DIATOMITE

BY

V.L. EARDLEY-WILMOT

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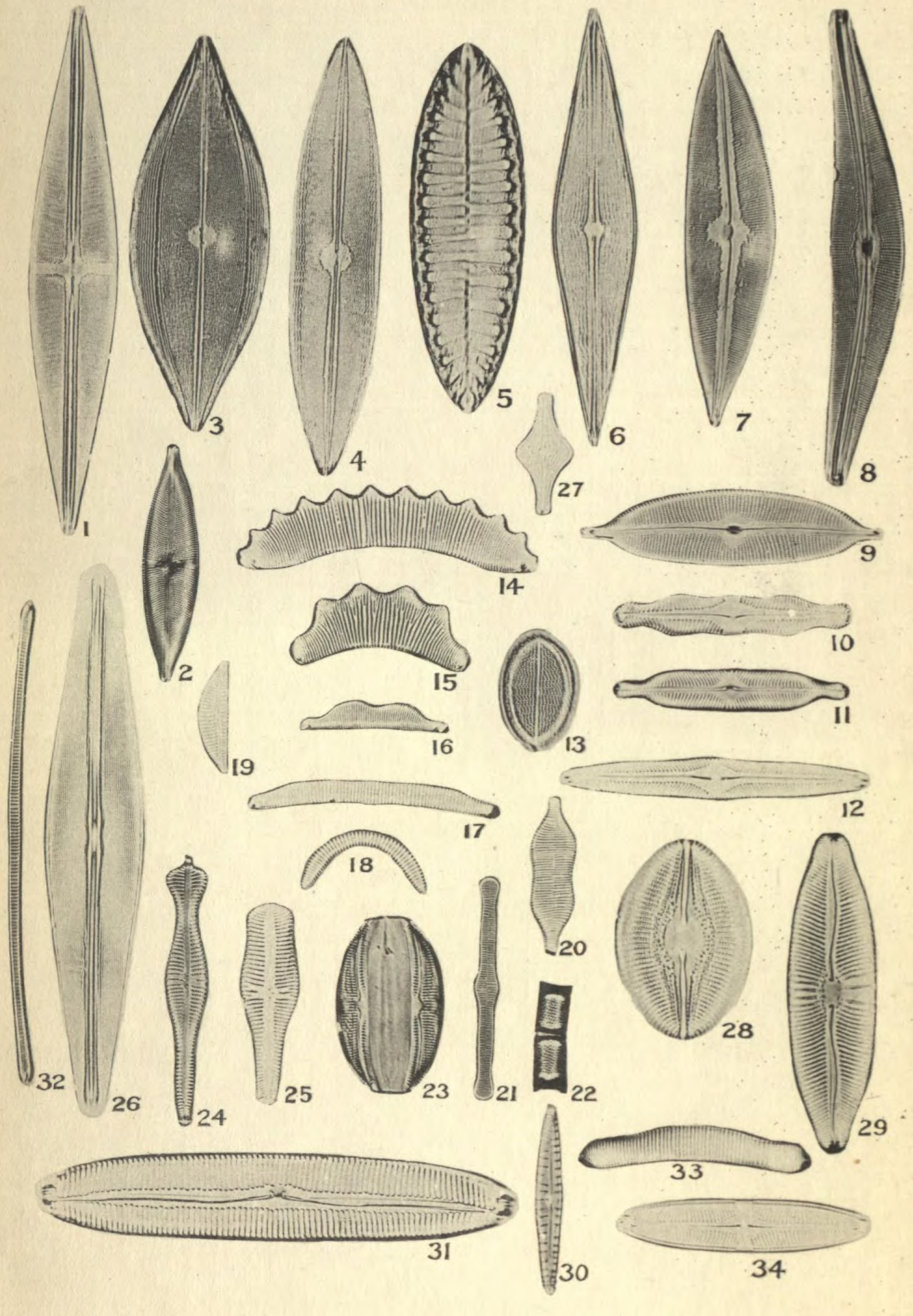

TYPICAL CANADIAN INDUSTRIAL DIATOMS

Photograph by:—
H. C. WHEELER, Montreal

KEY TO PLATE I *(Frontispiece)*

No.	*Diatom*	*Mag. Diameters*
1.	*Stauroneis phoenicenteron*	300
2.	" *anceps*	480
3.	*Neidium tumescens*	300
4.	" *iridis*	300
5.	*Surirella robusta*	300
6.	*Anomœoneis serians*	600
7.	*Cymbella heteropleura*	300
8.	" *lanceolata*	300
9.	" *cuspidata*	480
10.	*Pinnularia mesolepta*, var. *stauroneiformis*	480
11.	" *interrupta*	432
12.	" *gibba*	480
13.	*Cocconeis placentula*	480
14.	*Eunotia robusta decadon*	480
15.	" " *tetraodon*	480
16.	" *bidentula*	480
17.	" *pectinalis ventricosa*	480
18.	" *hemicyclus*	480
19.	*Cymbella ventricosa*	480
20.	*Fragilaria undata*	480
21.	*Tabellaria fenestrata*	480
22.	*Melosira granulata*	480
23.	*Amphora ovalis*	480
24.	*Gomphonema acuminatum capitatum*	480
25.	" *capitatum*	480
26.	*Frustulia (Navicula) rhomboides*, large form	480
27.	*Anomœoneis follis*	480
28.	*Diploneis elliptica*	480
29.	*Navicula semen*	480
30.	*Gomphonema puiggarianum aequatoriale*	480
31.	*Pinnularia major*	480
32.	*Eunotia biceps*	480
33.	" *major*, small form	480
34.	*Pinnularia brebissonii*	480

CANADA
DEPARTMENT OF MINES
HON. CHARLES STEWART, MINISTER; CHARLES CAMSELL, DEPUTY MINISTER

MINES BRANCH
JOHN McLEISH, DIRECTOR

Diatomite

Its Occurrence, Preparation, and Uses

BY

V. L. Eardley-Wilmot

OTTAWA
F. A. ACLAND
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1928

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INTRODUCTION

Although the number of industries in which diatomite is being successfully used is increasing rapidly, the great possibilities of this material are not as yet realized by many who might benefit by a knowledge of its uses. Many problems of industry, particularly those relating to filtration and insulation, have been solved or simplified by the use of diatomite, nevertheless, comparatively few people are aware of the sources of supply or of its occurrence in Canada.

Most of the Canadian diatomite occurrences were examined in 1923 and 1924 at the time of the writer's investigation of natural abrasives. However, it soon became apparent that the use of diatomite as an abrasive was of minor importance compared with its other uses, and a separate report on diatomite was therefore authorized.

As will be noted in the Bibliography at the end of this report there are a large number of comparatively short articles and reports dealing with the uses, or the occurrences of diatomite, but they are scattered and often inaccessible to many who are interested in the subject. The author has, therefore, endeavoured to collect together the more important information from some of these as well as that obtained from direct observation in the field and from correspondence with various producers and consumers.

The author wishes to express his appreciation and thanks to the numerous owners of the properties in the western United States for their many courtesies and kindnesses during his visit in 1926; to many who furnished information by correspondence; to the United States and California Bureaus of Mines; and to the Imperial Institute of Great Britain. The author is also much indebted to C. S. Boyer of Philadelphia, and the late H. C. Wheeler of Montreal, for their identification and photographs of the diatoms.

Diatomite: Its Occurrence, Preparation, and Uses

CHAPTER I

THE PROPERTIES AND USES OF DIATOMITE

NOMENCLATURE

Diatomite has several names, the most common of which are diatomaceous earth, diatomaceous silica, kieselguhr, infusorial earth, tripolite, tripoli, and fossil flour. Besides these, several other names are occasionally used, such as desmid earth, bergmehl, radiolarian earth, polirscheifer (polishing slate), white peat, molera, randanite, tellurine, ceyssatite, etc., and by trade names such as "Celite," "Filter-Cel," "Calatom," "Pacatome," etc.

Of the above names "diatomaceous earth" is the most widely used. It is not, however, a true "earth," though this term might be correct for the impure and peaty diatomaceous material. Recently the shorter and more convenient word diatomite has been substituted. *Kieselguhr* (flint-sediment) is the German name for the material which was first mined in Hanover, about 1860. The use of the term *infusorial earth* is erroneous since infusoria is a group of the animal kingdom, so named because some species will appear in infusions of decaying organic substances. They are, therefore, of different origin; their skeleton remains usually occur in deep sea deposits and are hardly ever present in true diatomite. *Tripolite* derives its name from the diatomite originally mined at Tripoli in northern Africa. *Tripoli,* on the other hand, is a similar substance but is of entirely different origin, being a residual material probably derived from the decomposition of novaculite, or of siliceous limestones, chert, etc., and contains no diatoms. When discovered in the western United States, about 1880, it was thought to be the same material as that found at Tripoli and was so called. The term is now more in the nature of a trade name. *Fossil flour* is also a trade name formerly used for diatomite.

GENERAL DESCRIPTION

Diatomite when dry is a whitish substance resembling chalk, but is very much lighter in weight and more porous. As it has an apparent specific gravity of considerably less than 1·0, it will float on water until saturated. It can generally be distinguished from clay, silt, etc., either by its extremely light weight or the absence of grit when tasted between the teeth. When wet it is not plastic like clay but is quite short. It does not effervesce with acid as does chalk or marl.

When diatomite is found in a saturated condition it varies considerably in colour and texture. It may be pure white and hard, light or dark grey, cinnamon yellow, or pale brown to dark brown. The last named is very high in carbonaceous matter which can be burnt away leaving a comparatively pure white diatomite. This is characteristic of many of the lower layers of the eastern Canadian deposits which occur under water. The hard and dense white is, as a rule, high in lime or alumina, but the cinnamon, which is common in the Maritime Provinces, is, after calcining, usually the purest material. Rusty and reddish streaked beds of diatomite indicate the presence of iron compounds. (Most of these diatomites have the same white or very pale grey colour when dry, except those high in carbonaceous matter which usually dry to shades of darker grey).

The infallible test for diatomite is the microscope, which will at once reveal the presence of the diatoms. Approximately 10,000 distinct species of diatoms have been recognized, named, and tabulated, each differing from the others in size, form, and design. The scroll work or engravings on many of these minute shells is so fine (in some instances 125,000 to the inch) that they can be seen only by the very highest-powered microscope. (*See* Plate I.)

After calcining, diatomite should be pure white. Iron gives it a pinkish to a brick-red tinge depending on the quantity present.

ORIGIN

The Diatom

The diatom, which belongs to a group of flowerless aquatic plants called algæ, secretes for itself an external case or box of clear silica consisting of two *valves* which slip over each other like the lid and bottom of a box. The form of the box may be any one of the 10,000 shapes and designs to which reference has been made. The two valves of the box are identical and are bound together around their edge by a separate ring or hoop called the *girdle* (Plate XVD). Each valve consists of two, or in some species three, plates, or layers, separated from each other by hollow pockets. The numerous dots or lines which can be seen on the valves are believed by some to be pores through which the diatom "breathes", but the general theory is that they are lumps covering internal hollows and that the breathing takes place through the girdle and through the *raphe*, which in many forms is the main central line.

There appear to be several methods of reproduction, the commonest of which is brought about by the separation of the individual, longitudinally, into two along the median dividing line. The bottoms of a box are formed back to back along this line, push outwards, slip snugly into the upper and lower valves of the parent, thus forming two new boxes which separate, and each repeats the process, and so on. This method of formation is the origin of the name diatom, from two Greek words meaning, "to cut through". Other species grow in chains and are attached to each other by various kinds of horns or tentacles.

The main agency for their reproduction is light, consequently the living frustules are not found in subterranean passages or in very deep water. The degree of salinity also appears to be an important factor for the production of the marine forms. A series of experiments conducted at Stanford University[1] on living diatoms collected from the south Washington coast and placed in waters ranging in salinity from 0·5 to 4·0 per cent, showed that their rate of production varied considerably. It was found that no noticeable increase took place in water of 0·5 per cent, but there was a gradual increase up to 3·0 per cent and at 3·2 per cent, which was the maximum, the production was exceedingly prolific. For higher percentages there is a marked decrease in production. The present average salinity of these west coast waters is about 3·5 per cent which in the above experiments showed slow rate of production. In shallow bays and mouths of rivers where excess of rain and fresh river waters reduce the salinity, some types of diatoms multiply rapidly at certain seasons of the year, depending on the temperature of the water. It is, therefore, possible that the immense Californian and other large Tertiary diatom deposits in the world are due, in part at least, to a lower degree of ocean salinity during Tertiary times.

