on ignition	5·16	7·16	20·85	20·92	19·32	19·63	20·29	20·82	21·00	17·77	20·78	21·20	20·90
Insoluble mineral water	0·10	......	......	......	0·80	4·20	4·00	0·40	0·50	0·40	0·90	0·10	0·10
	99·49	100·13	100·05	99·64	99·96	99·35	99·53	99·62	100·18	99·97	100·44	100·30	100·08

No. I. Leonard Carter: anhydrite occurring in close contact with carbonate of lime.
" II. A mixture of light grey and white, from Leonard Carter's.
" III. James Lockhart: white, compact.
" IV. John McCulloch: white, compact.
" V. Robert E. Benjamin: white, and greyish-white.
" VI. J. J. Snook: a red pinkish mixture associated with marls.
" VII. Robert E. Benjamin: black compact, somewhat columnar in structure.
" VIII. Alonzo Lockhart: soft white granular.
" IX. White granular, from John Irwin.
" X. White, streaked with red, from adjoining property.
" XI. Samples from Kennedy farm, Pleasant valley.
" XII. Blue, from James Morgan estate at Hilden.
" XIII. White, from James Morgan estate at Hilden.

Shubenacadie river, Colchester and Hants counties.

At the mouth of the Shubenacadie river, on the east side, occurs a black Carboniferous limestone, known as black rock, carrying small veins of manganite. Succeeding this is a series of soft marls and sandstones, filled with veins of reddish fibrous gypsum running in all directions, and it is not until Pitch brook is reached that we meet solid gypsum exposed in prominence. Here, about 1 mile from the shore, occur massive beds, which extend almost continuously eastward to Beaver brook, and to Irwin lake. At Pitch brook the gypsum is light grey in colour, and has a compact texture. Many years ago the deposits were operated, and the product exported to the United States. At Beaver brook the rock is a compact white variety, with some alabaster showing in some of the exposures; however, anhydrite has prominence. Ascending the river on the western side there is a small area known as Stephens area, where a good white compact variety of gypsum is seen, associated with soft reddish blue marls. Here is the largest deposit of fibrous gypsum known in the Provinces, occurring in veins running through the marls in all directions, often 12″ and 18″ wide, and when cleaned from the associated marls is very pure. In 1869, these deposits were operated for the fibrous variety, and a mill was erected at Noel, 15 miles from the deposit, at a cost of $12,000, for manufacturing the product into terra alba. These works were destroyed by fire the following year, and all operations abandoned.

Proceeding up the river, on the west side, the next deposit of importance is that of Capt. John Graham, just above and opposite Eaglesnest point. This, formerly known as Big Rock, presented a snowy white front to the river, and for many years was operated for export purposes.

It is a massive bed arranged in layers and bent in conical shape; the base and interior showing anhydrite, and the whole resting on a base of

Carboniferous limestone. It is here the Windsor series of the lower Carboniferous crosses the boundary line (Shubenacadie river) into Colchester county, and at this point it has a width of less than 1 mile, and west, about $1\frac{1}{2}$ miles, it tapers to a mere connecting link, but soon widens again on the Fivemile and Kennetcook rivers. Proceeding on the western side of the river, 1 mile south of the Fivemile river, again the gypsiferous area is met with in prominent outcrops of gypsum, which are almost continuous for several miles. At Rose point, Urbania, and Admiral rock, massive white beds are exposed on the river bank, from 40 to 60 feet in height; and not only at the river bank, but from one to three miles west prominent exposures occur of excellent quality.

Crossing the river near Fort Ellis point, and descending again on the eastern side large exposures are seen; but not in such prominence as those on the opposite side of the river. At Green Oak, on the property of Thos. Phillips, large and prominent exposures of white, snow-white, and blue gypsum occur, in compact crystallization. This property is near the river, where shipping facilities are good, and in the past was operated quite extensively. Again, on the property of G. W. Dart, and Tupper Fisher, outcrops occur, but here an excess of carbonate of lime is shown. The gypsiferous area included in the above description is 14·14 square miles in extent.

It will be seen by the above that in this section there is practically an unlimited supply of gypsum of good quality; and at one time considerable business was done exporting the crude material, but many causes have militated against the successful operation of these deposits. Operations were carried on in the days of small sailing vessels owned by those who were familiar with the tides of the Shubenacadie river, but as the size of vessels increased, and before the steamboat was known on this river, the plaster trade became controlled by a few, and these deposits were the first to suffer. To those interested in this trade it may be worthy of note to mention that the tide at the mouth of the Shubenacadie rises 30 feet in three hours and recedes in the same length of time. At Eaglesnest point the bore at high tides is often 10 feet high.

The following analyses will serve to show the different qualities of rock in this section:—

——	I	II	III
From Beaver brook—	%	%	%
Lime	36·80	33·20	33·72
Ferric oxide and alumina	0·40	....	....
Sulphuric anhydride	51·44	46·40	46·00
Water, loss on ignition	11·23	20·79	20·94
Insoluble mineral matter	....	....	0·35
	99·87	100·39	100·01

No. I. The interior of a boulder of anhydrite which has been exposed for about 25 years.
" II. An outside coating about 1″ thick taken from No. 1.
" III. White compact variety of gypsum occurring in the same deposit.

——	I	II	III	IV
From Pitch brook—	%	%	%	%
Lime	32·80	32·88	32·20	33·80
Sulphuric anhydride	45·72	44·92	44·64	44·92
Water, loss on ignition	20·60	20·47	20·44	20·54
Insoluble mineral matter	1·30	1·70	2·30	0·80
	100·42	99·97	99·58	100·06

No. I. Gregory Yuill: grey fibrous.
" II. Gregory Yuill: grey massive.
" III. Constine Wheelock: dark grey with radiating structure.
" IV. Samuel Creelman: light grey, massive.

——	I	II	III	IV	V
	%	%	%	%	%
Lime	33·20	33·20	4·40	32·80	32·92
Ferric oxide and alumina	....	0·40	2·50	....	0·40
Sulphuric anhydride	47·04	45·28	4·24	46·16	45·16
Water, loss on ignition	19·22	20·66	5·01	20·94	21·00
Insoluble mineral matter	·30	0·80	79·52	....	....
	99·76	100·34	95·67	99·90	99·48

Green Oak
No. I. General sample of the rock from property of G. W. Dart.
" II. Sample with dark bark-like incrustation.
" III. Clay mixed with the gypsum incrustation.
" IV. Pure white, granulated, from the property of Thos.Phillips.
" V. Pure white, compact, from the property of Thos. Phillips.

——	I	II	III
	%	%	%
Lime	32·92	32·80	38·40
Magnesia	tr.	tr.	tr.
Ferric oxide and alumina	tr.	....	1·60
Sulphuric anhydride	46·44	46·24	54·44
Carbonic anhydride	....	tr.	....
Water, loss on ignition	20·93	20·65	5·76
Insoluble mineral matter	0·20	1·00	0·60
	100·49	100·69	100·80

No. I. A snow-white, compact sample, from the Stephens property, S. Maitland.
" II. Soft greyish white rock, from an exposure on Capt. John Graham's farm.
" III. Anhydrite, from same location as No. 2.

Elmsdale, Halifax county, and Hants county.

In this section we have one of the largest gypsiferous areas in the Province, comprising 55 square miles and containing inexhaustible and valuable deposits of gypsum. Prominent exposures occur about 1 mile southeast from Elmsdale station, near Keys corner, and 1¼ miles farther on. Following the contact northeastwardly and lying unconformably with the Carboniferous limestones, on the Cambrian quartzites and slates, are several outcrops of soft white, greyish white, and blue gypsum. Three miles northeast of Elmsdale and east across the Shubenacadie river, quite extensive deposits of very pure selenite occur, near a very dark gypsum outcrop, known as the Black Rock gypsum quarry.

East and north of the Intercolonial railway, at the Horne settlement on the shores of Grand lake, further deposits of selenite occur, with more or less prominent deposits of gypsum; and again at Ninemile river, 6 miles from the railway, what is probably the most extensive outcrop of gypsum in the whole section occurs on the Thompson property. The outcrop is more than a mile in length, and has a maximum height of 60 feet. The greater part consists of a white compact variety. These deposits, however important, are not considered commercially valuable on account of the distance from Halifax, the nearest shipping port.

Gay river, Halifax and Colchester counties. Gypsiferous area 75·60 square miles.
Musquodoboit, Halifax county. Gypsiferous area 31·38 square miles.
Stewiacke river, Colchester county. Gypsiferous area 13·95 square miles.
Newton mills, Colchester county. Gypsiferous area 22·32 square miles.

To the four above mentioned sections, containing in all an area of 145·25 square miles, very little attention has been paid. There is no question but what they contain many of the largest and best deposits in the Maritime Provinces, but their location being far away from any means of transportation, destroys their commercial value. It is not pleasant to think of such extensive deposits of great purity being inaccessible, but a glance at the maps will show that beyond a few deposits on the northwest portion of Gays River map, all others are miles from transportation facilities, many being from 18 to 30 miles from the nearest railway connexion. Should the proposed Halifax and Guysborough railway be constructed through the Musquodoboit valley, it will materially improve the position of many of these deposits, and be a strong incentive to encourage manufacturing in this district.

GYPSUM DISTRICT "E."

South Maitland, Hants county.

The eastward continuation of the Kennetcook River valley is the valley of the Fivemile river, both rivers having their origin in close proximity, the Kennetcook flowing westwardly to the Avon, the Fivemile river eastwardly to the Shubenacadie. The Dominion Atlantic railway (Midland division) follows these valleys for nearly 30 miles west of the Shubenacadie river, which makes the gypsum deposits in this section very accessible.

On this sheet there are three gypsiferous areas, comprising a total of 9 square miles.

The most important of these is that at Latties brook, which is a continuation of the Windsor series eastward. It is here that the Windsor Plaster Company has a quarry and gets a partial supply for its calcining mill at Windsor. The quarry is situated near Burtons station, on the south side of the railway, and has an exposed face 40 feet high, covered with from 10 to 15 feet of clay. Attempts have been made, with a considerable degree of success, to remove this clay by the hydraulic method.

The rock is a white compact variety, well suited for the manufacture of plaster of Paris. This bed may be followed westward for some miles, but there are only a few outcrops, the greater part being concealed under a heavy overburden of clay. North, about 1 mile, near the public highway, prominent outcrops are again seen, but the rock is not as good in colour or texture as at Burtons.

Going east from Burtons we meet precipitous cliffs, from 75 to 140 feet in height, and over 2,000 feet long, on the Lawrence property, at Andrew Hayes (known as The Cave), and on the Royles property. On the Geary property, about 150 feet north of the railway and having a strike about parallel with it, is another exposure, with a length of 1,400 feet, and an average height of 85 feet.

On the Hayes property, the upper parts of the cliff show considerable disturbance, and are badly folded and contorted; while near the base the beds are more even in structure. The rock on this face shows considerable anhydrite, but on the south or opposite side of the ridge, where the rock has more covering, it is a good white gypsum, with some greyish white and blue associated. The face continues westwardly, with practically the same height, to the Lawrence property, and has a stratification more horizontal and even. In other conditions it is similar to the Hayes property.

On the Geary property, the rock again shows disturbance, with considerable anhydrite, and veins of dark carbonaceous and reddish gypsum of inferior quality cutting through it.

The natural shipping port for the deposits of this area would be the Shubenacadie river (distance from 3 to 5 miles), but it would necessitate the construction of a shipping pier above the railway bridge. Unfortunately, not sufficient attention was given to draw efficiency in the construction of this bridge, and the provision then made for this purpose is not suitable for modern shipping; and, therefore, makes what would be otherwise desirable gypsum properties (not only the above described, but several others on or near the Shubenacadie river), practically inaccessible for export purposes.

The next area of importance is that at Glencoe. It is to the south, and some distance from the valley of Fivemile river and on very much higher ground. The shipping port for this is on the Shubenacadie river, about 2 miles above the mouth of the Fivemile river.

Going north to Selma, near the head of Cobequid bay there occurs a small isolated gypsiferous area of 1·7 square miles. The topography of this is generally low dike lands, and the outcrops, which have but little prominence, occur about 2 miles from the shore. The rock is a grey slaty structure, with small quantities of white granular.