Living diatoms occur all over the globe and are found in hot springs as well as in the coldest waters, both salt and fresh, but are of greatest abundance in the Arctic and Antarctic regions. The brownish or yellowish slime found on submerged weeds or on the bottoms of ponds, still or stagnant waters, consists of masses of living diatoms.

THE USE OF THE DIATOM

The diatom, although individually so minute, nevertheless plays an important part in the general progress of human knowledge and information. It is so true to type that an expert diatomist can often tell from its shape and design, the part of the world, or even locality from which it originally came. This characteristic and the fact that the diatom is an inert substance capable of prolonged suspension in water, enable the direction and even the rate of flow of ocean currents to be gauged with a fair degree of accuracy. This knowledge of ocean currents is, of course, essential to navigation, and also the origin and movements of icebergs can be ascertained by a study of the diatoms contained within them.

The masses of floating living diatoms are an important source of food for fish, oysters, etc. The breeding and feeding grounds and even the migration of our food fishes are to a large extent determined by the existence of adequate supplies of living diatoms.[2]

The diatom is an intensely interesting object of microscopical research, and for testing the power and quality of a microscope it has no equal.

Geologically, diatoms have many fields of interest. Their type, structure, abundance, position in the strata, etc., serve as indications as to climatic conditions; to the degree of alkalinity, acidity, and salinity of waters in the past ages as well as to the age and geological period of the neighbouring rocks and sediments. Their association with and possible origin of certain oil fields, particularly in California, are dealt with later in brief detail. Their commercial use in the form of diatomite is also discussed separately in this report.

[1] Private information from L. B. Becking, Stanford University.
[2] Little, H. P.: Scientific American Monthly, vol. IV, pp. 77-78 (July, 1921).

FORMATION OF DIATOMITE

When the diatoms die they fall to the bottom of their habitat where the organic parts decompose and the silica skeletons *(frustules)* accumulate (when not disturbed) in beds of varying thickness. In time these beds become part of the sedimentary strata and are known as diatomite, which, however, is usually mixed to a varying extent with small quantities of clay, carbonaceous matter, and other insoluble materials present in the water. Some of the more ancient beds of the Tertiary period are hundreds of feet above the present water-levels, and are known to be as much as 2,000 feet thick. The diatomite in these dry beds is usually comparatively hard and can be cut into blocks. The majority of these dense Tertiary diatomite beds all over the world, particularly those of freshwater origin, are associated with basalt lava flows which in many instances are both above and below the diatomite. It is probable that this period was the most favourable for the formation of the diatoms. Until comparatively recently, it has been believed that the most ancient as well as the most prolific period of diatom formation was during the transition from Mesozoic to Tertiary. However, the existence of diatoms in the Cretaceous has now been definitely proved[1] in Russia, Germany, Jutland, and United States. Their discovery in the Cretaceous shales of Mereno, California, were first described by Anderson and Pack[2].

Other types of more recent origin are found at the bottoms of existent lakes, ponds, marshes, etc., and occur as a grey, yellow, or brown mud, as outlined under "General Description."

COMPOSITION

Diatomite is a hydrous or opalescent type of silica in the form of countless myriads of microscopic siliceous skeletons of diatoms, and may be either of freshwater or marine origin. It has been calculated that one cubic inch of diatomite contains from 40 to 70 million diatoms.

In the crude state diatomite contains 15 to 40 per cent moisture which can be removed by prolonged drying at 105° C. The water of composition varies considerably according to its purity; many diatomites high in organic matter contain as high as 15 per cent. It has been frequently stated that pure diatomite contains 4 to 5 per cent combined water when dried at 105° C. The writer has found, however, that owing to the enclosed cells and pores of the diatoms, it is difficult to drive out the last traces of moisture and that in some instances after drying for 2 hours at 105° C. as much as 5 per cent moisture still remains. As a result of a series of experiments it was ascertained that even after 12 hours a trace of moisture was left and that the samples should be dried for 24 hours for safety. After drying 24 hours the purer diatomites were found to contain 2·5 to 3·7 per cent combined water.

[1]Hanna, G. D.: "Cretaceous Diatoms from California", Occasional Papers; Cal. Acad. Sci., No. XIII. Sept. 17, 1927.

[2]Anderson and Pack: U. S. Geol. Surv. Bull. 603 (1915).

A pure dry diatomite contains about 97 per cent or less of diatom silica, the remainder being water, but this purity does not exist in nature, as lime, alumina, and often iron, are almost always present. It is believed that some of the silica is in the colloidal form, and in some diatomites the colloidal properties are strongly marked.

A few analyses of typical diatomites from various parts of the world are given below.

TABLE I

Analyses of Some Diatomites[1]

—	1	2	3	4	5	6	7	8
Silica (SiO_2)	80·53	80·66	81·53	88·68	86·89	82·62	82·00	81·30
Alumina (Al_2O_3)	5·80	3·84	3·43	2·68	2·32	5·43	2·82	2·44
Iron oxide (Fe_2O_3)	1·03	....	3·34	trace	1·28	0·67	0·78	0·16
Lime (CaO)	0·35	0·58	2·61	1·61	0·43	0·39	0·50	nil
Magnesia (MgO)	....	....	....	1·30	trace	0·73	0·37	1·03
Potash (K_2O)	....	....	1·16	....	3·58	....	n.d.	....
Soda (Na_2O)	....	....	1·43	....	....	....	n.d.	....
Water and organic matter	12·03	14·01	6·04	5·54	4·89	10·58	12·16	15·02
Total	99·83	99·09	99·54	99·81	99·39	100·42	98·63	99·95

—	9	10	11	12	13	14	15	16
Silica (SiO_2)	83·20	79·30	77·06	82·22	87·86	58·18	73·01	82·22
Alumina (Al_2O_3)	3·80	10·00	8·50	2·43	0·13	0·40	8·55	2·43
Iron oxide (Fe_2O_3)	3·00	0·54	1·20	1·27	0·73	0·91	2·09	1·27
Lime (CaO)	0·80	0·93	1·32	0·28	0·42	2·39	1·14	0·28
Magnesia (MgO)	2·23	0·85	0·73	0·93	....	0·86	0·83	0·53
Potash (K_2O)	0·89	n.d.	n.d.	0·38	....	0·25	0·28	0·46
Soda (Na_2O)	0·33	n.d.	n.d.	0·46	....			0·38
Water and organic matter	5·26	5·16	10·10	11·70	10·71	36·21	14·10	11·70
Total	99·51	96·78	98·91	99·67	99·85	99·20	100·00	99·27

1. Lake Umbagog, N.H., U.S.
2. Morris county, N.J., U.S.
3. Popes Creek, Md., U.S.
4. Lompoc, Santa Barbara county, Cal., U.S.
5. Monterey county, Cal., U.S.
6. Pollet lake, N.B., Canada.
7. Brora lake, N.S., Canada.
8. Oxford Tripoli Co., Silica lake, N.S., Canada.
9. Lot 906, Quesnel, B.C., Canada.
10. Chaffey tp., Muskoka, Ont., Canada.
11. Lake Michel, Chertsey tp., Quebec, Canada.
12. Hanover.
13. Oberohe, Prussia.
14. Black Moss, Aberdeen, Scotland.
15. River Bann, Antrim, Ireland.
16. Warrumbungle Ranges, Bugaldi, N.S.W., Australia.

[1] Nos. 1-5 from Non-Metallic Minerals, 1925, p. 190, R. B. Ladoo; Nos. 6-11 collected by writer and analysed by Mines Branch chemists, Ottawa. Remainder from various reports.

NOTE.—For further analyses of Canadian and United States diatomites see Tables XI and XII.

PROPERTIES OF DIATOMITE

Chemical Properties

Pure diatomite gives up its water of combination between 500 and 800° C. *See* "Calcination," Chapter V. It is insoluble in acids or neutral solutions, but is readily attacked by hydrofluoric acid and by caustic alkalis. In most respects it is an "inert" substance and is not affected by atmospheric conditions of intense cold, heat, or decay.

Physical Properties

Colour, when pure, diatomite is white. *Lustre,* dull and earthy. Its true *specific gravity* or density is 2·1 to 2·2 at 25° C., which is the average specific gravity of hydrous silica. The *apparent density* of dry blocks (California material) is about 0·45 (water taken as 1·0), or 28 pounds per cubic foot, but blocks from some compact diatomite deposits weigh from 30 to 35 pounds per cubic foot. The apparent density of the pure dry loose powder varies from 0·25 to 0·12 or 16 to 8 pounds per cubic foot. It has a high *power of absorption* and will absorb from 1½ to 3 times its weight of water depending on its purity and size of diatoms present. The absorptive power can be increased by calcination as this drives off the combined water. It is highly porous and its *porosity* increases with the temperature although the volume remains the same up to 700° C. Above this and especially beginning about 870° C. (1600° F.) the shrinkage is very pronounced due to its alteration into tridymite, its apparent density increasing until its true density of 2·2 is reached. The *melting point* varies from 1400° C. (2678° F.) to 1750° C. (3182° F.) according to its purity and compactness. The *index of refraction* is variable, but is usually between 1·44 and 1·46.

The *thermal conductivity* increases with the rise in temperature and varies according to the purity, nature, and compactness of the material, that of the pure loose powder being as low as 0·000127 gram-calorie seconds at 200° C., but gradually rising to 0·000397 at 800° C. Conductivity is discussed in detail in the section dealing with "Tests," Chapter II.

USES OF DIATOMITE

Diatomite was used as far back as the sixth century B.C. when the ancient Greeks and Romans used it as a building material to decrease the weight of certain structures. It is said that bricks made from diatomite were used in the Hagia Sophia dome of the Church of St. Sophia, Constantinople, in 522 A.D.

The two main characteristics of diatomite are its great porosity, with its low apparent density (average 0·33) and its chemical inertness, since it is composed entirely of silica. Its two main uses are, therefore, as a filtering medium and as an insulator against heat, cold, and sound. Besides its ability to withstand a high temperature and corrosion, its myriads of enclosed air cells form an almost perfect barrier against the influence of changes in temperature. Its use as an insulator is thus apparent.

Its porosity makes it of great value as a filtrant, for it builds up within the filter cake an open sponge-like structure which allows free passage for the filtrate, and at the same time holds back the minute particles which would ordinarily clog the filter leaves; by so doing not only does it considerably increase the clarity of the filtrate but also the rate of filtration.

For the polishing of metals diatomite is one of the best materials known, for the angular nature of the silica skeletons, especially when broken, gives it an efficient abrasive power—particularly where a mild abrasive is required, and, moreover, because of its low compressive strength there is no danger of scratching the surface of even the softest metal.

Its high power of absorption (150 to 300 per cent of its own weight) together with its inert qualities, renders it invaluable as an absorption agent and filler.

The shapes of the diatoms appear to play an important role in its use, but to what extent is a field for future study. For filtering purposes mixtures of round honey-combed and long, thin needle-shaped diatoms are preferred; whereas for polishing, the small spicules appear to give the best results.

The physical and chemical properties of diatomite have an important bearing on its ultimate use; consequently no decision regarding the value of diatomite for various purposes should be made until these properties have been determined.

The properties upon which the ultimate uses of diatomite are dependent have been summarized as follows:—[1]

I. Physical—
- (a) Form
  - (1) Enclosed air cells
  - (2) Large exposed surface of cells
  - (3) Fine state of subdivision
  - (4) Sharpness of cells
  - (5) Weakness or low compressive strength of cells
- (b) Refractory nature
- (c) Presence of large amount of colloidal matter
- (d) White colour

II. Chemical—
- (e) Siliceous or inorganic nature
- (f) Easy solubility in alkalis
- (g) Insolubility in acids or neutral solutions

Range of Uses

Heat, Cold, and Sound Insulation. In the form of (a) a coarse or a finely granular powder, (b) natural sawed bricks, (c) burnt bricks made with a mixture of clay and other bonds.

Filtering Medium. (a) In the pulverized form for liquids that can be filtered only with difficulty, (b) bonded blocks of various shapes, (c) pulverized, bonded, and burned.