The following analyses will give the general average composition of exposures in this section:—

——	I	II	III	IV	V	VI	VII
	%	%	%	%	%	%	%
Lime	39·60	34·20	35·60	34·20	38·80	33·32	32·80
Magnesia	tr.	....	....	....	....	....	....
Ferric oxide and alumina	....	0·40	0·40	0·40	....	0·28	0·12
Sulphuric anhydride	55·20	46·68	37·92	45·60	53·40	46·48	45·64
Carbonic anhydride	0·78	....	6·58	tr.	....	....	....
Water, loss on ignition	4·05	17·15	17·30	20·10	8·05	20·65	20·44
Insoluble mineral matter	tr.	0·92	2·20	....	·40	·12	1·68
	99·63	99·35	100·00	100·30	100·65	100·85	100·68

No. I. Andrew Hayes property, from high face near cave.
" II. Andrew Hayes, south side.
" III. Burgess property, Glencoe, dirty dark grey.
" IV. Burgess property, Glencoe, soft white, slightly granular.
" V. From the Garry property, or Midland railway.
" VI. Windsor Plaster Company's quarry at Burtons, soft compact rock.
" VII. From Selma quarry, grey shaly variety.

Noel, Hants county.

This district besides showing the continuation of the deposits of the Kennetcook valley, where there are several important exposures of gypsum similar in quality and texture to those that have been described in this valley, also shows a northern gypsiferous area belonging to the Windsor series. This branches off from the Kennetcook valley near Burtons, and follows a westwardly course skirting the older Devonian rock, to the Avon river on the west, and forms the northern boundary of the lower Carboniferous basin of Hants county.

In this section important exposures of all varieties occur. Many of them, however, being so far away from transportation facilities, are not considered commercially valuable. Among these may be mentioned the deposits on the Petite river, those on the West Branch of the Tennycape river, on Robinson brook, and those east of Northfield, together with those in an isolated area 1½ miles north of the Kennetcook river.

The first to be considered are those at Noel lake. Here the gypsum outcrops on both sides of the lake and shows beneath the water in the lake. The greater part of the deposit appears as a white compact variety of excellent quality. In some places anhydrite occurs, in a form peculiar to this place, not in veins, masses, or beds, but in round spire-like pinnacles protruding through the gypsum.

On the west side of the lake the O'Brien Company has been operating for a few years, and exporting the crude rock to the United States. The quarry is situated in a hollow between 30 and 40 feet below the surrounding country, and has a height of face equal to that depth. It is drained by natural watercourses through the rock. The top of the rock is covered with blow or pipe holes. At the east of the lake, on the property of J. S. O'Brien, some development work has been done, which has proved the existence of large quantities of gypsum of excellent quality.

The present system of transporting this rock to the shipping pier (3½ miles distant) is by horses and wagons, which makes an excessive cost. A line of railway, over a very easy location, is proposed for future development, and, if constructed, will make this property one of the most desirable on the Minas basin.

The next deposit of importance west of the above is one situated in the rear of Minasville, about 1½ miles from the shore. This property has an exposure averaging 50 feet in height, and over 1,500 feet in length. It is a good white compact variety of gypsum, showing but few irregularities. The topography of the country between the shore and the deposit is such that it would be difficult and expensive to construct a railway connecting the two points, but it has been proposed to make Tennycape harbour the shipping port, and build a railway to that point, a distance of 3½ miles.

Samples have been taken from the above described deposits, and the results are given in the following analyses:—

——	I	II	III	IV
	%	%	%	%
Lime	32·60	35·00	33·20	33·00
Magnesia	......	......	......	......
Ferric oxide and alumina	......	0·20	0·20	......
Sulphuric anhydride	46·84	48·96	45·32	45·96
Carbonic anhydride	......	......	1·15	0·65
Water, loss on ignition	20·80	14·90	20·55	20·60
Insoluble mineral matter	0·20	0·60	......	......
	100·44	99·66	100·42	100·21

No. I. From J. S. O'Brien's property, east of Noel lake, white to snow-white compact variety.
" II. Average sample from the O'Brien Company, west of Noel lake, greyish white, compact gypsum.
" III. Average sample from the Minasville property, compact, white to snow-white.
" IV. Best quality from Minasville property, snow-white, compact.

Walton, Hants county.

Following westwardly the gypsum can be traced almost continuously, by outcrops and other characteristics, the whole length of the gypsiferous area. The most important deposit is that at Walton. It is one of the largest deposits in the county, having a face 100 feet high, and may be followed, with a constant exposure, for over 2,600 feet, and continues for miles with a series of extensive outcrops.

The Walton deposit, which has been operated intermittingly for nearly a century, is now producing from 40,000 to 50,000 tons annually; operated by Mr. Albert Parsons. The rock is a greyish white and blue compact variety, showing comparatively small quantities of anhydrite occurring in lenticular veins surrounded by gypsum, graduating with increasing or diminishing prominence into each other. At this point the pipe or blow holes are very characteristic, having a circular area, with perpendicular walls and rounded bottoms. The rock, where excavated, has no covering of clay, and everything, except foreign material, that will not pass through a coke fork, is shipped. The deposit is situated 1 mile from the shipping pier and the rock is hauled there with horses and carts. At present the whole output is taken by Messrs. J. B. King & Co., of New York, and transported by this firm in its own barges.

——	I	II	III	IV
	%	%	%	%
Lime	33·20	40·00	32·40	33·32
Magnesia	....	....	....	....
Ferric oxide and alumina	0·20	0·36	....	0·32
Sulphuric anhydride	46·84	57·12	46·28	44·28
Carbonic anhydride	....	....	tr.	1·75
Water, loss on ignition	17·40	1·50	20·56	19·50
Insoluble mineral matter	2·00	0·52	0·20	0·48
	99·64	99·50	99·44	99·65

No. I. Average sample from stock pile at Walton quarry, light blue compact.
" II. Anhydrite from Walton quarry. This rock has a very sandy appearance and is full of grit.
" III. Sample from first level above and east of quarry floor, at Walton, bluish grey, compact.
" IV. Sample from South Mountain deposit, at Walton.

Cheverie, Hants county.

By many it has been considered that the gypsiferous area occurring at Cheverie was a continuation of the Windsor and Shubenacadie series, but this is not correct. They are separated by over 2 miles of intervening Devonian rocks at their nearest point, which is near Goshen, shown on the east side of the sheet.

Cheverie, consisting of an area of 4·3 square miles, is situated on the south side of Minas basin, about 6 miles east from the mouth of the Avon, and has good water transportation facilities. Here operations have been carried on intermittingly for many years. Outcrops occur at the shore, in high cliffs, associated with much anhydrite, and carbonate of lime in close contact. They also have prominence, and have been operated in the past, about a mile from the shore, where the rock appears to be freer from irregularities.

The present operations are carried on at the shore, at points known as the Cove quarry and the Upper head. The Lower head occurs about one mile distant, on the north side of Cheverie creek, in a small isolated area.

The Cove quarry is about 500 yards from the beach where the shipping pier is located. The gypsum is covered with clay from 10 to 15 feet thick, and underlain with anhydrite. The gypsum and anhydrite graduate from one to the other without any particular line of demarcation.

A tunnel is opened for underground mining and to develop deposits on the opposite side of the public highway, which runs near the face of the quarry. The Upper Head quarry is on the beach and a few hundred yards east of the shipping pier. The high tides of the Bay of Fundy do the work of cleaning the quarry, by washing the debris away from the rock. This rock is principally anhydrite with some gypsum intermixed.

The Lower head is a very similar rock to the last, but carries petroleum in embedded cells, from which small quantities have been collected during blasting operations. With this as partial encouragement, a company was formed to bore in this section for oil, and a record of one of the bore-holes, put down about half a mile from the shore, is given in Vol. XV, p. 161 AA, of the Geological Survey of Canada. A section of this bore hole is shown in Fig. 3. It is interesting, as it shows the occurrence of gypsum at different depths, the greatest body of white gypsum being between 130 and 370 feet from the surface. It is unfortunate that no record is given of the dip of the rock.

The following analyses are from samples taken from this section, and will serve to show the composition; also an analysis made by Prof. F. E. Engelhardt, of Syracuse, N.Y., and kindly furnished by Mr. A. A.

Hayward, of Halifax, of the brine from the Cheverie bore-hole mentioned above:—

——	I	II	III	IV	V	VI
	%	%	%	%	%	%
Lime	32·80	32·72	40·80	32·60	42·20	31·40
Magnesia	....	....	....	....	....	....
Ferric oxide and alumina	....	0·16	....	0·48	0·52	2·40
Sulphuric anhydride	46·56	46·96	58·16	46·68	43·32	14·40
Carbonic anhydride	tr.	....	....	tr.	9·36	16·75
Water, loss on ignition	20·80	20·65	1·55	20·75	1·70	8·40
Insoluble mineral matter	....	0·20	....	....	3·30	27·30
	100·16	100·69	100·51	100·51	100·40	100·65

No. I. From east side of tunnel in Cove quarry, Cheverie, snow-white, compact.

" II. From opposite side of same tunnel, much harder, but not anhydrous.

" III. Anhydrite from base of Cove quarry, Cheverie.

" IV. Top rock from Cove quarry, Cheverie, soft, white, compact. M. Parson's quarry.

" V. Rock associated with gypsum, Upper Head quarry at Cheverie.

" VI. Dark carbonaceous rock, overlying gypsum at Cove quarry, Cheverie.

SECTION
OF
BOREHOLE
IN THE
CHEVERIE GYPSIFEROUS AREA

From Geological Survey of Canada
Vol. XV, p. 161 A A.

No.	Thickness of Strata Feet	Section of borehole	Total depth bored Feet	Material Cut
1	20		20	Surface and drift
2	30		50	Dark gray shales
3	150		200	Shale and gypsum mixed in streaks
4	370		570	White gypsum
5	80		650	Red shale
6	10		660	Light-gray shales
7	240		900	Red. shale
8	100		1000	Red and gray shale in alternate layers
9	20		1020	Gray sandstone with a flow of salt water
10	200		1220	Light-gray shale, with a little sandstone
11	50		1270	Red and gray shales mixed
12	130		1400	Shales with gypsum
13	350		1750	Whitish quartzose sandstone, very gritty
14	60		1810	Dark-gray shale
15	30		1840	Dark-gray sandstone. Flow of salt water {not so strong as the last.
16	50		1890	Dark-gray shale
17	20		1910	Whitish-gray sandstone, with a great flow of salt water

Fig. 27

The following is an analysis of the Cheverie brine:—

Specific gravity, at 15° C., 1·1387.

	Results by weight Per cent.
Calcium sulphate	0·3957550
Calcium chloride	0·5152726
Magnesium chloride	0·3261256
Ferrous carbonate	0·0027988
Sodium chloride	16·8279620
Total mineral matter	18·0679140
Water	81·9320860
Total	100·0000000

An Imperial gallon of this brine contains:—

	Grains.
Calcium sulphate	315·46433
Calcium chloride	410·74208
Magnesium chloride	259·96628
Ferrous carbonate	2·23704
Sodium chloride	13414·16587
Total mineral matter	14402·57560
Water	65310·97440
Total	79713·55

Avon river, Hants county.

Total gypsiferous area, 70·56 square miles.

On both sides of the estuary of the Avon river extensive deposits of gypsum have been known since the early discovery of the country, and some of them were operated over a century ago. Beginning at Summerville, on the east side, and Mount Denson on the west side, and continuing up the river for a distance of 8 or 10 miles, or until it meets with the irruptive rocks of the Ardoise hills, is the width here of the lower Carboniferous measures in which the gypsum deposits occur. These measures, which extend eastwardly, and are described in the opening of this chapter, carry, almost without interruption, gypsum deposits as far as the Shubenacadie river.

Many of the operations of the past in this section have been, for various reasons, abandoned. Few have made any attempt to operate below drainage level, and water has driven them out. Many of these deposits have an overburden of clay, and owing to its increasing thickness, became too expensive to operate under existing circumstances; in others the prevalence of anhydrite has been discouraging, and concentration of trade has had much to do with closing out small operators; but not even in the quarries with the oldest history can it be said that the gypsum became exhausted.

Starting again at the northwest angle of this sheet, near Summerville, there is an area on the east side of the Avon, which by erosion of the river bank has been divided from the main body. It is known as Grant's quarry, and was operated for many years, but, although situated within a few hundred yards of the shipping pier, the rock dipping eastwardly under a heavy overburden of clay made operations too expensive, and the place has been abandoned. The rock here was a very fine white compact variety, showing a few streaks of black irregularly distributed through the white. The black was high in carbonate of magnesia, and carried some bitumen and iron pyrites.

A short distance above Summerville occurs the next outcrop, from which a small quantity has been taken. It has a small area, and is of little importance.

On the west side of the river, a few miles farther south, at Mount Denson, extensive cliffs 40 to 60 feet in height occur on the banks of the river and extend out on the beach to the river bottom. The greater part of the exposure here appears as anhydrite, but much of the concealed measures show evidence of a softer rock, and part of the rock on the beach is an excellent variety of gypsum, white, with a fine compact structure.

Prominent outcrops are also seen on the Scott estate and on the Hannah property, between the shore and the main road leading to Windsor. At the former place is one of the old quarries which was operated many years ago. It has a face exposed from 50 feet downwards, and much of it is white and blue gypsum, of a good variety, but associated with considerable anhydrite. On the Hannah property the principal outcrops are anhydrite. West of this property, about 1 mile from the shore, at the Duck pond, an extensive exposure is seen, from 40 to 60 feet in height. Much of the rock is harder than that allowed by the scale of hardness, yet in composition it is a true gypsum, white and compact. At Lower Falmouth there is a prominent exposure in the old quarry at Young's and continuing on to Falmouth many outcrops occur. The most extensive is on the Glebe property, situated about $1\frac{1}{2}$ miles from the western shores of the Avon river, opposite Windsor. Here the gypsum exposures have an average height above drainage level of 55 feet, and cover an area of several acres. Easy gradients could be secured from the deposit to the shipping point, and this, with a good white and grey compact rock showing but few irregularities, gives commercial value to the property. Continuing southwardly from the above, the outcrops are again met with on the Hanson property, but the gypsum, especially that occurring in lower ground, is irregular in colour and texture. This is another abandoned quarry.

The following analyses will show the general average composition of the gypsum in the Mount Denson and Falmouth section:—

—	I	II	III	IV	V	VI	VII	VIII	IX
	%	%	%	%	%	%	%	%	%
Lime	32·23	36·52	32·30	32·67	34·08	36·90	32·23	32·30	36·69
Magnesia	tr.	tr.	......	tr.	tr.	......	tr.	tr.	0·34
Ferric oxide and alumina	0·80	0·46	0·20	0·24	0·06	0·42	0·28	0·12	0·90
Sulphuric anhydride	45·92	52·32	46·68	44·64	43·62	52·80	45·27	46·58	41·32
Carbonic anhydride	0·56	0·59	0·15	1·87	2·11	0·51	0·86	0·08	4·86
Water, loss on ignition	20·55	10·20	20·70	20·15	19·55	8·95	20·33	20·65	18·30
Insoluble mineral matter	0·20	0·40	......	0·26	0·30	0·24	0·48	0·10	0·14
	100·26	100·49	100·03	99·83	99·72	99·82	99·45	99·83	102·55

No. I. White compact rock, from the Scott estate, Mount Denson.
" II. From Hugh Hannah property, at Duck pond, Mount Denson.
" III. Snow white, compact variety, from the shore below high water mark at Mount Denson.
" IV. Soft white rock from Young's old quarry, Lower Falmouth.
" V. Grey rock with snow-white streak, from Glebe property, Falmouth.
" VI. White rock from H. Hannah property near the shore.
" VII. Snow-white compact variety, from upper quarry, on Hanson property, Falmouth.
" VIII. The best from Hanson lower quarry, Falmouth, uneven in colour and texture.
" IX. Dirty greyish rock, from same location as No. 8.

Crossing the Avon river to Windsor on the east side we are on the historic ground of the gypsum industry of this Province. Here the gypsum beds lie almost parallel, having a strike east and west, the northern and southern boundaries converging slightly as they near the Kennetcook valley on the east. The greatest distance across the strike is about 6 miles. The most southern operations are those of the Wentworth Gypsum Company, at Meadow quarry, while the most northern are those of the Newport Plaster Mining and Development Co., Ltd., at Avondale.

Within the town of Windsor what was the most important deposit known (now abandoned), is the old Pellow quarry. This is an excavation about 800 feet long, 150 feet wide, with an average depth below the street level of 40 feet. It has been estimated that about 500,000 tons have been exported from this quarry. It is now more a point of scientific interest than an economic proposition. The anhydrite occurs here in lenticular masses from 2 to 10 feet thick in the centre, and from 50 to 75 feet long, embedded in the gypsum. Crude petroleum has also been reported as occurring in large cells, in nodules of gypsum found in the clay which formed a covering to the deposit.

One and a quarter miles south of Windsor there are what were known as the Wilkins and Redden quarries, long since closed, except for small quantities now being used for calcining purposes by the Windsor Plaster Company.

Beginning with the operations on the southern beds, the first is the Nova Scotia Gypsum Company quarry, at Threemile plains. This is situated about 3½ miles from Windsor, near the Dominion Atlantic Railway Company's line, on which the rock is transported to Windsor for export purposes. The rock is an excellent white, compact variety, having a working face 30 feet in height above drainage level; but it has a heavy overburden of clay, averaging 30 feet in thickness. This is considered the extreme limit of clay that can be moved profitably by the present methods of operating; that is, 1 foot of clay to 1 foot of face. An attempt was made to mine this rock, but sufficient height of face could not be secured without the use of pumps to make it an economic proposition.

South of this, about half a mile, is the Meadow quarry, owned and operated by the Wentworth Gypsum Company. Here the rock has no covering of clay. The surface is very uneven, being covered with kettle, pipe, or blow holes, and as usual, where the gypsum is free from covering, the first few feet of the exposed surface is badly disintegrated by atmospheric action. On the eastern side of the quarry the face is 75 feet in height, extending westward and gradually diminishing in height; it also shows a natural water course or cave near the bottom. These beds are practically horizontal, and slightly stratified.

This quarry is connected with the Dominion Atlantic railway by a branch road about one mile in length. Shipments are made over it to Windsor (4 miles) in summer, and occasionally to Halifax (41 miles) in the winter season.

The next property, 1½ miles east of the above, is the quarry of the Windsor Gypsum Company at Newport. The occurrence and the conditions under which it is operated are very similar to those of the Nova Scotia Gypsum Company above described, except that the operations are much more extensive. The superior quality of the rock in both these places is the only circumstance that makes it possible to operate under existing conditions. This property is also connected with the Dominion Atlantic railway, over which the crude rock is hauled to Windsor for water transportation to the United States.

A feature of considerable geological interest occurs here, which would warrant more complete investigation if time permitted. Within a distance of 2 miles, on the same strike and having a similar elevation above the sea-level, three exposures are seen. Two of these, one on either end, have been planed off by glacial action to practically an even surface, and covered with a heavy overburden of boulder clay, while the centre one is quite free from clay, and does not show the same glacial action, nor any overburden of clay.

East of this, at Newport, there are a few other deposits which in the past have been operated and are now closed, but they are of no particular importance, and so similar in quality to those described that it is not necessary to give a detailed description of each outcrop.

The following analyses will serve to show the composition of the rock from this section:—

——	I	II	III
	%	%	%
Lime	32·62	32·74	31·41
Magnesia	tr.	0·16	0·13
Ferric oxide and alumina	0·86	0·32	0·26
Sulphuric anhydride	46·06	45·68	45·15
Carbonic anhydride	tr.	tr.	tr.
Water, loss on ignition	20·30	20·52	20·20
Insoluble mineral matter	0·14	0·52	2·32
	99·98	99·94	99·47

No. I. White compact rock, from the Nova Scotia Gypsum Company's quarry at Threemile plains.

No. II. Average sample from the Meadow quarry at Newport.

No. III. Bluish white compact, average sample from Wilkins quarry, Windsor.

North of the above described quarries, between 1 and 2 miles, occurs the second series of parallel gypsum beds. The principal operations are on the Wentworth deposit, owned and operated by the Wentworth Gypsum Company. From here the largest gypsum exporting business of the Province is carried on. This trade in 1868 amounted to 10,000 tons, while in 1909 it exceeded 175,000 tons. The deposits are very extensive, the Company owning about 1,200 acres, all underlaid with gypsum. The rock is principally a white compact variety, well suited for all manufacturing purposes. Anhydrite occurs irregularly, in some parts in prominent exposures, in others beneath the floor of the quarries. The greater part is covered by a heavy overburden of clay, in some places from 25 to 30 feet thick, but it has an advantage over the southern deposits in having a higher working face beneath the clay.

In the past all this clay was brought down with the gypsum and removed by horses and carts to the waste dump. At present the steam shovel is being used in some places to remove the clay from the top, before the rock is blasted.

These quarries are connected by a standard gauge steam railway with the shipping piers, $2\frac{1}{2}$ miles distant, on the St. Croix river, which is a tributary of the Avon.

After the rock is blasted and broken to one man size (meaning the size one man can conveniently handle), it is put in carts and hauled to a loading stage sufficiently high to dump directly into cars. It is then taken by train to the shipping pier and loaded into barges, which are dismantled schooners of about 2,000 to 2,500 tons capacity, and towed to New York, generally three in a tow. These barges are usually taken out singly, at high tide on the Avon, and anchored in head waters of the Minas basin, where the whole tow is made up and taken by an ocean going tug. The whole product of these quarries is taken exclusively by Messrs. J. B. King and Company, who have extensive mills on Staten island. This firm is also a large holder in the Wentworth Gypsum Company.

East of the Wentworth Gypsum Company property, and adjoining it, is the Phillips farm. It has an area of 75 acres, and an average elevation above drainage level of 60 feet. It was tested in 1909 by a series of trenches and pits, and showed an excellent variety of white and snow-white gypsum of fine compact structure, the greater part being covered with clay; showing in the pits and trenches from 2 to 15 feet deep.

The proposed shipping point for this deposit is on the St. Croix river, above the railway bridge. This bridge is fitted with a draw having a width of 32 feet.

Above the St. Croix public bridge and east of the last described property, high prominent cliffs of gypsum and anhydrite are seen, and from here back to Newport station occurs an almost continuous series of outcrops, but the greater part of them show anhydrite in abundance. Above the St. Croix bridge, 30 or 40 years ago, gypsum was quarried and scowed down the river for export purposes.

Again, farther east on the Meander river, gypsum was quarried on the Woolaver property, and on the Chambers property. On the latter, prominent exposures are now seen of white and blue gypsum, of both granular and compact texture. The operations were carried on here many years ago, when the transportation was done in small vessels which loaded near the old shipyard.

Going north from the Wentworth quarries to the third range of gypsum beds, the principal operations are carried on at Avondale by the Newport Plaster Mining and Development Company, Ltd. (Messrs. J. B. King & Co., of New York, being the principal holders). This Company controls about 4,000 acres of gypsum land in this vicinity, and is preparing for extensive operations. The old quarry, which was operated here some years ago, has been reopened at a lower level, by driving a tunnel large enough for drainage and railway track. This will lower the floor of the quarry from

10 to 20 feet. They also extended their operations west about $2\frac{1}{2}$ miles, where they are opening up a new quarry, and connecting it with their shipping pier by a standard gauge railway, now under construction.

The rock is principally white in colour, with some little grey and black. Portions of it show an excess of carbonate of lime.

On the eastern extremity of this Company's property are the old quarries at Miller creek, which were abandoned many years ago, but are likely to be reopened by this Company.

Continuing eastwardly, prominent exposures occur on the west side of River Hebert, near the railway, and on the Chambers property on the east side. Here considerable anhydrite is in evidence, but some very superior snow-white gypsum is seen on the Chambers properties.

The exposures at this latter point are low, but the rising ground going east gives evidence of large quantities covered with clay.

The following analyses will show the composition of the principal exposures in this section:—

——	I	II	III	IV	V	VI	VII	VIII
	%	%	%	%	%	%	%	%
Lime	32·42	32·98	35·39	17·63	32·46	32·86	31·92	32·55
Magnesia	....	....	1·30	1·40	0·76	....	....	....
Ferric oxide and alumina	0·20	0·46	1·28	4·58	0·26	0·46	0·56	0·30
Sulphuric anhydride	46·12	45·11	32·47	25·44	43·48	46·60	46·56	46·28
Carbonic anhydride	0·87	0·74	11·10	....	2·01	0·83	....	1·61
Water, loss on ignition	20·60	20·30	13·67	12·75	19·95	20·55	20·75	20·52
Insoluble mineral matter	0·32	0·60	4·30	38·20	1·10	....	0·32	0·88
	100·53	100·19	99·51	100·00	100·02	101·30	100·11	102·14

No. I. Average sample from the Wentworth Gypsum Company's Eagle Swamp quarry.

" II. Average sample from the Wentworth Gypsum Company's stock pile at Wentworth.

" III. A dark greyish rock associated with gypsum at the Wentworth quarries.

" IV. Dark shaly pinkish material occurring on the north side of railway, about 100 yards east of Dimock station.

" V. From deposit south side of railway, east of No. 4, soft mixture of dark greyish blue and white.

" VI. Snow white nodule taken from test pit north side of hill on Phillips farm.

" VII. Taken from bottom of a blow hole about 40 feet deep, at the base of the hill, Phillips farm. The sample was hard enough to give a metallic ring when hit with hammer.

" VIII. From a test pit near the north boundary, white compact variety.

Besides the above described properties there are many other deposits of prominence in this section, as those farther south on the St. Croix river, in McKay settlement, and on the Kennetcook river, which are at present inaccessible to transportation facilities, and do not differ materially from many already described, and, therefore, will not be given here in detail.

Clarksville, Hants county.