Catalysts. As a carrier for catalytic agents.

Absorbent. Used in the pulverized form as an absorbent of many liquids.

Filler. In the finely pulverized form, particularly where light weight, inert fillers are required.

[1] Boeck, P. A.: "The Kieselguhr Industry," Chem. and Met. Eng. (Feb. 1914) pp. 109–113.

Mild Abrasive. In the grit-free, pulverized form, as a dry powder, paste, or suspended in solution.

Structural Material. Used as light weight building blocks, partitions, and roofing tiles. The use of the crude powder as a concrete admixture is gaining much favour.

Bleaching. Some grades are capable of bleaching and act in a similar manner to fuller's earth.

Chemical Uses. Substituted for silica sand or ground quartz in the manufacture of some compounds, also as a filler and absorption agent in various chemicals and products.

Miscellaneous Uses. In the powdered form diatomite has numerous uses not included in the above headings, such as a carrier for corrosive liquids, for packing purposes, parting medium in steel foundries, etc.

In the following pages will be found, under the above headings, the individual uses and brief details describing the method of application of diatomite in the various industries.

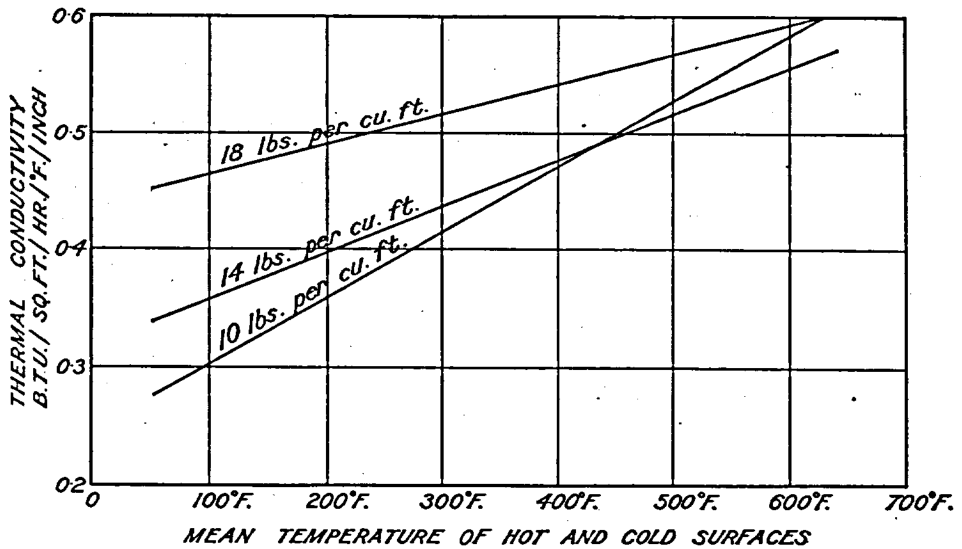
INSULATION

Insulation Properties of Diatomite

Diatomite, on account of its relatively low thermal conductivity, is one of the best known heat insulators over a wide range of temperature, and it is believed that more diatomite is now employed for this purpose than for any other use, although it is almost equalled by filtration. For temperatures below dull red heat, the thermal conductivities of different diatomites vary according to their apparent densities, the lower the density, the lower the heat conductivity. Several graphs compiled by Messrs. Calvert and Caldwell[1] as a result of experiments on California material, are reproduced below. Figure 1 shows the relation between density and thermal conductivity at low temperatures. The relationship, however, only applies to the same type of material. For instance, Figure 2 shows that diatomite has a lower conductivity than a magnesite block of lower apparent density, due no doubt to the air cells of the diatoms which are not present in the magnesite. At high temperatures, porosity due to fine air spaces or pores is more effective in insulation than the same volume of larger pores. This is probably due to the fact that there is an intense radiation and rapid convection through air at high temperatures which greatly increases with the rise in temperature—the larger the air spaces, the greater the radiation.

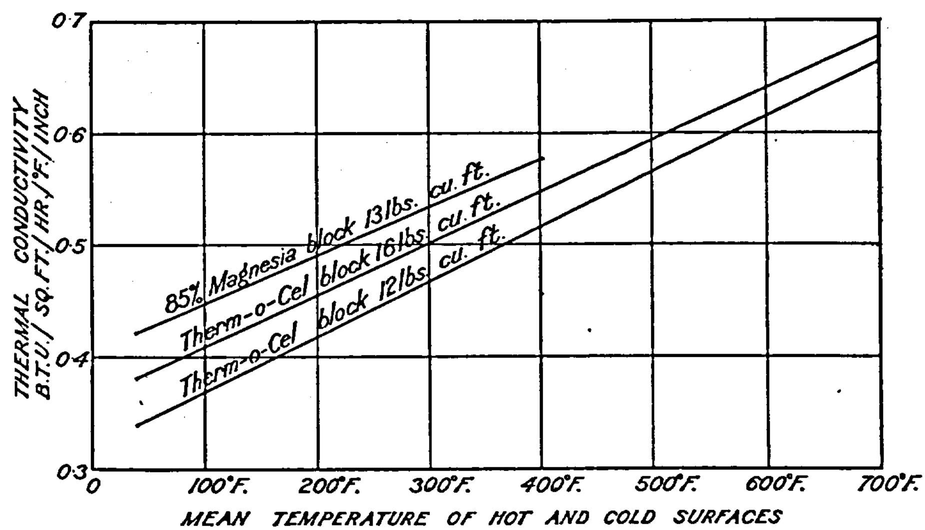
The importance of the diatom structure in respect to heat insulation will be readily seen from the above. Thus a very porous diatomite containing a high percentage of large unbroken diatoms will, at comparatively low temperatures, make a better insulator than one containing small diatoms, but at the high temperatures (above red heat) this will be reversed. Solid impurities, such as non-diatom silica (silt, etc.), act as conductors and lower the insulating value of the diatomite. Diatomite is not a refractory and should not be used in places where the temperature approaches its fusion point, which is comparatively low.

[1] Calvert, R., and Caldwell, L.: Ind. and Eng. Chem., vol. 16, pp. 483–490 (May 1924).



Reproduced from report by Calvert and Caldwell, Ind. and Eng. Chem., vol. 16, p. 486 (May 1924)

Figure 1. Effect of density on the conductivity of Sil-O-Cel powder.

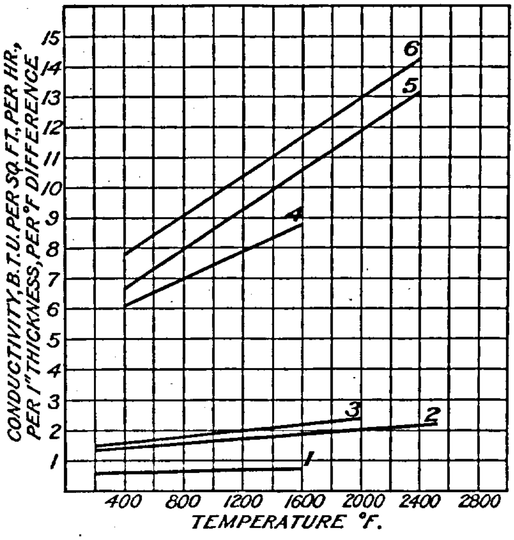


Reproduced from report by Calvert and Caldwell, Ind. and Eng. Chem., vol. 16, p. 486 (May 1924)

Figure 2. Effect of nature of pore spaces on conductivity of thermal insulators.

Manufactured Insulation Products

In many instances the application of diatomite in the form of powder is both inconvenient and impractical. There are several types of natural as well as burnt and bonded diatomite bricks, mortars, and other diatomite products now on the market. Their manufacture and other details will be discussed in Chapter V. The insulation value of a burnt and bonded diatom brick depends not only on the type of diatoms, but also on the type and firmness of the binders as well as on the temperature of burning.



1. Sil-O-Cel brick (Natural)
2. Sil-O-Cel super brick (Bonded and burned at 2500°F.)
3. Sil-O-Cel C-22 brick (Bonded and burned at 2000°F.)
4. Red brick
5. Fire brick
6. Silica brick

Reproduced from trade literature of the Celite Co., Lompoc, Cal.

Figure 3. Chart showing relative conductivity of insulating brick, firebrick, and red brick.

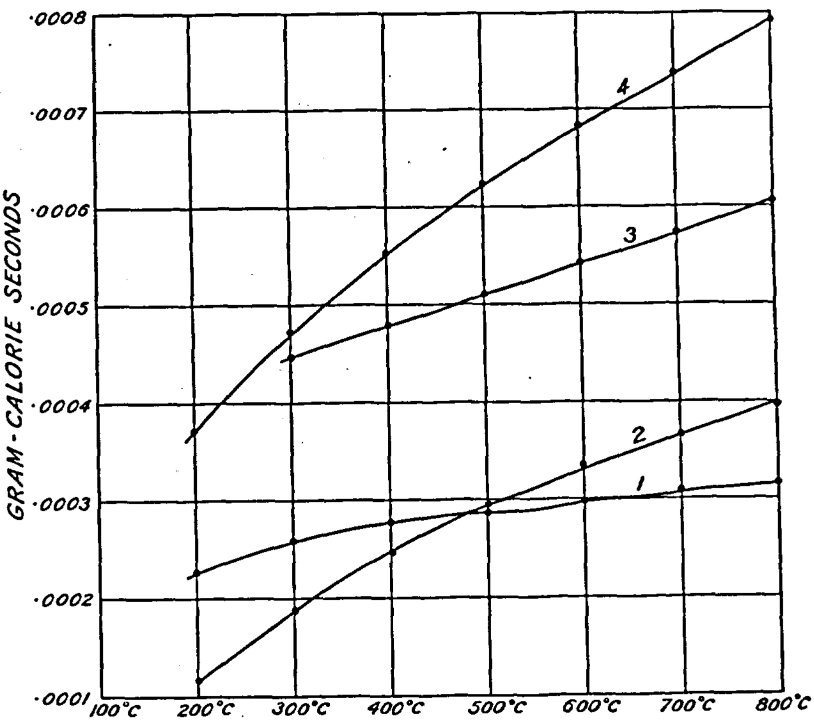
Another important factor is the extent of its shrinkage and the temperature at which this takes place. Shrinkage causes cracks and voids through which heat may escape. Several types of diatomite bricks are on the market. The natural brick cut from blocks is soft and can be used only in certain places, but has the lowest conductivity. The natural brick burned is slightly harder and has slightly higher conductivity. The bonded, pressed, and baked bricks are made both for their tensile and compressive strengths as well as for the high temperature they will withstand without shrinking. The conductivity ratios of some California diatomite bricks compared with one another and with other types of bricks are shown in Figures 3 and 4.[1]

[1] From trade literature; Celite Company, Lompoc, Cal.

Methods of Application

In the powdered form diatomite is sometimes used for filling hollows in walls or on top of furnaces, kilns, and other kinds of heating equipment.

The material should be lightly tamped to prevent settling and to avoid open spaces. Pure diatomite powders are said to be free from shrinkage up to 1600° F., so that in places where the temperature exceeds this the powder or natural bricks should not be used.