The continuation northeastwardly of the Avon sheet is an area consisting of 19·44 square miles, which will be known as the Clarksville.

This area is in the valley of the Kennetcook river, through which the Dominion Atlantic railway (Midland division) passes. At this point, the gypsiferous area seems to form the lower members of the lower Carboniferous group, and the principal outcrops are near its contact with the older rocks, and under present conditions have not sufficient prominence to be considered commercially valuable for anything beyond the local demand.

Ninemile river, Hants county.

This is a small gypsiferous area, consisting of 9·37 square miles, situated and adjoining Elmsdale area, and altogether it contains many prominent deposits of good gypsum. It is so far from transportation facilities that it may be considered inaccessible for everything except local uses.

GYPSUM DISTRICT "F."

Malagash, Cumberland county.

Near the eastern extremity of the Clairmont anticline is a gypsiferous area of 2·19 square miles. In this several important outcrops of gypsum occur. On the shore of Plaster cove, East Wallace, on the road leading to Wallace and eastwardly to North Shore, Malagash, the beds can be followed almost continuously, associated with greenish yellow marls, clay, and limestone. The rock is white, with compact crystallization. The location of these deposits, so easily accessible to water transportation by the Gulf of St. Lawrence, and having the Pictou coal fields on the east, and the Cumberland coal field, 35 miles distant by rail, on the west, makes it one of the most desirable in the district for supplying the Canadian markets, either with the crude or manufactured article.

Pugwash, Cumberland county.

Following the Clairmont anticline westwardly we again have important outcrops of gypsum near Hartford, associated with the limestones; at Canfield creek, a tributary to the Pugwash river, and 4 miles from its mouth; and also—principally in concealed measures—on the east and west side of the Pugwash River basin, and on Victoria island in the basin. This whole basin evidently was at one time a calcareous formation.

The most interesting part of this section is that of Canfield creek. Here the grey, greyish white, and white gypsum outcrop in extensive beds. They are within 2½ miles of railway, and if connected, it would place them within 5 miles of deep water shipping.

At the northern base of the gypsum outcrops, in a shallow basin of water, at the water's edge, the largest and purest deposit of selenite known has been discovered.

Analyses of the samples taken from Canfield creek show the following results:—

——	I	II
	%	%
Lime	33·25	32·86
Ferric oxide and alumina	0·74	0·40
Sulphuric anhydride	42·76	45·52
Carbonic anhydride	3·11	1·24
Water, loss on ignition	19·30	20·50
Insoluble mineral matter	1·72	0·40
	100·88	100·92

No. I. Sample from old quarry, greyish white in colour and slaty structure. This rock is being used in the manufacture of fertilizer at Pugwash.

" II. White, with compact crystallization.

Philip river, Cumberland county.

In this district there is a gypsiferous area of the Clairmont anticline, continuing westwardly from the Pugwash area, and it still continues westwardly in almost a straight line—but not of equal inportance—to Salt Springs and Clairmont Hill to within a few miles of Springhill mines.

The gypsum outcrops at Hansford, on Thompson road, and near Hansford siding. It consists principally of a blue and bluish white rock, with granular texture in prominence. This has an average of 1·83 square miles. North of this about 2½ miles near Roslin, on Philip river, is an isolated area consisting of 697 acres. It has prominent outcrops, on Plaster creek, and at Jasper Rushton's. Here the rock is a white compact variety. Again, east of this, near Oxford town, at a point known as Salt lake, in a similar area, prominent outcrops are observed. From this place small quantities are quarried and brought to the lower end of the lake, about 1½ miles, where it is ground for local purposes.

The following analyses will serve to show the quality of this rock:—

——	I	II	III
	%	%	%
Lime	33·69	32·86	32·55
Magnesia	....	....	tr.
Ferric oxide and alumina	0·40	0·50	0·54
Sulphuric anhydride	44·40	45·86	44·12
Carbonic anhydride	2·35	0·93	2·92
Water	20·37	20·47	20·45
Insoluble mineral matter	0·40	0·12	0·20
	101·61	100·74	100·78

No. I. White, compact rock, from Salt lake, Cumberland Co., Halifax.
" II. Bluish-white, granular, from Lockhart quarry.
" III. White, compact variety, from Thompson road.

Springhill mines, Cumberland county.

East of the Springhill coal mines about 2 miles, and at the western extremity of the Clairmont anticline, occurs a small gypsiferous area of 771 acres. It consists principally of concealed measures, and can be traced by mounds and sink holes. In the south branch of Black brook the gypsum is seen in beds associated with blue and yellowish marls and shales. The only importance attached to this is its close proximity to the coal mines, for manufacturing purposes.

Two miles east of Springhill junction, occurs a similar area of 620 acres. It is bounded on three sides by faults, and, therefore, shows much disturbance. In a small brook, running through Stewart's meadow, the gypsum is seen associated with red and greyish marls. This, like that at Springhill mines, may be of some economic value for manufacturing purposes, but only by mining or quarrying below the drainage level.

Reviewing this whole division "F" (exclusive of Parrsboro area), there is not much doubt that this gypsiferous area is much greater than that shown on the maps; that it extends the whole length of the Clairmont anticline from North Shore, Malagash on the east, through Hartford and Hansford, to Clairmont; terminates against the coal measures of Springhill mines; and that Nappan and Philip river form a northern boundary to the Cumberland coal fields, continuing westwardly to Minudie, across the Maringouin peninsula into the Hillsborough gypsum field of New Brunswick.

Not much energy has been shown in the development of this area, and although much of the gypsum is concealed beneath an overburden of clay, there is strong evidence that if systematically tested, it would show much very superior rock that would warrant the establishment of important industries.

Nappan, Cumberland county.

About 1 mile north of Nappan station, and extending westwardly to Cumberland basin, occur outcrops of importance, in a gypsiferous area traceable over 800 acres. The topography of the country is low, consisting principally of marsh or dike lands, which makes it difficult to trace boundaries. The exposures are known as the Newcombe, the Fowler, and those operated by the Maritime Gypsum Company, Limited, which cover an area of 12 acres. This Company has been operating for several years, shipping an average of 4,000 tons per year. Their operations have been carried on below the drainage level, in an open pit to a depth of 50 feet below the fractured surface, and they have tested the ground by bore holes to a depth of 100 feet. During the summer of 1909 they installed a Ledgerwood cable system, and are prepared to sink to a further depth. This property is connected with the Intercolonial railway by a branch line, which also connects with their shipping pier, at tidewater, on the Cumberland basin, 2½ miles from the quarry.

The rock at the surface is considerably fractured, and is mixed somewhat with clay and thin seams of dark carbonaceous material, but at depth it is white, compact, and very pure.

The following analyses will serve to show the average composition of the different exposures in this section:—

——	I	II	III	IV	V
	%	%	%	%	%
Lime	44·40	32·36	32·42	32·23	31·54
Magnesia	tr.	....	....	....	....
Ferric oxide and alumina	2·70	0·64	0·10	0·16	0·84
Sulphuric anhydride	6·92	44·32	46·72	46·56	44·20
Carbonic anhydride	32·22	2·42	....	....	0·35
Water, loss on ignition	3·35	19·90	20·80	20·80	19·75
Insoluble mineral matter	10·20	0·40	....	....	3·80
	99·79	100·04	100·04	99·75	100·48

No. I. From the old Fowler quarry, principally carbonate of lime.

" II. From the Newcombe deposit, dark dirty grey, granular crystallization.

" III. From property of the Maritime Gypsum Company, Nappan, snow-white compact variety, occurring in nodules.

" IV. From property of the Maritime Gypsum Company, their best variety slightly resembling white alabaster.

" V. From the property of the Maritime Gypsum Company, dirty red colour, mixed with small veins of clay throughout.

Parrsboro, Cumberland county.

In this area two small patches of gypsiferous ground occur, the first about 2 miles east of Parrsboro, the other at Clarks head, about 4 miles east of Parrsboro.

On the shore at the latter place it occurs in contact with the igneous rock, in thin layers or veins, pink, black, white, and grey, associated with heavy beds of marl.

About one-quarter of a mile inland the occurrence has much more prominence, and at one time quite extensive operations were carried on, and the products exported to the United States. At this quarry the rock is a white compact variety, showing some little anhydrite.

The following analyses are the results of samples taken from this section:—

——	I	II	III
	%	%	%
Lime	32·80	32·95	32·42
Magnesia	0·70	tr.	....
Ferric oxide and alumina	0·40	0·58	0·40
Sulphuric anhydride	44·28	44·03	46·56
Carbonic anhydride	1·91	2·46	....
Water, loss on ignition	19·72	20·00	20·80
Insoluble mineral matter	0·40	....	0·20
	100·21	100·02	100·38

No. I. Sample from the shore at Clarks head, soft white, with grey spots, semi-granular.

" II. Sample from old quarry, bluish-white, compact, Swan Creek.

" III. Sample from pink vein in the marl on shore, Swan Creek, Colchester Co.

OTHER DEPOSITS.

There are a few smaller deposits, in addition to the above described, occurring in Nova Scotia. They may be enumerated as follows:—

Deposit in Colchester county.—In a small lower Carboniferous area protruding through the Triassic sandstones on the Lynds property, at Debert, is an occurrence of a thin band of impure gypsum, associated with carbonate of lime. It is a dirty greyish colour, and has the following composition:—

	Per cent.
Lime	36·15
Magnesia	1·35
Ferric oxide and alumina	0·56
Sulphuric anhydride	22·60
Carbonic anhydride	18·67
Water, loss on ignition	11·10
Insoluble mineral matter	9·52
	99·95

West Advocate, Cumberland county.—Here, on the north shore of the Bay of Fundy, occurs an outcropping of gypsum below the high water mark.

Blomidon, Kings county.—In the marly beds that overlie the conglomerates near Pereau, and extending to Blomidon, occur many veins of selenite and fibrous gypsum, usually less than one foot in thickness and often coloured.

Indian point, Mahone bay, Lunenburg county.—At this point is a gypsiferous area of about one square mile, of the Windsor series. Gypsum is indicated by funnel-shaped depressions extending for over 3,000 feet across the area, and forming the road bed for the Halifax and Southwestern railway. It is possible that this deposit may develop a proposition of commercial value, as the natural facilities are good, and near both home and foreign markets.

Gypsum Deposits of New Brunswick and Magdalen Islands.

GYPSUM DEPOSITS OF NEW BRUNSWICK.

The occurrence of gypsum in New Brunswick, like that in Nova Scotia, is in the lower Carboniferous measures, and Dr. L. W. Bailey, in the Mineral Resources of New Brunswick, says: "They usually occupy a position at or near the summit of the group, and are generally in close connexion with beds of limestone, from which, in part at least, they may have been derived by alteration." But Dawson, in Acadian Geology, says: "They occur in all parts of the lower Carboniferous." With which view the writer concurs.

The principal deposits are seen in southern New Brunswick, in the counties of Kings, Albert, and Westmorland. In Kings, prominent outcrops are seen in the vicinity of Sussex and Upham; in Albert, near Hillsborough, Hopewell hill, and Demoiselle creek; and in Westmorland at Cape Merangouin and in the vicinity of Petitcodiac. In the northern part of New Brunswick gypsum is only known to occur at Plaster rock, on the Tobique river, Victoria county.

Again, like those of Nova Scotia, the deposits here present every variety of colour and texture, yet a much greater quantity of that white clear translucent variety known as alabaster exists, and it has been extensively operated in the vicinity of Hillsborough.

An index map, showing the location of the different deposits of New Brunswick, has been prepared to accompany this work, and with the following descriptions an attempt will be made to show as nearly as possible from superficial examination, the true value of each deposit, hoping that it will prove of value in the development of this important industry.

Plaster rock, Victoria county.

In the lower Carboniferous measures of the Tobique valley, very prominent and extensive deposits of impure gypsum occur in the cliffs of the Tobique river, and its tributary, the Wapskehegan.

These cliffs are very conspicuous in the bank of the Tobique, often rising 125 feet or more above the river bed. The impure gypsum occurs in practically horizontal beds, often interstratified with thin veins of pure, white, compact gypsum, with smaller quantities of selenite and fibrous varieties.

In colour it is reddish, sometimes mottled with grey, resembling somewhat the Triassic sandstone, and is coarsely granular in texture. It is unfit for the manufacture of the many products to which the other deposits of New Brunswick and Nova Scotia are so well adapted, but it is highly valued as a mineral fertilizer, and will be referred to in another chapter.

In the past, for many years considerable quantities of this rock have been removed and taken to Aroostook county in Maine, and used extensively in the cultivation of potatoes; and small quantities have also been used to advantage in the St. John River valley.

At present this deposit, having connexion with the Canadian Pacific railway, is operated by Messrs. Donald Fraser and Sons, and the product taken to Montreal by rail for use in the manufacture of cement.

The following analyses of the rock will serve to show its average composition:—

——	I	II
	%	%
Lime	27·92	28·95
Magnesia	1·96	tr.
Ferric oxide and alumina	2·72	9·80
Sulphuric anhydride	38·21	41·06
Carbonic anhydride	2·39	0·58
Water, loss on ignition	17·80	18·45
Insoluble mineral matter	8·86	1·18
	99·86	100·02

No. I. Sample of reddish grey rock, from face on Tobique river.
" II. Sample resembling Triassic sandstone, from top of deposit on Fraser's farm.

St. Martins, Kings, and St. John counties.

This area, which covers a large tract of country, is made particularly to show the location of the Hammond River gypsum deposits with reference to the St. Martins railway, which connects Quaco harbour, on the Bay of Fundy, with the Intercolonial railway at Hampton (distance 28 miles). They also cover a small area at Martins head.

The Hammond River gypsiferous area, consisting of 250 acres, although it is reported that a few hundred tons have been removed, has never been systematically operated, or even prospected, yet there is much evidence of a deposit of commercial importance.

The location of this area is in Upham parish, and crosses the railway about 11 miles from the Bay of Fundy terminus at Quaco. An outcrop of a very excellent snow-white gypsum occurs on the Hammond river, about one mile below the railway bridge. Other outcrops are observed at points 1½ and 2½ miles eastwardly from the railway. These are much more prominent exposures, and show white, compact gypsum, somewhat varied with the selenitic varieties.

If, on testing, this property should prove as good as the surface indicates, being so easily accessible to railway and comparatively near a shipping port, it would be a desirable location for a manufacturing industry for supplying either the home or foreign market.

The following analyses show the composition of average samples taken from this area:—

——	I	II
	%	%
Lime	32·40	32·61
Magnesia	tr.	tr.
Ferric oxide and alumina	0·10	0·34
Sulphuric anhydride	46·12	46·72
Carbonic anhydride	0·75	....
Water, loss on ignition	20·40	20·55
Insoluble mineral matter	0·06	0·12
	99·83	100·34

No. I. Snow-white, from Hammond River outcrop, near Upham.
" II. White, 2½ miles from Hammond River outcrop.

This area also shows a small isolated gypsiferous area, consisting of 40 acres situated at Martins head, on the Bay of Fundy coast, 21 miles north-east from Quaco. Here the gypsum shows much disturbance, and is in close contact with the older Pre-Cambrian rocks.

The outcrops are greyish-white in colour, and have associated with them heavy beds of marl, which carry veins of fibrous gypsum and irregular masses of much contorted gypsum; and although at tide waters, it is on an exposed coast, where it is difficult to provide protection for shipping, it cannot be considered of much commercial value.

Sussex valley, Kings and Westmorland counties.

On this sheet are shown four gypsiferous areas, known as Apohaqui, consisting of 313 acres; Mount Pisgah, 678·4 acres; Smith creek, 320 acres; and Petitcodiac, 454 acres. A great part of some of these areas is in low ground.

Beginning at the west, the Apohaqui area is the most important. The location is on high ground and the opportunities for development are good. On the farm of Col. Campbell prominent outcrops of gypsum occur, from 20 to 40 feet high. It is white and very compact, having the appearance of anhydrite at some points, but by analyses shows the requisite amount of water, and is suitable for all ordinary manufacturing requirements.

About 4 miles east of Sussex station, in the valley of Smith creek, other outcrops occur, but the greater part of the exposures are in low land, and show much anhydrite.

Again, on the east and skirting the Piccadilly mountains, considerable prominence is shown in pits and mounds, with a few exposures which are principally anhydrite.

The Petitcodiac area is situated about 2½ miles northwest of Petitcodiac station (I. C. R.), where the outcrops occur on Fawcetts brook and may be followed for about one mile. The gypsum is greyish-white in colour, and granular in texture. Much coarse selenite is mixed and associated with the gypsum in veins. For this reason the rock is not considered desirable for calcining, but is suitable for fertilizer or land plaster.

The following are the results of analyses from gypsum samples taken from the different deposits, as indicated below:—

——	I	II	III	IV
	%	%	%	%
Lime	32·86	32·16	31·98	32·48
Magnesia	....	tr.	tr.	tr.
Ferric oxide and alumina	0·24	0·03	0·23	0·14
Sulphuric anhydride	46·00	46·27	45·21	46·55
Carbonic anhydride	0·77	....	0·57	....
Water, loss on ignition	19·63	20·75	20·50	20·48
Insoluble mineral matter	0·34	0·46	1·20	0·32
	99·84	99·67	99·69	99·97

No. I. From Piccadilly: hard bluish rock with every appearance of anhydrite.
" II. From Mount Pisgah: closely associated with anhydrite.
" III. From Col. Campbell's: white, very compact.
" IV. From Petitcodiac: greyish-white, granular.

Hillsborough, Albert, and Westmorland counties.

At this place we reach the historic point of the gypsum industry of New Brunswick. Here for nearly a century the business of manufacturing and exporting the crude rock has been carried on under efficient management and with the most modern equipment of any place within the territory under consideration. This has had much to do with making it one of the leading industries in the Province.

In this part of New Brunswick the deposits of gypsum are more extensive and prominent than at any of the other points. They may be divided and known as Hillsborough, Demoiselle brook, Hopewell, and the Little Ridge deposits, running northwardly from Cape Enrage, in Albert County, and the Cape Maringouin area on the eastern side of Shepody bay. Of the Albert County deposits having the greatest purity, are those operated at Hillsborough and Demoiselle brook, consisting of a total area of 14 square miles. These gypsum deposits, and their operation, while of great economic importance, present favourable opportunities for studying the many interesting geological problems connected with their formation. The great variety and occurrence of both gypsum and anhydrite having various colours and textures, generally white and firmly compact, but sometimes grey, pink, and selenitic, occurring closely associated with anhydrite, gives much food for thought.

The rock is usually massive—although much of it has a stratified appearance, lying in horizontal beds of various thickness—showing little disturbance. Although the greater part of the rock is white and compact, in places where the gypsum is covered with an overburden of clay, a grey granular, often selenitic variety occurs near the surface, sometimes intermixed with selenitic crystals. Again, very occasionally veins occur cutting through the strata, having a folded or crumpled ribbon-like structure.

Dr. Bailey[1], who has made a special study of these deposits, gives the following description: "At several points on the northern edge of the outcrops considerable quantities of gypsum are found, being snow-white in colour, and varying in molecular structure, some if it being of exceedingly fine grain, and some quite coarse and sufficiently soft to be crushed between the fingers, with intermediate grades of fineness, but all grades equal in purity and colour.

[1]Mineral Resources of the Province of New Brunswick, p. 90.

"This part of the deposit is in masses, and not any in regular seams. With the pure white stone are intermixed veins of discoloured gypsum, of all shades of red, grey, and blue-grey. Most of these discoloured masses contain more or less grit, and when subjected to hydrochloric acid effervesce and show evidence of the presence of carbonate of lime. Occasionally seams of red marl-like stone fill the space betwen the seams and fissures in the gypsum. These are rarely in horizontal positions, but as a rule cut the face at varying angles, and occasionally are nearly perpendicular. This marl-like substance also contains carbonate of lime. Underlying the beds of pure white and mixed stone, as above described, masses of anhydrite are found; sometimes in thin layers only, and at other times in beds of such thickness that attempts to penetrate them have been given up as unprofitable, and work has been pursued elsewhere. Immediately under the white stone, and running into it without any perceptible break, are generally found beds of pure anhydrite, which at this time have no commercial value.

"Indications of pure, white stone, of this character, are visible at many points along the northern edge of the gypsum deposit, for a distance of about three-quarters of a mile. The surface indications of this gypsum belt extend in width for about half a mile, the belt running in a northeasterly and southwesterly course, the southern edge rising somewhat abruptly against a very steep hillside, which is supposed to consist largely of a reddish conglomerate that apparently forms the south wall against which the gypsum rests. Still higher up on the hillside, and on the summit, freestone boulders are seen, and a short distance below the summit a clean break and opening exposing the freestone is quite conspicuous. At this point, several natural trenches, parallel to each other, with walls of freestone, and about 20 or 30 feet apart, are exposed for a distance of several hundred yards, strongly suggesting the existence of a series of faults or downthrows. Thus, the gypsum area would seem to be bounded on two sides by marked dislocations converging westward at an angle of about 45°. Between the northerly and southerly edges of the gypsum formation are several small valleys, evidently the work of brooks which have cut their way through the gypsum and have created at some points small bays or openings that have caught and retained alluvial deposits, producing meadows or intervals, which are exceedingly fertile. At many points the gypsum has entirely disappeared, leaving only the anhydrite exposed. The main brook on the northerly side rises apparently at the west end of the gypsum deposit, and flows in an easterly direction, until it falls over a limestone bed, with a descent of about 8 feet, and at this point the conglomerate rock upon which the limestone rests is exposed, dipping towards the northwest at an angle of about 20 degrees, and rising rapidly to the south until it reaches the top of a hill about three-quarters of a mile distant, at an elevation of about 150 feet. At this point the limestone is exposed and plainly seen on the surface. It then dips slightly to the south, and again underlies a gypsum formation of from 50 to 60 feet in height. The conglomerate rock is also to be seen a little farther to the westward, on the slope of the hill as it descends towards the river. This exposed body of gypsum is very much broken and discoloured, and of so little value that, though much nearer a convenient point for shipment than the main quarries now in operation, it is not at present worked and is not considered a profitable field from which to draw a supply. Following the main brook already referred to, in a westerly direction, the wall of anhydrite extends the whole length of the gypsum deposit, though not unbroken."

Several quarries have been opened and operated in this section by the Albert Manufacturing Company, and much underground work is being carried on. The working face of these quarries varies from 25 or 30 feet to over 100 feet, and some parts are covered with a heavy overburden of clay, while others are quite free from it. Where the surface of the gypsum is free from clay covering, it is very uneven and full of depressions and blow holes, which extend downwards many feet. In some of the quarry faces anhydrite occurs in veins or bands, cutting across and through the quarry in very irregular forms, at times destroying the whole value of the quarry, but in some cases it has been worked through and the quarry redeemed. This is also true of the underground workings, where large rooms 40 feet or more in height have been worked out, usually having a floor of anhydrite. Attempts have been made to test the depth of this floor, but so far no satisfactory results have been obtained.

The Albert Manufacturing Company—as before mentioned—has been operating at this point more or less extensively for years, and has shipped its crude products, with few exceptions, to the Calvin Tomkins Company in New York. The quarries are connected by railway with the Company's shipping pier, and transportation to New York is usually done with steamers, which load only when the tide is out.

On the southern end of this area, at Demoiselle brook, the Wentworth Gypsum Company has been operating for a few years in a small way.

For about 15 years this Company has quarried from the surface, and shipped annually about 5,000 tons. Very similar conditions to those at Hillsborough were found; with perhaps the anhydrite more prevalent, hence the quarries were abandoned. In the latter part of 1908 this Company started underground operations, and was successful in developing an excellent deposit of snow-white, finely compact variety of gypsum.

From these underground workings the Company had mined at the end of 1909, 7,000 tons, which has been hauled over the Harvey and Salisbury railway to a shipping point at Hillsborough, a distance of 8 miles, whence it is forwarded to J. B. King and Company, at New York.

Sixteen miles south from Hillsborough, and about 2 miles west from the shore of Shepody bay, the next gypsiferous area occurs—known as Hopewell hill. The area contains 7·5 square miles, but principally concealed measures. The southern boundary is the Shepody river, and no further indications are seen, going south, until New Horton is reached, 28 miles south of Hillsborough, where a narrow gypsiferous area occurs, extending to the shore at Cape Enrage, but here, like at Hopewell hill, few outcrops occur, and the measures are only traceable by surface indications.

In Westmorland county, on the peninsula which divides Shepody bay from Cumberland basin and terminates in Cape Maringouin, occurs a gypsiferous area of 3·14 square miles. The gypsum occurs at Pink rock on the west side of the peninsula, and has a variety of colours, as white, grey, and pink, outcropping on the beach. It is both granular and compact in texture, and associated with it is seen lenticular masses of anhydrite, in some cases only part of the original mass being intact, thus giving it the appearance of a wedge. This deposit is controlled by a company subsidiary to the Albert Manufacturing Company, that has operated to a small extent; shipping the product to the United States.