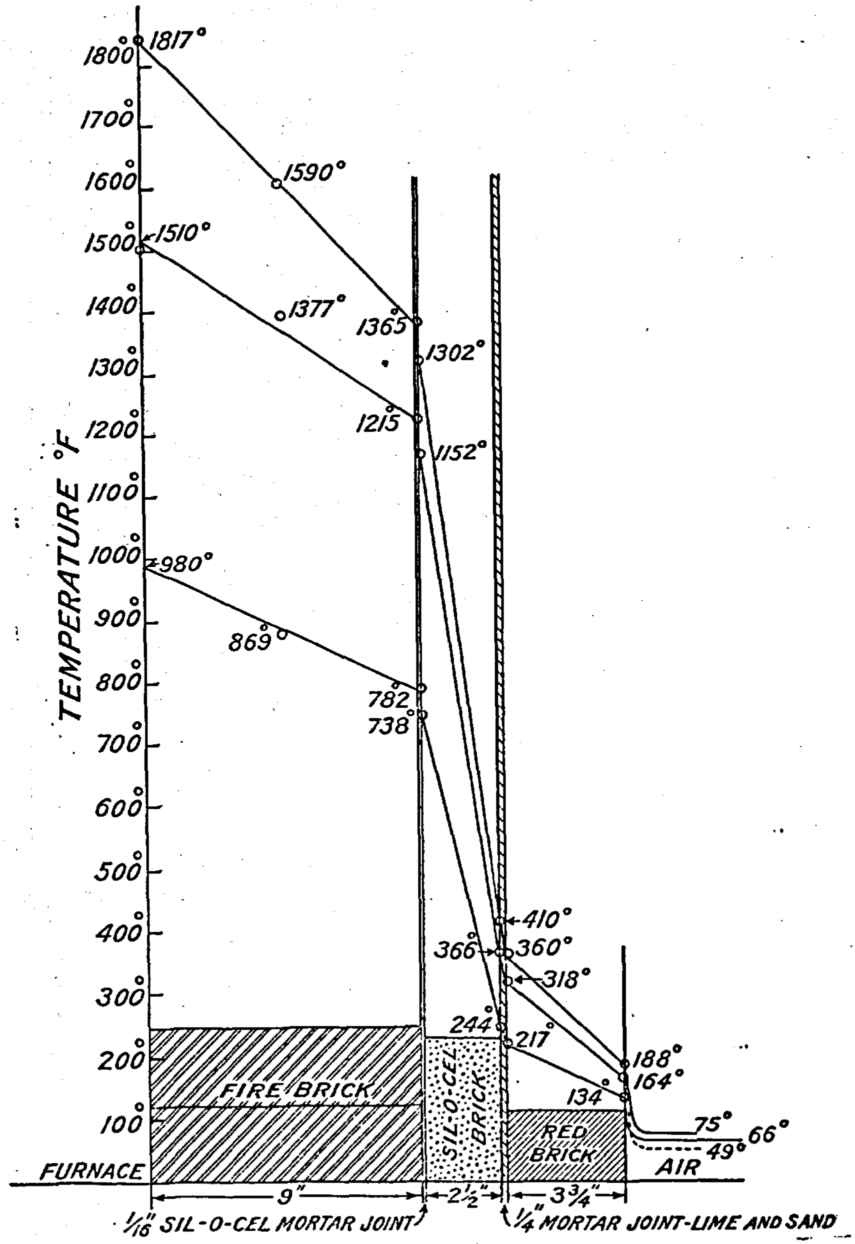


1. Natural Kieselguhr block (dried)	apparent density	0·53
2. Pulverized Kieselguhr (loosely packed)	" "	0·12
3. Kieselguhr insulating brick (burned)	" "	0·75
4. Kieselguhr firebrick (burned)	" "	1·05

Reproduced from figures by P. A. Boeck (Chem. and Met. Eng., 1914).

Figure 4. Thermal conductivity of diatomite products.

Bricks. Diatomite bricks are extensively used in the wall construction of high-temperature furnaces, ovens, boilers, etc., and are laid in one course (2½ inches) between the firebrick (9 inches) and the outside common bricks (4 inches). It has been demonstrated that a wall insulated in this manner loses only 40 per cent as much heat as an uninsulated wall. Figure 5 illustrates the temperature gradient in a wall so insulated. A layer of diatomite approximately 0·5 to 0·75 inch thick has an insulating value equivalent to about 9 inches of firebrick or silica brick.



Reproduced from drawing by Calvert and Caldwell, Ind. and Eng. Chem., vol. 16, p. 488 (May 1924)

Figure 5. Temperature gradient of a composite furnace wall, illustrating the use of diatomite.

The bricks should not be placed where they will be exposed to direct contact with sudden spurts of flame or be subjected to temperature close to the shrinkage point. Diatomite bricks are made in which the shrinkage points are 2000° F. to 2500° F.

In building construction, diatomite is used between walls as powder, natural bricks, or in slabs for insulating against external heat or cold. The material is also said to prevent the formation of fungus and dry rot, and to keep out ants, rats, and other kinds of vermin. In damp climates, however, there is a danger of moisture being absorbed in the lower walls of buildings, unless they are exceptionally well protected. Since diatomite is an inert non-inflammable powder, it enables buildings to have a lower fire hazard than those insulated with cork or other combustible materials. Diatomite is also manufactured, with suitable bonds, into roofing tiles, etc., which not only protect the top floors of buildings from the heat of the sun but also retard radiation of interior heat.

The different methods of applying both the powder and the bricks to insulate the innumerable heating equipments will be found in the publications mentioned in the bibliography and in trade literature.

Pipe-covering Compounds. A considerable quantity of diatomite is used in the insulation of hot-water and steam pipes, both industrial and domestic. For low-temperature work magnesium carbonate is often used since it is lighter and cheaper than most diatomites. At 700° F., however, the carbonate begins to be converted to the oxide when its insulating properties are impaired. For hot-blast and superheated gas pipes a double insulation is sometimes used in which the first covering, or "fire-backing", is the diatomite and the outer covering the magnesium carbonate compound.

The pipe coverings are usually marketed in various lengths, cut longitudinally into two halves and wrapped with canvas. Before placing around the pipes the canvas is taken off and after the two halves have been put in position the canvas is tightly rewound.

Diatomite Mortars and Cements. Diatomite mortars are used in a manner similar to ordinary mortars. Crude diatomite powder mixed with about 20 per cent Portland cement makes an efficient mortar for general purposes. Only the minimum amount of water to make a workable paste should be used. The calcined powder mortar is better for high temperatures since its shrinkage point is higher than that of the crude diatomite. These mortars, or cements, are also sometimes used for covering irregular surfaces, or applied by tamping into inaccessible pockets or corners. One large California firm now has a considerable variety of mortars and cements on the market, one of which is especially prepared to prevent air filtration and to act as a waterproof covering for the brick surfaces of heating equipments. Special mortars are usually marketed by the firms supplying diatomite insulation products.

Cold Insulation

Diatomite is often used for the insulation of refrigerators, refrigerator cars, and cold storage equipment generally. On account of the danger of moisture absorption, it is not placed on the bottoms or lower side-walls, particularly in the case of railway refrigerator cars.

Sound Deadening

It appears that the qualities required for sound deadening are approximately the same as those required for heat insulation. Diatomite has in many instances been applied for this purpose in buildings, music-testing rooms, telephone booths, etc.

Fire-proofing

An appreciable quantity of diatomite is now used for lining safes. It is usually applied in the form of made-up slabs bonded with a small percentage of asbestos or other suitable materials. For ordinary purposes diatomite is just as fire-proof as asbestos, and has the advantage of being a better insulator. The use of a diatomite lining for safes considerably reduces the risk of losing valuable documents by fire. Some filing cabinets are also lined with a diatomite composition. As stated above, by its use in buildings it serves the dual purpose of fire-proofing and insulating.

General List

The following is a list of different equipment that is being successfully insulated with diatomite in some form such as powder, bricks, slabs, pipe-coverings, or cements.[1]

Steam-power Plant Equipment:
Boilers, steam pipes, breechings and flues, superheaters and economizers.

Petroleum Refinery Equipment:
Stills, still furnaces, rotary kilns, boilers, pipes, oil lines and flues, storage tanks and reservoirs, forewarmers, dephlegmating towers, etc.

Iron and Steel Melting and Fabricating:
Hot-blast stoves, mains and bustle pipes, regenerators and flues, by-product coke ovens, core baking ovens, producer gas mains, billet heating furnaces, annealing furnaces, heat-treating furnaces, malleable annealing ovens, foundry ladles, furnace doors, crucible furnaces, gun furnaces.

Non-Ferrous Smelting, Refining, and Fabricating:
Reverberatory furnaces, rolling mill melting furnaces, sintering furnaces, roasters (single and multiple hearth), melting furnaces, annealing furnaces, heat-treating furnaces, calcine hoppers, zinc retorting furnaces, sulphur burners, lead pots, metal mixers.

Lime and Cement Plant Equipment:
Rotary kilns, vertical shaft lime-kilns, boilers, flues and settling-chambers.

Glass Manufacturing Equipment:
Day tanks, pot arches, boilers, producer gas mains and flues, refining end of melting tanks, regenerators and recuperators, tunnel kilns for preheating pots, flattening ovens.

Ceramic Plant Equipment:
Periodic kilns, tunnel kilns, fritting-furnaces, enamel drying ovens, waste heat or direct heat boilers, waste heat flues, enamelling furnaces.

Gas-generating Equipment:
Water and oil gas sets, coke ovens, gas producers, mains and flues, coal gas retorts, waste heat flues, boilers (waste heat and direct fired).

General:
Bakers' ovens, crematories, driers, dust catchers, electric furnaces, evaporators fireless cookers, forewarmers, incinerators, pipe-covering (all kinds) pre-heaters, safes, filing cabinets, soap-kettles, etc.

Refrigeration and Construction:
Chill rooms, ice cellars, cold storages, refrigerators, in walls of buildings, roofing tiles, fire-proof and other paints, and for sound deadening.

[1] Mainly from trade literature; Celite Company, Lompoc, Cal.

FILTRATION

Properties of Diatomite Suitable for Filtration

A good filter medium should be insoluble in the liquid to be filtered, free from clay and other impurities, and ensure clarity of filtrate with high rate of flow.

Importance of Size and Shape of Diatoms. Some diatomites are better suited for filtering purposes than others and their efficiency depends largely on the shapes and sizes of the diatoms present. It appears that the best material is a mixture of various shaped diatoms—thin needle-shaped, round, or oval of varying sizes, some of these latter being comparatively large and some small—the needles predominating. At any rate this is the typical diatom structure of the California coast material which is claimed to be the most efficient diatomite for filtration.

There are freshwater diatomites in Canada that contain thin rod-like *Eunotia* and thin forms of *Tabellaria, Gomphonema,* etc., as well as the stout oval forms of *Pinnularia, Stauroneis, Neidium, Surirella,* etc., (Plate I, Nos. 32, 17, 21, 30, 24, and 31, 1, 3, 4, 5, all of which often occur mixed together with smaller forms and fragments). Diatomites of this type should make good filter media, but to date do not appear to have been commercially tested in Canada. Those from the Maritime Provinces which have been tried out have almost invariably been from deposits in which the diatoms are badly broken and consequently do not possess the necessary variations in size and shape. Deposits containing a predominance of small diatoms, particularly if they are uniform in size, are inferior as regards filtering properties. For this reason, the small cylindrical *Melosira* diatomites such as occur at Quesnel, B.C., and in parts of northern California and Nevada are not considered suitable.

According to E. T. Winslow[1] the assorted sizes and nature of the diatoms and fragments become all important in filtration for the following reasons:—

1. Particles or groups of particles that cannot comfortably pass through the openings in the cloth are necessary for proper matting.
2. Particles should be in proper size relation so that interspaces may vary down to that size particle which is the largest to remain in the liquor.
3. More than the proper amount of finest particles will reduce the average size of the opening and cut down the rate of filtration.
4. A superabundance of large particles will cause so many interspaces that many large pores will remain unmodified by intermediate sizes and allow cloudy filtrate to pass through.
5. When intermediate sizes are lacking the finer particles may pass through the interspaces between the larger, and probably through the cloth to cause a cloudy filtrate.
6. To the diatoms there are attached clay and impurities. When the diatom comes to rest in the mat the clay may deform and clog the interspaces between that and other diatoms. Removal of clay and impurities diminishes the actual size of the diatom or diatom fragment and may upset the balance of assortment of sizes.
7. The "colloidal" silica present may be so fine as to pass through the interspaces and into the liquor, especially that fraction near the cloth at the start of filtration.
8. The stick-like diatoms may serve as spacers to keep the disk-like or flat fractions from being forced close together when pressure is exerted.
9. Electrical charges which are supposed to exist on both the diatoms and the suspended particles may have their effect while the liquor and diatomite are being agitated. A second possibility is that electrical phenomena tend to pull the suspended particles away from the interspaces as the liquor passes through and ground them on the diatom itself. This would tend to keep the openings clear.

[1] Private report by E. T. Winslow, Western Sugar Refining Co., San Francisco. Printed by permission.

No. 8 in the above is important in so far as the main types of filter diatoms are concerned, moreover, the points of the needle-shaped diatoms stick into the cloth and hold them in place during the filtering operations.