The following analyses of samples from points indicated will serve to show the general average of the gypsum in this district:—

——	I	II	III	IV	V	VI	VII	VIII	IX	X
	%	%	%	%	%	%	%	%	%	%
Lime	32·92	32·72	33·28	33·00	33·00	32·60	33·00	32·92	32·04	36·69
Magnesia	....	....	....	....	....	....	....	....	tr.	....
Ferric oxide and alumina	0·60	1·80	....	0·40	....	tr.	....	....	0·18	0·18
Sulphuric anhydride	46·36	45·24	46·36	46·32	46·80	46·60	46·64	46·40	46·30	49·73
Carbonic anhydride	tr.	tr.	tr.	....	....	....	....	....	0·64	1·52
Water, loss on ignition	19·55	20·17	20·65	20·45	20·80	20·90	20·90	20·72	20·40	12·15
Insoluble mineral matter	0·40	0·80	tr.	....	tr.	....	....	....	....	tr.
	99·83	100·73	100·29	100·17	100·60	100·10	100·54	100·04	99·56	100·27

No. I. A very fine compact rock, dull white in colour, from the Albert Manufacturing Company, Hillsborough.
" II. A grey compact variety, from the same location as No. 1.
" III. Rock containing crystals of selenite, colour white, compact texture, from Hillsborough quarries.
" IV. Sample of banded dark grey and white gypsum, from Hillsborough quarries.
" V. Ordinary white rock, from Hillsborough quarries.
" VI. White alabaster, from Hillsborough quarries.
" VII. Pink alabaster, from Hillsborough quarries.
" VIII. Manufactured terra alba, from the Albert Manufacturing Company's mill at Hillsborough.
" IX. From Wentworth Gypsum Company's underground quarry at Hillsborough, snow-white, compact variety.
" X. Location same as No. 9, and similar in colour and texture.

GYPSUM DEPOSITS OF THE MAGDALEN ISLANDS.

Before entering on a particular description of the gypsum deposits, it is considered advisable to give a general description of the whole group as shown on the accompanying map.

Situation.—The Magdalen islands are situated about the middle of the Gulf of St. Lawrence, and are within the parallels of 47 degrees and 30 minutes and 47 degrees and 5 minutes north latitude, and between 61 degrees and 8 minutes and 62 degrees and 12 minutes west longitude, and at a distance of about 150 miles from the coast of Gaspe; 60 miles from Meat cove, Cape Breton, where they are connected by submarine cable with the mainland; and 120 miles from Pictou, Nova Scotia, from which port the mail steamer makes connexions twice each week during the open season on the Gulf of St. Lawrence.

Description.—There are ten distinct islands in the group, now designated on all charts, and in public documents, under the names of Entry, Amherst, Deadman, Grindstone, Alright, Wolfe, Grosse Isle, Coffin, and Brion, and the grant also included the Bird islands. Four of these, namely, Entry, Deadman, Brion, and the Bird islands, are isolated, having no connexion with each other, or with the principal group. The other six islands, namely, Grosse Isle, Coffin, Alright, Wolfe, Grindstone, and Amherst, comprised in the Letters Patent under the collective name of Magdalen islands, are united to each other by sand dunes, and in some places lagoons of considerable extent are formed by the sand dunes.

Harbours.—The principal harbours are Amherst, House harbour, and Grand Entry.

The steamer also calls at the breakwaters at Amherst and Grindstone, and the landing places at Alright island, Coffin island, and Etang du Nord.

By reference to the Admiralty Chart of these islands, it will be seen that these harbours are safe and sufficient for small draft vessels, and the recent addition to the breakwaters gives ample protection to all ordinary shipping.

Topography.—The low lands, which border the sea coast, present a uniform appearance, generally undulating or level. The centre of the islands is made up of numerous conical shaped hills, some as high as 580 feet above sea-level.

No rocks are observed protruding through the soil, which extends from the highest to the lowest levels, and every foot of land is available for cultivation, except a small part of the low lands, which are occupied by swamp.

These islands are not the barren, isolated spots conceived by some; but on the contrary, the best authorities assert that the soil of the Magdalen islands is well suited for agricultural purposes, and richer than that of Prince Edward Island, which is considered the Garden of the Gulf.

Inhabitants.—The population is about 7,000, principally of French descent. The exceptions are: Entry island, which is Scotch, and Coffin island, which is English. The people are of good moral character, cheerful, and industrious. The men are capable of enduring great fatigue, and unsurpassed as able seamen. They are expert as fishermen, which, with farming, is their principal occupation.

Roads.—The islands are furnished with good roads, well maintained, and good accommodation for driving can be secured at reasonable rates, at almost any point.

Gypsum Deposits.—It would be very much a repetition of what has already been said to deal at length with the geology of the deposits on these islands. They occur practically as those of Nova Scotia and New Brunswick, in the lower Carboniferous measures, and associated with the deposits of carbonate of lime. It might be said, that here they are in a closer position to the irruptive rocks—dolerite and diabase—which make up the many conical-shaped hills, and are the nucleus of the whole geological structure of the Magdalen islands; and many times they form the lower members of the lower Carboniferous group.

The most important deposits occur on Grindstone, Alright, Amherst, and Entry islands.

On Entry island the gypsiferous area, consisting of 208 acres, occurs on the south coast, near the lighthouse. It is well exposed on the seashore, in the immediate vicinity of the irruptive rocks, overlaid by heavy beds of marl, containing boulders of dark limestone and gypsum, with veins of the fibrous variety cutting through it in many directions.

Some of the fibrous gypsum is very pure and white. The gypsum is a soft granular variety, varying in colour from white to dark grey.

At Amherst it occurs in considerable dimensions in the same position with the older rocks, on the coast at Pleasant bay, east of Demoiselle hill, and has a total area of 720 acres. It extends inland almost to the southern coast, a distance of nearly $1\frac{1}{2}$ miles, and skirting the hill appears again on the coast west of Demoiselle. The deposits are well exposed on the coast and are traceable inland by deep depressions or sinkholes. Some of these depressions are an acre or more in area, and from 40 to 50 feet deep. In the larger of these the gypsum may be observed. The rock is a white compact variety, with parts of it showing red streaks.

An area of similar appearance, consisting of about 400 acres, occurs on the northwest of this island, extending from Southwest cape to West point. The gypsum here outcrops on the coast, and has associated with it marls carrying fibrous gypsum.

Grindstone island has the largest area (5·20 square miles) and most prominent exposures of all the islands. It occurs on the sea coast a short distance north of Cape Meule, in high cliffs of marl and limestone and extending northwardly $1\frac{1}{2}$ miles, where it again outcrops on the Arseneau property with considerable prominence. It has a dark dirty grey colour, and a large portion of it has a granular texture. From the shore it can be traced westwardly, following the contour of the hills, by outcrops and depressions, to Etang du Nord, where it outcrops on lot 184, in a prominent ridge, and also on the adjoining lot, in a depression which forms a pond of water, and where cliffs may be seen on one side from 40 to 60 feet high. Again, about midway between the coast and Etang du Nord, on vacant lands, more outcrops are observed. The rock presents many varieties both of colour and texture, as will be noted below in the table of analyses.

Again, skirting the irruptive cliffs near Cape Alright on Alright island, another very similar gypsiferous area is seen. The high cliffs at this point are only the remnants of one or more irruptive hills, that form the base of the gypsum deposits, and, therefore, the exposures of gypsum on the sea coast are not extensive. Inland, however, the same conditions are observed, and outcrops are seen in several places on the higher grounds, and where the depressions have left the gypsum exposed. This area extends westwardly across the island to Little bay, but here the land is low and the gypsum concealed.

Many years ago a few small cargoes of gypsum were taken from these islands to the Quebec market, but owing to the indiscretion of the operators in making a selection of the rock, the results were not satisfactory. Since that time no attempts have been made to develop or even test these deposits, which showed much evidence of the existence of a good variety of gypsum, and no evidence of the occurrence of anhydrite.

The deposits are not as prominent nor as extensive as many of those of Nova Scotia and New Brunswick, yet with their vantage-point for the Canadian market they should be considered among those having considerable commercial value.

The following are the results of analyses taken from the different deposits:—

——	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
	%	%	%	%	%	%	%	%	%	%	%
Lime	32·61	30·50	32·73	32·70	32·63	32·30	32·93	31·98	32·29	32·49	32·67
Magnesia	tr.	0·25	tr.	tr.	....	0·46	tr.	0·59	0·40	....	tr.
Ferric oxide and alumina	0·10	1·36	0·20	0·20	0·16	0·82	0·24	0·46	0·41	0·18	0·12
Sulphuric anhydride	46·37	43·94	45·38	45·51	45·72	44·69	44·93	46·16	44·86	46·41	46·03
Carbonic anhydride	....	0·27	0·79	1·20	0·57	1·33	0·86	....	1·23	tr.	....
Water, loss on ignition	20·60	19·75	20·50	20·30	20·25	20·35	20·00	20·10	20·00	20·35	20·82
Insoluble mineral matter	0·20	3·62	0·10	0·10	0·36	0·30	0·60	0·80	1·12	0·12	0·32
	99·88	99·69	99·70	100·01	99·69	100·25	99·56	100·09	100·31	99·55	99·96

No. I. From lot No. 100, Alright island: a very pure white compact rock.

" II. Fibrous gypsum associated with the gypsum, Alright island.

" III. From lot No. 184, Etang du Nord, has rather a slaty structure, with a greyish white colour.

" IV. White compact gypsum taken from an exposure in the wall of a sink hole or depression at Etang du Nord, near Lot No. 184.

" V. Sample of pink rock associated with the marls in cliffs near Cape Meule, Grindstone island.

" VI. A dirty greyish granular rock from Arseneau lot, Grindstone island.

" VII. An average sample taken from vacant lands on Grindstone island, greyish white, with compact texture.

" VIII. A dark bluish rock from Ryan cove, Grindstone island.

" IX. Dark greyish with selenitic crystals, occurring on the shore near Cape Meule.

" X. Fibrous gypsum from Entry island.

" XI. White compact gypsum, with some streaks of red, occurring on the shores near Demoiselle hill, Amherst island.

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CANADA
DEPARTMENT OF MINES

HON. LOUIS CODERRE, MINISTER; R. W. BROCK, DEPUTY MINISTER;

MINES BRANCH

EUGENE HAANEL, PH.D., DIRECTOR.

REPORTS AND MAPS

PUBLISHED BY THE

MINES BRANCH.

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†10. Mica: Its Occurrence, Exploitation, and Uses—by Fritz Cirkel, M.E., 1905. (See No. 118).

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†12. Zinc Resources of British Columbia and the Conditions affecting their Exploitation. Report of the Commission appointed to investigate—by W. R. Ingalls, 1905.

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* A few copies of the Preliminary Report, 1906, are still available.
† Publications marked thus † are out of print.

†21. Summary Report of Mines Branch, 1907–8.

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†23. Iron Ore Deposits along the Ottawa (Quebec side) and Gatineau rivers. Report on—by Fritz Cirkel.

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†55. Report on the Bituminous, or Oil-shales of New Brunswick and Nova Scotia; also on the Oil-shale industry of Scotland—by Dr. R. W. Ells.

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N ote.—*The following preliminary bulletins were published prior to the issuance of the Annual Report for 1907–8.*

- †31. Production of Cement in Canada, 1908.
- 42. Production of Iron and Steel in Canada during the Calendar Years 1907 and 1908.
- 43. Production of Chromite in Canada during the Calendar Years 1907 and 1908.
- 44. Production of Asbestos in Canada during the Calendar Years 1907 and 1908.
- †45. Production of Coal, Coke, and Peat in Canada during the Calendar Years 1907 and 1908.
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59. Chemical Analyses of Special Economic Importance made in the Laboratories of the Department of Mines, 1906–7–8. Report on—by F. G. Wait, M.A., F.C.S. (With Appendix on the Commercial Methods and Apparatus for the Analysis of Oil-shales—by H. A. Leverin, Ch.E.).

Schedule of Charges for Chemical Analyses and Assays.

†62. Mineral Production of Canada, 1909. Preliminary Report on—by John McLeish.

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67. Iron Ore Deposits of the Bristol Mine, Pontiac County, Quebec. Bulletin No. 2—by Einar Lindeman and Geo. C. Mackenzie, B.Sc.

†68. Recent Advances in the Construction of Electric Furnaces for the Production of Pig Iron, Steel, and Zinc. Bulletin No. 3—by Dr. Haanel.

69. Chrysotile-Asbestos: Its Occurrence, Exploitation, Milling, and Uses. Report on—by Fritz Cirkel. (Second Edition, enlarged.)

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† Publications marked thus † are out of print.

†71. Investigation of the Peat Bogs and Peat Industry of Canada, 1909–10; to which is appended Mr. Alf. Larson's Paper on Dr. M. Ekenberg's Wet-Carbonizing Process; from Teknisk Tidskrift, No. 12, December 26, 1908—translation by Mr. A. v. Anrep, Jr.; also a translation of Lieut. Ekelund's Pamphlet entitled 'A Solution of the Peat Problem,' 1909, describing the Ekelund Process for the Manufacture of Peat Powder, by Harold A. Leverin, Ch.E. Bulletin No. 4—by A. v. Anrep (Second Edition, enlarged).