It is believed by many that filtration actually takes place through pores or minute holes in the diatoms. On the other hand the more accepted theory is that these markings, or dots, are not pores but lumps, which may, however, cover internal hollows, though the raphe or central line is believed to be hollow. Under these latter circumstances most of the filtration would take place between the individual diatoms or broken particles.

Physical and Chemical Properties. Although micro-analysis of a diatomite, already described, is the best guide to its filtration qualities, physical tests to determine its weight per cubic foot (apparent density) and its water absorption ratio are also of value. Diatomite, which is very light in weight and possesses high absorption, generally makes the best filter medium, provided that the proper types of diatoms are present. Chemical analysis gives an indication of its character and suitability, though only to a minor degree, but high percentages of some impurities in a diatomite, particularly iron and clay, are detrimental. A high silica content, on the other hand, is not always indicative of diatom silica, but may be very fine quartz in the form of silt, which tends to destroy the porosity.

Clarity and Rate of Flow

No universally successful methods are known for determining the clarity or turbidity of filtrates, except relatively, particularly with coloured or dense solutions, and the degree of clarity is, therefore, usually judged by the eye.

Some diatomites give a clear filtrate but the rate of flow may be too slow for practical purposes, some others with high rate of flow give a slightly turbid filtrate. The Celite Company, Lompoc, California, by means of special treatments, produce three types of filter powder from their deposit: (a) "Filter-Cel" which is the crude product pulverized and air-sized; (b) "Super-Cel" which is a calcined product; (c) "Hyflo-Super-Cel" which is a product calcined with an alkali and the finest particles removed by air separation. Filter-Cel gives the clearest filtrate but has the slowest rate of flow; while Hyflo-Super-Cel, which is a pure white fluffy powder, has the highest flow rate, but the filtrate is not usually so clear; and Super-Cel is a mean between the other two.

A formula whereby the filtering efficiency may be determined through the silica content and weight per cubic foot has been suggested by E. T. Winslow[1], as follows:—

$$\text{Efficiency} = \frac{6 \times \text{per cent silica}}{\text{Weight per cubic foot}} + 33$$

Although this may be a guide in many instances the several factors already outlined might upset the accuracy of this formula and in any case "rate of flow" factor seems to be a better word than "efficiency" since the clarity of the filtrate appears to be independent of the purity or to some extent the apparent density of the diatomite.

Winslow, E. T.: loc cit.

Action and Application of Diatomite for Filtration

The method of application and the stage at which diatomite is introduced depend to a certain extent upon the nature and viscosity of the fluid to be filtered. The two main classes of these fluids are: (1) those in which the suspended solids are rigid and are either crystalline or amorphous, (2) those in which the suspended solids are non-rigid and approach the colloidal.[1] Many liquids, however, contain a mixture of these two.

Diatomite is rarely used for direct filtering alone, although, by means of suitable bonds and burning, solid plates are made through which liquids can be filtered, but blocks cut direct from beds and used in the same manner as tripoli would disintegrate in water. Diatomite powder is generally used as a filter-aid in conjunction with ordinary filters or presses, the cloths or plates of which, however, after a short period of operation, act as a backing or retainer for the diatomite. The usual practice in large-scale operations for filtering many liquids is to "pre-coat" the filter cloths with a layer of the diatomite. This is done in several ways, the commonest of which is to thoroughly mix some liquor with the diatomite in a small "pre-coat" or charging-vat and then pass a certain quantity through the presses. The diatomite builds up on the cloth as a protecting coat of an open spongelike structure. The flow from the pre-coat vat is then shut off and the crude liquors from the main storage vats are passed through. In most instances small amounts of diatomite are also continually added to the main vats and kept well agitated. This ensures a gradual and more efficient building up of the filter cake and tends not only to keep it open and porous and thus permit free passage of the liquors, but also greatly facilitates the clean removal of the cake.

It is also probable that during the agitation previous to filtration the diatoms collect upon themselves particles of the minute, or non-rigid bodies mentioned above, and so prevent them from being passed through the filter. Coagulation is usually aided by heating the liquors in the presence of rigid bodies such as diatomite, though some fluids, such as oils, are chilled to bring this about.

Advantages of Filtration with Diatomite

The advantages claimed by a large producer of diatomite are as follows:[2] clarity; increased capacity due to the formation on the filter cloth of a highly porous cake instead of slime; increased recovery; improved colour of filtrate; reduced operating costs due to less wear and tear of the filter cloth which is protected by a coating of diatomite and enables quick easy removal of the cake, so that washing and replacement of cloth are reduced to a minimum. Thinner and less expensive cloths can also be used giving results equal, or superior, to those obtained with heavy cloth alone; all of which result in saving of labour and costs.

[1] Jordan, W. L.: "Developments in Filtration", Chem. and Met. Eng., Jan. 15, 1918, p. 101.
[2] Trade literature; Celite Company, Lompoc, Cal.

Some Fluids Filtered through Diatomite

The greater part of the diatomite used for filtration purposes is absorbed by the *sugar* industry, particularly cane sugar. The diatomite is generally applied first as a pre-coat and after this is formed small quantities are added to the main liquors in the manner described above. The stages in which it is used in a cane-sugar filtration plant is illustrated in Figure 6.

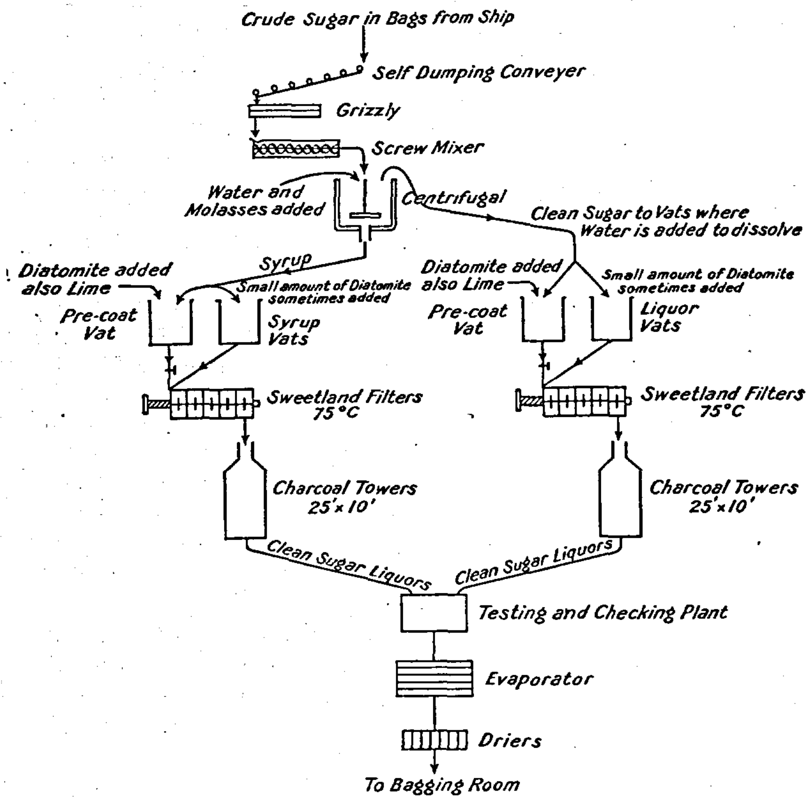


Figure 6. Rough flow-sheet of a cane-sugar refinery, showing stage where diatomite is used.

The amount of diatomite used varies, but is about 20 pounds per ton of sugar or 15 to 20 pounds per 100 square feet of filtering area. In some plants the filter cake containing the used diatomite, sugar, lime, etc., is regenerated by burning in a rotary calciner, washed by decantation, and used again with the addition of some fresh materials.

In the beet-sugar industry diatomite is also successfully employed, but the problems are somewhat different to those of cane sugar because the juices from the beets are higher in organic impurities. At one time it required an abnormal quantity of lime in the carbonation process to carry d wn the albuminous bodies, in order to render the cake filterable. The addition of diatomite, however, greatly facilitates the operation and avoids excess of lime.

For the filtering of *cereal beverages, cider*, etc., much the same method is applied as in the case of cane sugar. In the check fermentation process diatomite is used in the first stage to filter off the albumens, hop resins, etc., and again after fermentation to remove the yeast cells and slimes so that the filtrate can be stored without danger of further fermentation. The same system of filtration can be used for the re-filtration of the beverage or cider after carbonation, but in this case the diatomite should be mixed in a closed tank to prevent the escape of gas.

In the past, *wines* were clarified by means of coagulants such as albumen, gelatine, etc., but the introduction of the pressure filter and the use of filter-aids such as diatomite have resulted in higher rates of flow and more perfect clarifications.

The filtering of converted *starch* liquor in the manufacture of corn syrups, also the filtering of *corn oil*, is facilitated by the introduction of diatomite to the liquors before going to the presses.

In the manufacture of certain *chemicals*, recrystallization can often be avoided by filtering the solutions with diatomite prior to crystallization.

As far back as 1893 tests by Dr. Martin Kuchner,[1] on the filtration of *bacteria* through diatomite, showed that this material was in some cases four times more efficient than any similar filter in use at that time, as to quality and quantity of filtrate. In a continuous operation, bacteria were found in the filtrate after 3 days with an ordinary filter, but none were found even after 6 days in the case of diatomite.

In the manufacture of certain *dyestuffs*, a small quantity of slimes, or gums, are produced as by-products of the main reaction, and these seriously interfere with the completeness of the final step in the process. These slimes can be completely removed by the addition of a small quantity of diatomite before filtering through the presses.

Filtering *lard* through diatomite removes the impurities and water. This prevents the formation of acids (rancidity) due to the presence of water, the water being absorbed by the diatomite and retained on the filter plates.

High-grade *varnishes* are sometimes filtered through diatomite, to remove minute air bubbles. The used diatomite being saturated with varnish is used as a filler in paints.

Diatomite is sometimes used for removing moisture usually present in *crude oils*. The oil is heated to about 250° F., the diatomite is added and the mixture pumped through a filter press, thereby breaking up the emulsion and freeing the water; at the same time the diatomite forms a porous cake on the filter and retains the slimes. The liquors are then pumped to storage tanks where the water settles to the bottom, enabling the oil on top to be run off to the refinery. Here the oil is given a final treatment in which a small percentage of diatomite is sometimes added to a mixture of fuller's earth and bleaching carbon. The slight decolorizing action of some diatoms has an additional advantage when filtering vegetable and mineral oils.

Lubricating oils or paraffin-base oils can also be dewatered by means of diatomite. The oil is chilled in order to flocculate the paraffin and is then pumped through a filter press pre-coated with diatomite. The flocculent

[1] Zeit. für Hygien, 1893, p. 1429.

paraffin is retained on the filter forming a cake which is easily removed after the operation. The paraffin is recovered either by heating or dissolving in gasoline and the diatomite is either settled or filtered out and may be used again.

For filtering *gasoline and asphalt base oils* the diatomite is not used in the first stages of the operation since the oils are bleached with fuller's earth or treated clays. The suspended earth or clay is removed by straight filtering using diatomite as a filter-aid in the usual manner.

Diatomite is now fairly extensively used in the recovery of *crank-case and waste oils.* The very finely divided carbon and other impurities are removed by diatomite filtration after which the filtrate is distilled to remove water, gasoline, etc. It is claimed by some that the reclaimed oil is as good as, or even superior, to the original.

In *soap* plants the hydrogenated oil is given a caustic treatment to throw out the soap, which leaves a crude soap lye containing some crude glycerol. This lye is pumped to a tank and neutralized with acid and alum to which a small percentage of diatomite is added. The solution is filtered, whereby the slimes are retained leaving a clear glycerol water. The removal of the slimes prevents foaming in the evaporators. It is claimed that the filter cake so formed can be removed so cleanly that the filter cloths do not require washing and can be used again immediately.

A small amount of diatomite is sometimes used for filtering out the excess of oil from certain *perfumes and extracts.* In the crude compounds, oil and alcohol are mixed and shaken together with water which causes the solution to become turbid owing to the formation of minute oil globules. This is then filtered through diatomite which retains the oil as well as the suspended impurities.

In Germany, *filter papers* have been manufactured into which diatomite has been incorporated. These papers are, however, relatively brittle and a better method is to pre-coat the ordinary filter paper with diatomite previous to filtering the solution.