81. French Translation: Chrysotile-Asbestos: Its Occurrence, Exploitation, Milling, and Uses. Report on—by Fritz Cirkel.

82. Magnetic Concentration Experiments. Bulletin No. 5—by Geo. C. Mackenzie.

83. An investigation of the Coals of Canada with reference to their Economic Qualities: as conducted at McGill University under the authority of the Dominion Government. Report on—by J. B. Porter, E.M., D.Sc., R. J. Durley, Ma.E., and others—
 Vol. I—Coal Washing and Coking Tests.
 Vol. II—Boiler and Gas Producer Tests.
 Vol. III—
  Appendix I
   Coal Washing Tests and Diagrams.
 Vol. IV—
  Appendix II
   Boiler Tests and Diagrams.
 Vol. V—
  Appendix III
   Producer Tests and Diagrams.
 Vol. VI—
  Appendix IV
   Coking Tests.
  Appendix V
   Chemical Tests.

†84. Gypsum Deposits of the Maritime Provinces of Canada—including the Magdalen Islands. Report on—by W. F. Jennison, M.E. (See No. 245.)

88. The Mineral Production of Canada, 1909. Annual Report on—by John McLeish.

NOTE.—*The following preliminary bulletins were published prior to the issuance of the Annual Report for 1909.*

†79. Production of Iron and Steel in Canada during the Calendar Year 1909.

†80. Production of Coal and Coke in Canada during the Calendar Year 1909.

85. Production of Cement, Lime, Clay Products, Stone, and other Structural Materials during the Calendar Year 1909.

89. Reprint of Presidential address delivered before the American Peat Society at Ottawa, July 25, 1910. By Dr. Haanel.

90. Proceedings of Conference on Explosives.

92. Investigation of the Explosives Industry in the Dominion of Canada, 1910. Report on—by Capt. Arthur Desborough. (Second Edition.)

93. Molybdenum Ores of Canada. Report on—by Professor T. L. Walker, Ph.D.

100. The Building and Ornamental Stones of Canada. Report on—by Professor W. A. Parks, Ph.D.

100a. French translation: The Building and Ornamental Stones of Canada. Report on—by W. A. Parks.

102. Mineral Production of Canada, 1910. Preliminary Report on—by John McLeish.

†103. Summary Report of Mines Branch, 1910.

104. Catalogue of Publications of Mines Branch, from 1902 to 1911; containing Tables of Contents and List of Maps, etc.

105. Austin Brook Iron-bearing district, Report on—by E. Lindeman.

110. Western Portion of Torbrook Iron Ore Deposits, Annapolis county, N.S. Bulletin No. 7—by Howells Fréchette, M.Sc.

111. Diamond Drilling at Point Mamainse, Ont. Bulletin No. 6—by A. C. Lane, Ph.D., with Introductory by A. W. G. Wilson, Ph.D.

† Publications marked thus † are out of print.

118. Mica: Its Occurrence, Exploitation, and Uses. Report on—by Hugh S. de Schmid, M.E.

142. Summary Report of Mines Branch, 1911.

143. The Mineral Production of Canada, 1910. Annual Report on—by John McLeish.

Note.—*The following preliminary Bulletins were published prior to the issuance of the Annual Report for 1910.*

†114. Production of Cement, Lime, Clay Products, Stone, and other Structural Materials in Canada, 1910.

†115. Production of Iron and Steel in Canada during the Calendar Year 1910.

†116. Production of Coal and Coke in Canada during the Calendar Year 1910.

†117. General Summary of the Mineral Production of Canada during the Calendar Year 1910.

145. Magnetic Iron Sands of Natashkwan, Saguenay county, Que. Report on—by Geo. C. Mackenzie.

†150. The Mineral Production of Canada, 1911. Preliminary Report on—by John McLeish.

151. Investigation of the Peat Bogs and Peat Industry of Canada, 1910–11. Bulletin No. 8—by A. v. Anrep.

154. The Utilization of Peat Fuel for the Production of Power, being a record of experiments conducted at the Fuel Testing Station, Ottawa, 1910–11. Report on—by B. F. Haanel, B.Sc.

155. French translation: The Utilization of Peat Fuel for the Production of Power, being a Record of Experiments conducted at the Fuel Testing Station, Ottawa, 1910–11. Report on—by B. F. Haanel.

156. French translation: The Tungsten Ores of Canada. Report on—by Dr. T. L. Walker.

167. Pyrites in Canada: Its Occurrence, Exploitation, Dressing, and Uses. Report on—by A. W. G. Wilson.

170. The Nickel Industry: with Special Reference to the Sudbury region, Ont. Report on—by Professor A. P. Coleman, Ph.D.

184. Magnetite Occurrences along the Central Ontario Railway. Report on—by E. Lindeman.

196. French translation: Investigation of the Peat Bogs and Peat Industry of Canada, 1909–10; to which is appended Mr. Alf. Larson's paper on Dr. M. Ekenburg's Wet-Carbonizing Process: from Teknisk Tidskrift, No. 12, December 26, 1908—translation by Mr. A. v. Anrep; also a translation of Lieut. Ekelund's Pamphlet entitled "A Solution of the Peat Problem," 1909, describing the Ekelund Process for the Manufacture of Peat Powder, by Harold A. Leverin, Ch.E. Bulletin No. 4—by A. v. Anrep. (Second Edition, enlarged.)

197. French translation: Molybdenum Ores of Canada. Report on—by Dr. T. L. Walker.

198. French translation: Peat and Lignite: Their Manufacture and Uses in Europe—by Erik Nystrom, M.E., 1908.

201. The Mineral Production of Canada during the Calendar Year 1911. Annual Report on—by John McLeish.

Note.—*The following preliminary Bulletins were published prior to the issuance of the Annual Report for 1911.*

181. Production of Cement, Lime, Clay Products, Stone, and other Structural Materials in Canada during the Calendar Year 1911. Bulletin on—by John McLeish.

†182. Production of Iron and Steel in Canada during the Calendar Year 1911. Bulletin on—by John McLeish.

183. General Summary of the Mineral Production in Canada during the Calendar Year 1911. Bulletin on—by John McLeish.

199. Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and other Metals of Canada, during the Calendar Year 1911. Bulletin on—by John McLeish.

† Publications marked thus † are out of print.

200. The production of Coal and Coke in Canada during the Calendar Year 1911. Bulletin on—by John McLeish.

202. French translation: Graphite: Its Properties, Occurrence, Refining, and Uses—by Fritz Cirkel, 1907.

216. Mineral Production of Canada, 1912. Preliminary Report on—by John McLeish.

224. Summary Report of the Mines Branch, 1912.

226. French translation: Chrome Iron Ore Deposits of the Eastern Townships. Monograph on—by Fritz Cirkel. (Supplementary Section: Experiments with Chromite at McGill University—by Dr. J. B. Porter.)

227. Sections of the Sydney Coal Fields—by J. G. S. Hudson.

†229. Summary Report of the Petroleum and Natural Gas Resources of Canada, 1912—by F. G. Clapp. (See No. 224.)

230. Economic Minerals and the Mining Industry of Canada.

231. French translation: Economic Minerals and the Mining Industry of Canada.

233. French translation: Gypsum Deposits of the Maritime Provinces of Canada—including the Magdalen Islands. Report on—by W. F. Jennison.

245. Gypsum in Canada: Its Occurrence, Exploitation, and Technology. Report on—by L. H. Cole.

259. Preparation of Metallic Cobalt by Reduction of the Oxide. Report on—by H. T. Kalmus, B.Sc., Ph.D.

262. The Mineral Production of Canada during the Calendar Year 1912. Annual Report on—by John McLeish.

NOTE.—*The following preliminary Bulletins were published prior to the issuance of the Annual Report for 1912.*

238. General Summary of the Mineral Production of Canada, during the Calendar Year 1912. Bulletin on—by John McLeish.

247. Production of Iron and Steel in Canada during the Calendar Year 1912. Bulletin on—by John McLeish.

256. Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and other Metals of Canada, during the Calendar Year 1912—by C. T. Cartwright, B.Sc.

257. Production of Cement, Lime, Clay Products, Stone, and other Structural Materials during the Calendar Year 1912. Report on—by John McLeish.

258. Production of Coal and Coke in Canada, during the Calendar Year 1912. Bulletin on—by John McLeish.

NOTE.—*Lists of manufacturers of clay products, stone quarry operators, and operators of lime-kilns, are prepared annually by the Division of Mineral Resources and Statistics, and copies may be had on application.*

IN THE PRESS

56. French translation: Bituminous or Oil-shales of New Brunswick and Nova Scotia: also on the Oil-shale Industry of Scotland—by R. W. Ells.

149. French translation: Magnetic Iron Sands of Natashkwan, Saguenay county, Que. Report on—by Geo. C. Mackenzie.

169. French translation: Pyrites in Canada: Its Occurrence, Exploitation, Dressing, and Uses. Report on—by A. W. G. Wilson.

180. French translation: Investigation of the Peat Bogs, and Peat Industry of Canada, 1910–11. Bulletin No. 8—by A. v. Anrep.

195. French translation: Magnetite Occurrences along the Central Ontario Railway. Report on—by E. Lindeman.

203. Building Stones of Canada—Vol. II: Building and Ornamental Stones of the Maritime Provinces. Report on—by W. A. Parks.

209. The Copper Smelting Industry of Canada. Report on—by A. W. G. Wilson.

† Publications marked thus † are out of print.

222. Lode Mining in Yukon: An Investigation of the Quartz Deposits of the Klondike Division. Report on—by T. A. MacLean.

254. Calabogie Iron-Bearing District. Report on—by E. Lindeman.

263. French translation: Recent Advances in the Construction of Electric Furnaces for the Production of Pig Iron, Steel, and Zinc. Bulletin No. 3—by Dr. Haanel.

264. French translation: Mica: Its Occurrence, Exploitation, and Uses. Report on—by Hugh S. de Schmid.

265. French translation: Annual Mineral Production of Canada, 1911. Report on—by John McLeish.

266. On the Investigation of Peat Bogs and Peat Industry of Canada, 1911 and 1912. Bulletin No. 9—by A. v. Anrep.

279. On the Building and Ornamental Stones of Canada: Vol. III. Report on—by W. A. Parks.

287. French translation: Production of Iron and Steel in Canada during the Calendar Year 1912. Bulletin on—by John McLeish.

288. French translation: Production of Coal and Coke in Canada, during the Calendar Year 1912. Bulletin on—by John McLeish.

289. French translation: Production of Cement, Lime, Clay Products, Stone, and Other Structural Materials during the Calendar Year 1912. Bulletin on—by John McLeish.

290. French translation: Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and Other Metals of Canada, during the Calendar Year 1912. Bulletin on—by C. T. Cartwright.

291. On the Petroleum and Natural Gas Resources of Canada. Report on—by F. G. Clapp and Others.

299. Peat, Lignite, and Coal: Their Value as Fuels for the Production of Gas and Power in the By-product Recovery Producer. Report on—by B. F. Haanel.

MAPS.

†6. Magnetometric Survey, Vertical Intensity: Calabogie Mine, Bagot township, Renfrew county, Ontario—by E. Nystrom, 1904. Scale 60 feet=1 inch. Summary report, 1905. (See Map No. 249.)

†13. Magnetometric Survey of the Belmont Iron Mines, Belmont township, Peterborough county, Ontario—by B. F. Haanel, 1905. Scale 60 feet=1 inch. Summary report, 1905. (See Map No. 186.)

†14. Magnetometric Survey of the Wilbur Mine, Lavant township, Lanark county, Ontario—by B. F. Haanel, 1905. Scale 60 feet=1 inch. Summary report, 1905.

†33. Magnetometric Survey, Vertical Intensity: Lot 1, Concession VI, Mayo township, Hastings county, Ontario—by Howells Fréchette, 1909. Scale 60 feet=1 inch.

†34. Magnetometric Survey, Vertical Intensity: Lots 2 and 3, Concession VI, Mayo township, Hastings county, Ontario—by Howells Fréchette, 1909. Scale 60 feet=1 inch.

†35. Magnetometric Survey, Vertical Intensity: Lots 10, 11, and 12, Concession IX, and Lots 11 and 12, Concession VIII, Mayo township, Hastings county, Ontario—by Howells Fréchette, 1909. Scale 60 feet=1 inch.

*36. Survey of Mer Bleue Peat Bog, Gloucester township, Carleton county, and Cumberland township, Russell county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

*37. Survey of Alfred Peat Bog, Alfred and Caledonia townships, Prescott county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

*38. Survey of Welland Peat Bog, Wainfleet and Humberstone townships, Welland county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

*39. Survey of Newington Peat Bog, Osnabruck, Roxborough, and Cornwall townships, Stormont county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

NOTE.—1. Maps marked thus * are to be found only in reports.
2. Maps marked thus † have been printed independently of reports, hence can be procured separately by applicants.

*40. Survey of Perth Peat Bog, Drummond township, Lanark county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

*41. Survey of Victoria Road Peat Bog, Bexley and Carden townships, Victoria county, Ontario—by Erik Nystrom and A. v. Anrep. (Accompanying report No. 30.)

*48. Magnetometric Survey of Iron Crown claim at Klaanch river, Vancouver island, B.C.—by E. Lindeman. Scale 60 feet=1 inch. (Accompanying report No. 47.)

*49. Magnetometric Survey of Western Steel Iron claim, at Sechart, Vancouver island, B.C.—by E. Lindeman. Scale 60 feet=1 inch. (Accompanying report No. 47.)

*53. Iron Ore Occurrences, Ottawa and Pontiac counties, Quebec, 1908—by J. White and Fritz Cirkel. (Accompanying report No. 23.)

*54. Iron Ore Occurrences, Argenteuil county, Quebec, 1908—by Fritz Cirkel. (Accompanying report No. 23.)

†57. The Productive Chrome Iron Ore District of Quebec—by Fritz Cirkel. (Accompanying report No. 29.)

†60. Magnetometric Survey of the Bristol Mine, Pontiac county, Quebec—by E. Lindeman. Scale 200 feet=1 inch. (Accompanying report No. 67.)

*61. Topographical Map of Bristol Mine, Pontiac county, Quebec—by E. Lindeman. Scale 200 feet=1 inch. (Accompanying report No. 67.)

†64. Index Map of Nova Scotia: Gypsum—by W. F. Jennison

†65. Index Map of New Brunswick: Gypsum—by W. F. Jennison

†66. Map of Magdalen Islands: Gypsum—by W. F. Jennison

(Accompanying report No. 84.)

†70. Magnetometric Survey of Northeast Arm Iron Range, Lake Timagami, Nipissing district, Ontario—by E. Lindeman. Scale 200 feet=1 inch. (Accompanying report No. 63.)

†72. Brunner Peat Bog, Ontario—by A. v. Anrep

†73. Komoka Peat Bog, Ontario—by A. v. Anrep

†74. Brockville Peat Bog, Ontario—by A. v. Anrep

(Accompanying report No. 71.)

†75. Rondeau Peat Bog, Ontario—by A. v. Anrep.

†76. Alfred Peat Bog, Ontario—by A. v. Anrep.

†77. Alfred Peat Bog, Ontario: Main Ditch profile—by A. v. Anrep.

(Accompanying report No. 71.)

†78. Map of Asbestos Region, Province of Quebec, 1910—by Fritz Cirkel. Scale 1 mile=1 inch. (Accompanying report No. 69.)

†94. Map showing Cobalt, Gowganda, Shiningtree, and Porcupine districts—by L. H. Cole, B.Sc. (Accompanying Summary report, 1910.)

*95. General Map of Canada, showing Coal Fields. (Accompanying report No. 83—by Dr. J. B. Porter.)

*96. General Map of Coal Fields of Nova Scotia and New Brunswick. (Accompanying report No. 83—by Dr. J. B. Porter.)

*97. General Map showing Coal Fields in Alberta, Saskatchewan, and Manitoba. (Accompanying report No. 83—by Dr. J. B. Porter.)

*98. General Map of Coal Fields in British Columbia. (Accompanying report No. 83—by Dr. J. B. Porter.)

*99. General Map of Coal Field in Yukon Territory. (Accompanying report No. 83—by Dr. J. B. Porter.)

†106. Geological Map of Austin Brook Iron Bearing distric 1 Bathurst township, Gloucester county, N.B.—by E. Lindeman. Scale 400 feet=1 inch. (Accompanying report No. 105.)

†107. Magnetometric Survey, Vertical Intensity: Austin Brook Iron Bearing district—by E. Lindeman. Scale 400 feet=1 inch. (Accompanying report No. 105.)

NOTE.—1. Maps marked thus * are to be found only in reports.
2. Maps marked thus † have been printed independently of reports, hence can be procured separately by applicants.

*108. Index Map showing Iron Bearing Area at Austin Brook—by E. Lindeman. (Accompanying report No. 105.)

*112. Sketch plan showing Geology of Point Mamainse, Ont.—by Professor A. C. Lane. Scale 4,000 feet = 1 inch. (Accompanying report No. 111.)

*113. Holland Peat Bog, Ontario—by A. v. Anrep. (Accompanying report No. 151.)

*119–137. Mica: Township maps, Ontario and Quebec—by Hugh S. de Schmid. (Accompanying report No. 118.)

†138. Mica: Showing location of Principal Mines and Occurrences in the Quebec Mica Area—by Hugh S. de Schmid. Scale 3·95 miles = 1 inch. (Accompanying report No. 118.)

*139. Mica: Showing Location of Principal Mines and Occurrences in the Ontario Mica Area—by Hugh S. de Schmid. Scale 3·95 miles = 1 inch. (Accompanying report No. 118.)

†140. Mica: Showing Distribution of the Principal Mica Occurrences in the Dominion of Canada—by Hugh S. de Schmid. Scale 3·95 miles = 1 inch. (Accompanying report No. 118.)

†141. Torbrook Iron Bearing District, Annapolis county, N.S.—by Howells Fréchette. Scale 400 feet = 1 inch. (Accompanying report No. 110.)

†146. Distribution of Iron Ore Sands of the Iron Ore Deposits on the North Shore of the River and Gulf of St. Lawrence, Canada—by Geo. C. Mackenzie. Scale 100 miles = 1 inch. (Accompanying report No. 145.)

†147. Magnetic Iron Sand Deposits in Relation to Natashkwan harbour and Great Natashkwan river, Que. (Index Map)—by Geo. C. Mackenzie. Scale 40 chains = 1 inch. (Accompanying report No. 145.)

†148. Natashkwan Magnetic Iron Sand Deposits, Saguenay county, Que.—by Geo. C. Mackenzie. Scale, 1,000 feet = 1 inch. (Accompanying report No. 145.)

†152. Map showing the Location of Peat Bogs investigated in Ontario—by A. v. Anrep.

†153. Map showing the Location of Peat Bogs investigated in Manitoba—by A. v. Anrep.

†157. Lac du Bonnet Peat Bog, Manitoba—by A. v. Anrep.

†158. Transmission Peat Bog, Manitoba—by A. v. Anrep.

†159. Corduroy Peat Bog, Manitoba—by A. v. Anrep.

†160. Boggy Creek Peat Bog, Manitoba—by A. v. Anrep.

†161. Rice Lake Peat Bog, Manitoba—by A. v. Anrep.

†162. Mud Lake Peat Bog, Manitoba—by A. v. Anrep.

†163. Litter Peat Bog, Manitoba—by A. v. Anrep.

(Accompanying report No. 151.)

†164. Julius Peat Litter Bog, Manitoba—by A. v. Anrep.

†165. Fort Francis Peat Bog, Ontario—by A. v. Anrep.

(Accompanying report No. 151.)

*166. Magnetometric Map of No. 3 Mine, Lot 7, Concessions V and VI, McKim township, Sudbury district, Ont.—by E. Lindeman. (Accompanying Summary report, 1911.)

†168. Map showing Pyrites Mines and Prospects in Eastern Canada, and Their Relation to the United States Market—by A. W. G. Wilson. Scale 125 miles = 1 inch. (Accompanying report No. 167.)

†171. Geological Map of Sudbury Nickel region, Ont.—by Prof. A. P. Coleman. Scale 1 mile = 1 inch. (Accompanying report No. 170.)

†172. Geological Map of Victoria Mine—by Prof. A .P. Coleman

†173. " " Crean Hill Mine—by Prof. A. P. Coleman.

†174. " " Creighton Mine—by Prof. A. P. Coleman.

(Accompanying report No. 170.)

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†194. Magnetometric Survey, Vertical Intensity: Bow Lake iron ore occurrences, Faraday township, Hastings county, Ontario—by E. Lindeman, 1911. Scale 200 feet=1 inch. (Accompanying report No. 184.)

†204. Index Map, Magnetite occurrences along the Central Ontario Railway—by E. Lindeman, 1911. (Accompanying report No. 184.)

†205. Magnetometric Map, Moose Mountain iron-bearing district, Sudbury district, Ontario: Deposits Nos. 1, 2, 3, 4, 5, 6, and 7—by E. Lindeman, 1912. (Accompanying report No. 266.)

†205a. Geological Map, Moose Mountain iron-bearing district, Sudbury district, Ontario. Deposits Nos. 1, 2, 3, 4, 5, 6, and 7—by E. Lindeman. (Accompanying report No. 266.)

†206. Magnetometric Survey of Moose Mountain iron-bearing district, Sudbury district, Ontario: Northern part of Deposit No. 2—by E. Lindeman, 1912. Scale 200 feet= 1 inch. (Accompanying report No. 266.)

†207. Magnetometric Survey of Moose Mountain iron-bearing district, Sudbury district, Ontario: Deposits Nos. 8, 9, and 9A—by E. Lindeman, 1912. Scale 200 feet=1 inch. (Accompanying report No. 266.)

†208. Magnetometric Survey of Moose Mountain iron-bearing district, Sudbury district, Ontario: Deposit No. 10—by E. Lindeman, 1912. Scale 200 feet=1 inch. (Accompanying report No. 266.)

†208a. Magnetometric Survey, Moose Mountain iron-bearing district, Sudbury district, Ontario: Eastern portion of Deposit No. 11—by E. Lindeman, 1912. Scale, 200 feet=1 inch. (Accompanying report No. 266.)

†208b. Magnetometric Survey, Moose Mountain iron-bearing district, Sudbury district, Ontario: Western portion of Deposit No. 11—by E. Lindeman, 1912. Scale 200 feet=1 inch. (Accompanying report No. 266.)

†208c. General Geological Map, Moose Mountain iron-bearing district, Sudbury district, Ontario—by E. Lindeman, 1912. Scale, 800 feet=1 inch. (Accompanying report No. 266.)

†210. Location of Copper Smelters in Canada—by A. W. G. Wilson, Ph.D. Scale 193·7 miles= 1 inch. (Accompanying report No. 209.)

*215. Province of Alberta: Showing properties from which samples of coal were taken for gas producer tests, Fuel Testing Division, Ottawa. (Accompanying Summary report, 1912.)

†220. Mining Districts, Yukon—by T. A. MacLean. Scale 35 miles=1 inch. (Accompanying report No. 222.)

†221. Dawson Mining District, Yukon—by T. A. MacLean. Scale 2 miles = 1 inch. (Accompanying report No. 222.)

*228. Index Map of the Sydney coal fields, Cape Breton, N.S. (Accompanying report No. 227.)

†232. Mineral Map of Canada. Scale 100 miles=1 inch. (Accompanying report No. 230.)

†249. Magnetometric Survey, Caldwell and Campbell mines, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet=1 inch. (Accompanying report No. 254.)

†250. Magnetometric Survey, Black Bay or Williams Mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale, 200 feet=1 inch. (Accompanying report No. 254.)

†251. Magnetometric Survey, Bluff Point iron mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet=1 inch. (Accompanying report No. 254.)

†252. Magnetometric Survey, Culhane mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet=1 inch. (Accompanying report No. 264.)

†253. Magnetometric Survey, Martel or Wilson iron mine, Calabogie district, Renfrew county, Ontario—by E. Lindeman, 1911. Scale 200 feet=1 inch. (Accompanying report No. 254.)

Note.—1. Maps marked thus * are to be found only in reports.
2. Maps marked thus † have been printed independently of reports, hence can be procured separately by applicants.

†261. Magnetometric Survey, Northeast Arm iron range, Lot 339 E.T.W. Lake Timagami, Nipissing district, Ontario—by E. Nystrom, 1903. Scale 200 feet = 1 inch.

IN THE PRESS

268. Map of Peat Bogs Investigated in Quebec—by A. v. Anrep, 1912.

269. Large Tea Field Peat Bog, Quebec " "

270. Small Tea Field Peat Bog, Quebec " "

271. Lanoraie Peat Bog, Quebec " "

272. St. Hyacinthe Peat Bog, Quebec " "

273. Rivière du Loup Peat Bog " "

274. Cacouna Peat Bog " "

275. Le Parc Peat Bog, Quebec " "

276. St. Denis Peat Bog, Quebec " "

277. Rivière Ouelle Peat Bog, Quebec " "

278. Moose Mountain Peat Bog, Quebec " "

Address all communications to—

DIRECTOR MINES BRANCH,
DEPARTMENT OF MINES,
SUSSEX STREET, OTTAWA.

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