The following is a list of some of the liquids that are, or can be, advantageously filtered on a large scale with diatomite.[1]

Animal oil, adhesives, alcoholic extracts, antitoxins and serums.
Beverages.
Castor oil, cereal beverages, cider, coconut oil, chemically pure chemicals, corn oil, cottonseed oil.
Dyestuffs.
Fish oil, flavouring extracts, fruit juices.
Glue, glucose, glycerine, grapefruit juices.
Intermediates.
Lemon juice, linseed oil, liquid soap, lubricating oil, used automobile oil.
Magnesia solutions, maltose, maple syrup, metallurgical solutions, milk sugar, mineral oils.
Paraffin, peanut oil, pharmaceuticals.
Shellac, soap lye, stearic acids, serums.
Sugar syrups, raw sugars, molasses, sorghum syrups, etc.
Tannic acid, tonics, toilet waters, toxins.
Varnish and lacquer, vegetable oils, vinegar.
Waxes, wines, whiskey.

Besides the above there are operations in which diatomite functions as a carrier as well as a filter medium.

[1] Mainly from trade literature; Celite Company, Lompoc, Cal.

CATALYSTS

Diatomite is often used as a carrier for the catalyzer in the *hydrogenation* or "hardening" of oils necessary for the manufacture of soaps, edible fats, greases, etc. In the present practice, nickel is largely used as the catalyzer and is introduced in the form of a soluble salt that can be easily reduced. For example, in the dry reduction process, the diatomite is added to a solution of nickel sulphate and sodium carbonate which is then boiled. The diatomite assists in keeping the materials in suspension while the following reaction takes place: $NiSO_4 + Na_2CO_3 = NiCO_3 + Na_2SO_4$. The solution of sodium sulphate is then passed through a filter press (in which the diatomite acts as a filter-aid), leaving a filter cake of nickel carbonate and diatomite. This cake is dried and roasted at about 315° C. in an atmosphere of hydrogen, and the carbonate is reduced to nickel in the form of a fine black powder. The hot powder is then dropped into the oil to be hardened and hydrogen gas passed through. Under these conditions a hydrogen atom is transferred to the oil, changing it from olein to stearine as follows: $(C_{18}H_{33}O_2)_3\ C_3H_5$ (olein) $+ 6\ H = (C_{18}H_{35}O_2)_3\ C_3H_5$ (stearine).

When the reaction is finished the hot oil and catalyzer are pumped into a filter to remove the catalyzer and accompanying diatomite. The oil is then run into tanks where it solidifies into a hard fat ready to be made into lard, soap, etc.

In the wet reduction process, a finely ground nickel salt such as nickel formate is added to the oil which is heated and hydrogen introduced until the reaction is complete. In the wet process the catalyzer (nickel) is partly colloidal and filtration is greatly accelerated by the addition of a filter-aid such as diatomite, which, however, does not act as a carrier as in the case of the dry process. After filtration the filter cake of catalyzer and diatomite can be agitated with a fresh batch of oil and employed repeatedly for the hydrogenation until the strength of the catalyst is lost.

ABSORBENTS

Diatomite is extensively used as a carrier of chemicals in the purification of *acetylene gas*. The process varies somewhat in different plants. Sometimes the crude gas is passed under pressure through cylinders of loose diatomite impregnated with sulphuric acid, sodium chromate, etc., which removes the hydrogen and water from the acetylene. These diatomite impregnated reagents are sometimes specially prepared and sold under trade names, one of them being "Catalysol" and comes from Paris, France. Some methods use diatomite saturated with acetone which dissolves acetylene. Another method used a special cylinder filled with diatomite, asbestos, and charcoal impregnated with sulphuric acid; after the mixture had been well puddled and baked the acetone was added.

Claims have been made that diatomite has a beneficial action, when used as a carrier or absorber for *fungicides*. It is also claimed that when used as a carrier for *fertilizers*, it works into the soil rendering the latter more porous. According to the Kern[1] patent, diatomite when saturated with waste sulphite liquors, makes a good fertilizer. There is, however, some doubt as to the benefits conferred by using diatomite in these instances and the claims made have not been substantiated in practice.

[1] Kern, L.: U.S. Pats. 1144905; 1145370.

Owing to its high power of absorption, diatomite was at one time exclusively used in *dynamite* as a convenient carrier for nitro-glycerine which was loaded into paper cartridges in this form and sold as 75 per cent dynamite or No. 1 Giant Powder. This is the original dynamite invented and manufactured by Nobel. The disadvantage of this dynamite is that it contains at least 25 per cent inert matter (diatomite) which reduces its explosive strength. For this reason the use of diatomite has been largely discontinued in this industry. This absorbent is now replaced by wood pulp, flour, or cornstarch, which will also absorb the nitro-glycerine, but since these contain carbon and hydrogen they combine explosively with oxygen under the proper conditions. These conditions are usually brought about by the presence of sodium and ammonium nitrates in the explosive mixture. However, diatomite is still used to a small extent by some explosive manufacturers in the western part of the American continent and in parts of Europe, as a carrier for the nitrates.

As an absorbent diatomite has many other applications such as for absorbing liquid disinfectants and various chemicals such as acids and bromides.

FILLERS

Finely pulverized diatomite is used as a filler in the manufacture of a large number of products. Besides its use as fillers in the final products, it also, in several instances, acts as a convenient carrier, or distributor, during the actual processes of manufacture.

Diatomite is often used as an "inert" filler for *paints* and *varnishes*. It has the additional advantage that during mixing the diatomite assists in keeping the ingredients from settling. It also extends the colours and helps to give a flat finish when required.

The amount of diatomite now used in the *rubber* industry is comparatively small. Several companies who used it in the past have now discontinued its use since it is claimed that other fillers such as china clay are better and cheaper. It is said that in some rubbers diatomite reduces the tensile strength and dries up the stock so that it becomes difficult to work. It is, however, used in the manufacture of acid-resisting and hard rubbers, such as hard rubber rods, sheets, tubes, rubber valves for water pumps, etc.

The use of diatomite as a filler in *cold-pressed battery boxes* is gaining favour.

It is also sometimes used in combination with bakelite as an insulation filler in the manufacture of *meter terminal boxes* and similar products.

Some of the principal products in which diatomite is used as a filler, are as follows:—

Rubber, gutta percha, magnesite flooring to give an even surface, wooden flooring previous to varnishing or oiling, Portland cement, phonograph records, plaster, papier mâché, blotting paper, sealing wax, insecticides, match heads, wall papers, paint, oilcloth, linoleum, curtain cloth, calcimine, drugs, and in many other products where an inert, light weight filler is required. Some dolls manufactured in Germany are said to be filled with a diatomite composition, thereby rendering them unbreakable.

MILD ABRASIVES

Diatomite is the abrasive base in a large number of domestic *metal polishes* now on the market. Although all diatomites make good metal polishes, their quality varies mainly according to their structure. It is essential that the powder be fine and absolutely free from grit or coarse hard particles. One single hard grain may destroy the finished surface of the metal which is being polished. On the other hand the diatoms are so fragile and have such a low compressive strength that there is no danger of scratching the surface of even the softest metal. The diatoms always break under pressure into minute, sharp, angular or needle-shaped fragments which impart the microscopic scratches comprising a highly polished metal surface. However, if the diatoms are too fragile the process of polishing becomes too slow. Some diatoms are tougher than others and it is claimed that the freshwater types are usually tougher than those of marine origin. Under these circumstances small freshwater diatoms make the most efficient metal polish. This type of diatom (the cylindrical *Melosira*) is typical of the deposits at Quesnel, British Columbia, Canada; also those of Nevada (Electro-Silicon Company and Tri-O-Lite Company) and other western Tertiary freshwater deposits.

Diatomite metal polishes are specially suitable for silverware, surgical or scientific instruments, etc., and are usually marketed in the form of pastes or dry powders. These polishes are seldom made in the liquid form since on prolonged standing the diatomite is liable to sink to the bottom where it forms a cake which in some cases is difficult to break up even on shaking the container, also it does not readily mix with gasoline and allied liquid mediums.

A small amount of mild abrasive considerably improves a rubbing polish for paint or varnished surfaces. By its abrasive action it removes a film from the surface, thereby eliminating minute scratches, brush marks, etc., and this combined with the liquid ingredients of the polish leaves, when properly applied, a well-finished glossy surface. Diatomite is now gaining considerable favour as an *automobile polish,* particularly for surfaces dulled or soiled by use. Continued rubbing in one spot or many applications will, however, eventually entirely remove the top surface and expose the undercoatings or the metal. This type of polish can also be advantageously used for furniture.

The purest and finest air-floated diatomite is used by several manufacturers of *dental powders and pastes.* It is also marketed in the form of small cubes for use as *finger nail polish.* These cubes can be made with the aid of a suitable binder such as plaster of Paris, or else cut direct from compact diatomite deposits.

Although diatomite makes such a good polishing medium it is seldom used for *buffing,* since owing to its high absorption properties, in order to bond sufficiently it requires too much tallow or other greases, which are the most expensive ingredients in grease brick compounds. Other forms of silica which possess the ideal absorption value such as tripoli and amorphous silica are mainly used for this purpose.[1]

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[1] Eardley-Wilmot, V. L.: "Abrasives" (Siliceous Abrasives) Part I, Mines Branch, Dept. of Mines, Rept. 673 p. 72 (1927).

Diatomite makes a very good material for cleaning glass surfaces. It is applied either as a very dilute liquid or with a wet rag coated with the powder. After drying the glass is wiped clean with a soft, dry cloth.

In cleaning compounds diatomite is used to a limited extent as a mild and harmless abrasive in some types of polishing soaps and cleansers. It is also used in some of the floating soaps. For scouring purposes it is too mild and is replaced by pumice or volcanic dust. An English scouring soap on the market at present, contains a little flour emery mixed with the diatomite.

Diatomite acts both as an absorbent for the chemicals and as a friction agent either in match heads or on the sides of the boxes. This use has, however, been discontinued by some large match producers.

STRUCTURAL MATERIALS

Diatomite as a component of the materials used in construction, is being used in increasing quantities.

During the last year or two, the use of diatomite as an *admixture in concrete* has been receiving more attention than has any other of its various uses. Only small percentages, 1½ to 3 per cent, are added; the principal advantages gained thereby are an increase in workability and an increase in strength. These advantages are discussed further and the results of tests are given in Chapter V. The kind of diatomite or types of diatoms most suitable for concrete admixtures are at present undetermined, since up to the present almost all the material used for this purpose, and now on the market, is of one type only. High-grade material does not appear essential and a small amount of clay may even be an advantage in bonding. The crude, uncalcined material is generally used and it is possible that its water of composition (2 to 4 per cent) plays a part in the final setting.

A considerable quantity of diatomite *roofing tiles* is now produced by some of the western United States producers. They are made by bonding and burning in a manner similar to the bricks. Diatomite light weight *building blocks and bricks* are compact and elastic under temperature changes, possess sufficient strength for the purposes required, and resist weathering. These blocks are said to be suitable for buildings in earthquake regions. For structural purposes these products are marketed either in the natural state or made up with clay either with or without burning. Diatomites which contain a little clay and are too impure for most purposes, might advantageously be used here. A typical example of this material is the "moler" from Denmark, a mixture of clay and diatomite, which has been successfully used in buildings in Europe for many years.

BLEACHING

Although the action of bleaching solutions by means of fuller's earth or treated clays has not been satisfactorily explained, it is, however, believed to be due, in part at least, to the presence of colloidal matter. That diatomite actually bleaches is disputed by some chemists as it is claimed that any lightness in colour produced is decolorization due to the removal of minute suspended bodies by direct filtration. It is, however, doubtful in these cases whether different diatomites were tested; some appear to possess more colloidal matter than others, also the nature and type of the diatoms may have some direct bearing on the question, and without extensive tests with different varieties results must be considered inconclusive. It is, however, generally accepted that the average diatomite does possess mild bleaching properties. Samples of dark aniline blue were shaken up with a small quantity of average California diatomite and allowed to settle and it was found that the treated solution was of a decidedly lighter colour than the original. Some diatomites possessing good bleaching qualities contain considerable impurities, which may impart the necessary combination of physical and chemical properties to bring this about. A striking example of this is in the impure diatomite at Copper Creek, Kamloops lake, British Columbia, which contains about 30 per cent diatom silica. (*See* Table XI, analysis No. 5).

Diatomites possessing good bleaching combined with their high filtering qualities are a decided advantage when used in the treatment and filtration of many oils, syrups, and other liquids.

Almost any diatomite can be made suitable for bleaching by means of a preliminary acid treatment. Patents have been issued covering the impregnation of diatomite with starch or other carbonizable material such as molasses. The mixture is then heated to a charring temperature after which it is said to possess good bleaching and purification properties for sugar solutions or other liquids.

CHEMICAL USES

In many of its chemical uses diatomite acts in the capacity of a filler or carrier such as already outlined. It is also used as a body for ultramarine and aniline colours and dyes, casein glue, fireworks, artificial meerschaum, and in the direct manufacture of water glass.

The manufacture of *water glass* or sodium silicate calls for the use of a high grade of silica either in the form of silica sand or diatomite. There are two processes in commercial use for the manufacture of sodium silicate, namely, the "Dry or Fusion Process" which is almost entirely used on the American continent, and the "Wet or Solution Process," mainly used in Europe.

The silica required in the manufacture of silicate of soda should be of a high degree of purity and be entirely free of calcium and magnesium compounds, since these tend to form troublesome insoluble silicates, which are detrimental to the finished product. For the dry process, silica sand similar in texture and quality to a good glass sand is preferable; but for the wet process, diatomite, on account of its fine division and large surface exposure, is preferred, as it is found to go into solution in caustic soda more readily than silica sand or finely powdered flint.

MISCELLANEOUS USES

As a prepared *parting medium,* diatomite has been used only to a small extent in the form of paste to spread on ingot moulds. Good results are believed to have been achieved and probably one reason for its not being used, is the lower price of the tripoli which is at present largely used as a parting medium for the moulds in steel foundries.

Diatomite is often used for *packing* some corrosive liquids such as nitric and sulphuric acids and other reagents for shipment. If the containers break or leak, the highly absorbent nature of the diatomite prevents the escape of the liquid with resultant damages; and on this account freight insurance is reduced. It is also used for the preservation of delicate fruits during shipment from tropical climates.

Diatomite is often substituted for *chalk* in blackboard crayons; *dusting powder* used on automobile tubes, and in numerous other places such as draughtsman's chalk for use in tracing cloth.

Diatomite is used in the *ceramic industry* as a constituent of porcelains and tile glazes, porous chemical ware, etc.

It also has a variety of other uses some of which are as a constituent in *modelling putty; almond meal;* as a *coating for coffins;* as an adulterant in *cheap chocolate creams, flour,* etc. It has also been used as a medium through which to blow air into solutions in order to produce intensely fine *aeration* and *oxidation.* In *suede shoe powders* or sticks, diatomite acts as a cleaning abrasive, as well as a filler and a good absorber of the various colours. Even by itself diatomite makes a fairly good, white shoe powder. Diatomite, being an inert material and not affected by acids, has recently been used in place of soapstone by some English calico-printing firms.

CHAPTER II

EXAMINATION OF DEPOSITS AND TESTS ON DIATOMITE

The commercial uses of diatomite are largely dependent on certain qualities and physical properties which vary appreciably in different diatomites. It is, therefore, essential that the nature of the deposit should be determined and that the material itself should be tested as much as possible for each type of use before being put on the market.

SAMPLING AND EXAMINATION OF DEPOSIT

Sampling

Since all the tests are to be made from the samples, it is highly important that these samples should be truly representative of the material to be ultimately produced.

In compact dry deposits such as occur in the west, sampling is comparatively easy, as many of the beds are exposed by landslides or in steep banks. The material in an individual bed is not likely to vary to any appreciable extent, but different beds often vary both as to chemical composition and types of diatoms. Samples should, therefore, be taken at definite intervals at right angles to the bedding. If no sections are exposed, samples can be obtained by trenching or by boring with a twist auger.

In wet, swamp, or lake deposits it is often difficult to obtain representative samples before any work has been done. A convenient tool is a twist drill made up in 3-foot sections of ¾-inch piping with a T-joint through which a stick can be passed for turning. The bit section should have one foot of twist (of 1½- to 2-inch diameter) so that one foot of material can be taken up at a time. When taking samples at different depths care should be taken to go always into the same hole, not to push, but twist, and draw out carefully every foot. For example, after the fifth 1-foot sample from the surface of the deposit, the drill should be twisted down six feet (top of second section) and drawn up straight without a reverse twist. The sludge on top of the bit is cave-in material from the sides and should be discarded, as well as the outside surface along the bit, the true sample can then be peeled off in the form of a worm. This is then repeated until the bottom of the deposit is reached when the depth and position is noted. Similar samples should be taken at various measured intervals over the deposit. In some of the dry deposits samples can be taken by digging holes at various intervals.

For samples under water the exact position of the hole should be marked with a stake or pipe section as guide, but a better way for shallow lakes is to bore through a 3-inch pipe which has been pushed as far as possible into the deposit.

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Estimation of Tonnage

Since the moisture content and tonnage in place are usually required, it is necessary to have the samples tested and weighed as soon as possible before evaporation takes place, otherwise they should be kept in closed containers until this can be done.

For the tonnage estimation of deposits the area, average thickness, and weight per cubic foot of the material must be known and the last named should be in terms of the dry finished diatomite. The method for determining the weight of the finished product in a cubic foot of the deposit is described later. When this factor has been obtained it is convenient to convert it into tons per foot-acre, for example, the average for the Maritimes diatomite in place is about 12 pounds per cubic foot and is equivalent to about 260 tons per acre of 1 foot in thickness.

TESTS

Colour

Diatomite when pure is snow white and this colour is a good indication of its purity, although some white diatomites may be comparatively high in lime or magnesia. In the western deposits, which are dry and compact, the true colour may be determined by moistening a finely powdered sample. Where exposed to the sun, the face of the deposit often appears a uniform white, but if it be wetted, bands of varying shades of cream to yellow-brown are revealed. If present, the higher the clay (alumina) content the darker will be the colour. Small pieces from different parts of the deposit may be conveniently compared by moistening with the tongue. The various colours of the swamp or lake deposits have already been mentioned, but their colour in the crude state is of little guide, as they are rarely marketed without calcining, though in the Maritime Provinces the cinnamon-coloured material is usually the best. The true test is the colour after calcining at a temperature of about 600° C. to burn off the carbonaceous matter and other volatiles. If the calcined material is pink, iron is present, and the diatomite is undesirable for many uses including filtration, unless the iron content is not high or the material has been given special treatment during calcination.

Micro-analysis

One of the first and essential tests is a microscopic examination to determine the type and nature of the diatoms and existence of impurities. A rough method is to put a small quantity in a beaker with a comparatively large volume of water, stirring well to break up the lumps and then before the solution settles to transfer, with the stirring rod, a drop onto a clean dry micro-slide or convenient piece of glass. The drop should be spread out into a circle of about ½-inch diameter so as to spread and separate the individual grains as much as possible. The excess water is then evaporated off or else a thin cover glass can be put over the drop, care being taken not to crush the diatoms. On examining the wet solution with a microscope (using 250 or preferably 500 magnification), the diatoms (especially some types) are often difficult to see owing to the closeness of their refractive index to water, but their faint outline can be picked out on close examination. On the other hand, the more solid impurities and mineral silica (silt, etc.) stand out in comparatively bold relief, thereby indicating the presence of a large or small per cent of non-diatomaceous silica. As the slide dries the diatoms and minute fragments begin to appear. If the sample is impure and too much material is on the slide it is often difficult to make satisfactory examination when it is perfectly dry owing to the excessive masking of the individual particles. Another and a more rapid method is to place a very small bit of the dry material on the slide, add a drop of water or alcohol, stir and spread gently. Alcohol evaporates quickly and is better than water.

PREPARATION OF STREWN SLIDES

The most satisfactory way, however, is to spread a drop of the water solution (mentioned above) onto a thoroughly clean and dry cover glass and evaporate to dryness over a small flame. A small drop of prepared storax is then placed in the centre of the micro-slide and the cover glass is placed face downward onto the drop of storax. The slide is then gently heated from underneath till the air is boiled out; the slide is then cooled rapidly. Owing to the large difference in refractive index between the diatoms and storax the former stand out very clearly and the minute markings can be readily seen, and further, the fragments and numerous diatoms which in the first examination could not be recognized can now be identified. If necessary the slide can be labelled and kept for further reference. Storax is prepared by dissolving ordinary commercial storax in alcohol and filtering the solution two or three times. The excess of alcohol is then gently evaporated off, after which the purified storax can be bottled for use. Canada balsam can also be used, but is not so good as storax. Some synthetic resins are, however, superior to any natural gums. One of these, which is an orange-coloured resin dissolved in aniline, is called "A.F.S." and is manufactured in San Francisco. It has a refractive index of 1·83, which is far above that of the common type of mounting mediums (Canada balsam, 1·53, and storax, 1·58), and causes the diatoms and their minute markings to stand out in great contrast. An announcement of this medium was made in a recent issue of "Science".[1] The method of cleaning and preparing diatoms for mounting is described at the end of this report.

RECORDING OBSERVATIONS

After having prepared the material by the above or any other method, the following should be noted during examination: extent of visible impurities; the proportions of large and small diatoms; the extent to which they are broken and comparative size and proportion of fragments; the prevailing type or types; their uniformity and shapes, and whether they are clear or are filled and coated with "dust". A sample of the calcined material should also be prepared and examined in a similar manner.

As a result of the above examination an approximate estimation can be formed as to the commercial utility of the diatomite and the industries for which it should be most suitable. Some suitable types of diatoms have been discussed in the section dealing with general and individual uses.

[1]Hanna, G. D.: "A.F.S.—A New High Refractive Index Resin"; Science, Jan. 14, 1927, pp. 41, 42.

Estimation of Grit

The presence of grit (hard impurities and non-diatomaceous silica) can readily be detected by spreading some of the dry material on a glass surface and slowly drawing the flat of a knife blade (with slight pressure) across it. A rapid and (with practice) a more sensitive method is by the feel between the teeth. Clean diatomite feels like blotting paper and any grit can at once be distinguished, and even an approximate estimate as to the abundance of coarse grit particles can be formed. For rapid examination of wet deposits containing different layers of diatomite as well as other material, this method is invaluable. A fair idea as to the percentage of harmful or coarse grit can be obtained by thoroughly stirring up a previously weighed dry sample with a comparatively large volume of water, allow to settle for half a minute and then decant. Repeat this a number of times taking care always to break up any lumps or masses. After 5 or 6 times, this solution will clear quickly and the residue should be dried and examined with a microscope and if no diatoms are present other than a few isolated specimens of the very largest type, the grit can then be weighed and its proportion estimated. If many diatoms are present the washings can be continued with shorter periods of settling. Any grit that is decanted off with the diatoms would be too fine to seriously affect the value of the material, but coarse grit is very harmful and must be eliminated before marketing, especially for metal polishes.

Weight per Cubic Foot

In order to estimate the available tonnage of a deposit the weight-volume of the deposit in place should be reduced to terms of the marketable product. In order to do this several blocks should be cut out whenever possible, carefully trimmed, and the volume measured. After they are thoroughly dried and weighed, the average weight per cubic foot can be calculated for material that can be marketed in this form.

The apparent density of a weighed block of solid, dry diatomite can also be calculated from the weight of the water displaced by complete immersion. The sample must, however, be previously coated with paraffin to render it impervious to water. By substituting mercury, which will not be absorbed, it can be immersed direct. A convenient form of apparatus having a gooseneck attachment is described by G. W. Davis.[1]

In swamp deposits in which the material is soft, and cannot be cut into blocks, the samples can be placed in containers of known (or afterwards determined) volume. This should be done immediately the sample is taken, and packed in exactly the same condition as it occurs in the deposit, care being taken to fill the container completely without undue pressure or shaking. The sample can be weighed both wet and after thoroughly drying, the difference giving the percentage of moisture. It is then calcined in order to prepare it for market and again weighed, the difference between the last two being loss on ignition (carbonaceous matter, combined water, etc.). The weight of the calcined material which is in a marketable condition and the original volume being known, the weight of finished product in a cubic foot of the deposit can then be calculated.

[1] Davis, G. W.: U.S. Bur. of Mines Repts. Investigation, Serial 2718 (Nov. 1925).

No standard methods for accurately determining the weight per cubic foot or apparent density of the finished powder has been devised as yet. The weight of the powder placed into a container of known volume varies considerably according to whether it is put in loosely, shaken, or tamped with a rod, and also on the human element. However, a number of different samples measured by the same person and method should give an accurate relative comparison. A simple method is to loosely fill a container with freshly screened powder which is free from lumps or "balls", and scrape off the excess with a straight edge. The weight of the diatomite divided by the weight of an equal volume of water will give the apparent density and this factor multiplied by 62·5 will give the weight per cubic foot. The container should not have a curved edge or lip, an ordinary straight glass tumbler being quite suitable. The figures obtained by this method will be somewhat lower than the shipping weight of the bagged material, since the latter will be shaken down and compressed. A definite amount of shaking or "rodding" of the sample, in order to equal shipping conditions, can be devised in the laboratory.

The apparent density of any diatomite is a guide to many of its physical properties and is a highly important factor in pre-determining its industrial uses, those of the lowest density being best suited for most purposes.

The densities and weight of a few diatomite samples, determined by the method recommended above, are given in Table II.

TABLE II

Apparent Densities of Some Diatomites

Location of sample	Apparent density	Pounds per cubic foot
Digby Neck, N.S. (calcined powder)	0·182	11·5
Oxford Tripoli Co., N.S. (calcined powder)	0·205	13·0
Lake Michel, Chertsey, Que. (crude powder)	0·277	17·5
Quesnel, B.C. (crude powder)	0·287	18·0
Quesnel, B.C. (cut block)	0·544	34·0
Lompoc, Cal. (Celite, crude concrete grade powder)	0·158	10·0

Porosity

A diatomite having high porosity or high power of absorption is particularly valuable as a heat insulator, or as a filter medium. In most diatomites the power of absorption varies according to its apparent density, the lower the density the higher will be the absorption.

The absorption values of a compact diatomite can be obtained by taking a cut block, drying and immediately weighing and then saturating with water and again weighing. The difference, being the water absorbed, can be expressed either in terms of per cent of its own weight or as the coefficient of absorption which is an expression of cubic centimetres of water absorbed per gramme of the dried sample.

For a powder, water is gradually added to a sample placed on a plate and worked in with a spatula until the material starts to flow. Enough fresh powder is then added until the mixture will just stand up by itself, but not as a pulverent (powdery) mass. The mixture is then immediately weighed, completely dried at 105° C., and again weighed. The difference in weights gives the water absorbed. After some practice the absorption point can be recognized without having to take up the excess of water with fresh powder.

Chemical Analysis

The main ingredients to be determined are silica, iron, alumina, lime, magnesia, organic matter, and combined water. High silica is very important, but it must be diatom silica; chemical analysis does not distinguish it from ordinary silica or silicates and this can be done only by means of the microscope. Iron is injurious for almost all uses, particularly filtration, and should be below 1·5 per cent. Alumina is generally represented by clay and a high content is injurious for many uses. However, for the manufacture of brick or bonded product some clay may be slightly advantageous, and it may not be detrimental in concrete mixtures. Lime and magnesia are not usually high and do not appear to have any marked injurious effects. Organic matter can be completely removed by calcining, although if the proportion is high the marketable tonnage of a deposit is considerably reduced and for this reason the mining and production costs of the finished product are likely to be high. Combined water is always present in the crude state and can be driven off by calcination if so desired.

A brief outline of a method of analysis is hereby quoted from an article by P. A. Boeck.[1]

Chemical Analysis:—One-half gramme sample is weighed in a platinum crucible, heated to redness to drive off organic matter, cooled, moistened with small amount of distilled water, about four drops of dilute sulphuric acid and one cubic centimetre of hydrofluoric acid added. Heat on a sand bath to fumes, and repeat the operation until decomposition is complete, after which the crucible is ignited strongly until constant in weight. The loss consists of moisture, organic matter, combined water and silica. Of these the moisture is determined on a separate sample at 105° C. and the organic matter and combined water are determined on the same sample as "Loss on Ignition" by continued strong heating until constant weight is obtained. These values are then deducted from the complete loss, giving the silica content of the sample. The residue from the hydrofluoric acid treatment is fused with sodium potassium carbonates, dissolved in diluted hydrochloric acid, oxidized with bromine water and the hydroxides precipitated by means of ammonia which are filtered off, ignited, and weighed. In the precipitate the iron, alumina, and titanium oxides are determined by any of the well-known methods and the lime and magnesia determined in the filtrate.

Thermal Conductivity

Thermal conductivity is the quantity of heat that passes by internal radiation, conduction, and convection through unit cross-sectional area, of unit length or thickness, at unit thermal potential difference, in unit time. These are expressed as the number of British thermal units transmitted per square foot of material, one inch thick, in one hour, for a temperature difference of one degree F. This can be converted to the c.g.s. system, by dividing by the factor 2903.

[1] Boeck, P. A.: "The Kieselguhr Industry", Chem. and Met. Eng., vol. 12, p. 113 (Feb. 1914).

The measurement of the thermal conductivity of different diatomites and their comparison with other materials is somewhat beyond the facilities of the average diatomite producer's laboratory. A method of conducting the tests, formulæ used, and sketch of apparatus are given by Calvert and Caldwell.[1]

Briefly, this apparatus, designed by the U.S. Bureau of Standards, consists of a circular, double hot plate mounted horizontally midway between two water-cooled copper plates of the same diameter. The two specimens to be tested are placed on either side of the hot plate between it and the water coolers. The whole is enclosed in the centre of a larger circular container and the intervening space filled with a good insulator, such as powdered diatomite. The heating elements are spirally wound on the plates and two differential thermocouples are embedded in the surface of each face of the hot plate. In the latest apparatus hot plates of alundum or carborundum are used. Diatomites of different apparent densities have different conductivity values, also the conductivity of the same material rises as the temperature is raised, so that a series of readings must be made when testing.

The thermal conductivities of various materials are shown in Figures 1 to 4.

[1] Calvert, R., and Caldwell, L.: "Loss of Heat from Furnace Walls", Ind. and Eng. Chem., vol. 16, pp. 483–490 (May 1924).

CHAPTER III

MARKETS AND PRICES

Crude diatomite is marketed in the form of sawed blocks or ground into aggregates or powder. Sometimes blocks from the quarries are sold as crude material for the preparation of products or compounds. The greater quantity is, however, marketed after calcining and treating. The market distribution is indicated in the long list of its uses.

UNITED STATES

The prices of diatomite have been steady for the last few years, but vary considerably according to grade, density, and ultimate use.

The following are the United States quotations for June 1927.[1]

Diatomite per short ton, f.o.b. plant:—Kiln-dried brick, $65; kiln-fired aggregate ¼ in., $45; insulating powder, $30; natural aggregate ¼ in., $20; air-floated powder, $40; over 85 per cent silica, 98 per cent through 200 mesh, $15 to $16, depending on quantity.

The above quotation was the same for the previous 12 months. Much of the business in filtration materials, which calls for powders ranging from 10 to 15 pounds per cubic foot, is done on a contract basis of about $20 to $25 per ton.

Bricks and blocks, being fragile, must be packed in cartons or crates. The powders and aggregates are packed for shipment in burlap bags holding 90 to 100 pounds each. The crude air-dried material is shipped in bulk. Owing to the very light weight and great bulk of the material, the freight rates are naturally high and the maximum possible load rarely exceeds the minimum 20-ton car. One producer presses the filled bags between rolls in order to reduce the shipping bulk.

GREAT BRITAIN

The following extract shows the market quotations in the United Kingdom early in 1926.[2]

Shipments are usually made in bags, and quotations are per long ton c.i.f. United Kingdom port. Prices vary anywhere from £2 10s. up to £12 per ton, but recent quotations based on samples furnished to this office are as follows: Algerian diatomite snow white £8 per ton in free bags c.i.f., Liverpool, in 10-ton lots; Spanish white milled diatomite £5 18s. in 50-ton lots; Irish diatomite raw milled, one-eighth inch mesh £3 10s., in free bags c.i.f., Liverpool, in 10-ton lots. Norwegian diatomite, brown milled and white milled, same prices as Irish, excepting delivery is c.i.f., Liverpool. A further set of samples are quoted as follows:—Spanish £8 10s., c.i.f.; Algerian, 3 samples £5 10s., £5 7s. 6d., and £5. Descriptions of different varieties usually give the specific gravity and full analysis particulars.

The following tables of imports are given as a guide to consumption.

[1] Eng. and Min. Jour. Press, June 4, 1927.
[2] Commercial Intelligence Journal, March 6, 1926.

TABLE III

Imports of Diatomite into Great Britain[1], 1922-1926

Exporting country	1922 Quantity	1922 Value	1923 Quantity	1923 Value	1924 Quantity	1924 Value	1925 Quantity	1925 Value	1926 Quantity	1926 Value
	Long tons	£	Long tons	£	Long tons	£	Long tons	£	Long tons	£
Norway	76	1,180	92	902	70	1,353	225	1,559	761	2,944
Germany	1,701	11,237	1,059	5,502	723	4,094	501	2,972	697	3,491
France	228	1,342	283	1,250	630	3,120	308	1,144	832	2,646
Algeria	1,943	10,187	2,299	10,803	2,738	11,310	2,722	11,684	2,768	11,075
Spain	638	5,753	623	4,149	762	4,434	713	5,121	745	4,778
United States	778	9,341	1,570	16,055	1,274	13,345	909	9,518	1,591	16,822
Other foreign countries	145	1,281	364	2,756	291	1,494	376	2,478	1,630*	4,273
Total from foreign countries	5,509	40,321	6,290	41,417	6,488	39,150	5,754	34,476	9,024	46,029
Total from British possessions	......	......	......	......	253	1,068	21	193	36	685
Total	5,509	40,321	6,290	41,417	6,741	40,218	5,775	34,669	9,060	46,714

* Includes 1,468 tons from Sweden.

TABLE IV

Some Countries Importing Diatomite[2]

	Long tons							
	1919	1920	1921	1922	1923	1924	1925	1926
United Kingdom	(a)	2,386	3,518	5,481	6,229	6,644	5,633	8,091
Algeria	......	20	14	17	40	(a)	(a)	(a)
Esthonia	(a)	(a)	(a)	(a)	(a)	12	39	21
Finland (e)	(a)	103	156	217	505	186	297	434
France (b)	3,233	2,155	1,622	1,378	1,824	2,506	2,884	3,221
Germany	(a)	501	18	64	55	4,250	4,609	7,310
Hungary	(a)	(a)	(a)	(a)	(a)	54	76	34
Italy:								
Crude	(a)	(a)	(a)	(a)	(a)	168	90	190
Calcined	(a)	(a)	(a)	(a)	(a)	141	273	138
Jugoslavia	(a)	(a)	(a)	(a)	(a)	163	187	99
Latvia	(a)	(a)	(a)	(a)	(a)	36	102	112
Poland (e)	(a)	(a)	(a)	(a)	(a)	2,624	1,164	1,563
Peru	(a)	(a)	(a)	(a)	151	51	27	(a)
Sweden (c)	477	299	155	263	441	1,272	2,133	7,795
United States (d)	(a)	(a)	(a)	339	363	194	(a)	(a)

(a) Data not available.
(b) Mainly from Algeria.
(c) Including bauxite and cryolite.
(d) Including tripoli and rottenstone.
(e) Total imports.

[1] Commercial Intelligence Journal, No. 1153, p. 309, March 6, 1926; also private information.
[2] Imp. Inst. "The Mineral Industry of the British Empire and Foreign Countries", Statistical Summary (Annual)

CANADIAN CONSUMPTION OF DIATOMITE

During 1926 a large number of possible users of diatomite in Canada were communicated with, as the result of which the following table has been compiled. It is more than probable that many firms using this material in one of its numerous applications have not been approached. For insulation, for example, its use is almost unlimited and can be installed with advantage in every form of heating unit, so that an accurate estimation is almost impossible. On the other hand, many heat insulation installations will last for many years so that a true annual average can only be obtained over a period of several years. This compilation may, however, be found useful as a guide.

TABLE V

Canadian Industries in which Diatomite is Used, 1926

	Approximate quantity used annually	
	Tons	
Abrasives (polishes, tooth powders, etc.)		15
Catalytic agents (oil hardening, etc.)		35
Chemicals (packing, filling, etc.)		5
Filtering:		
Flavouring extracts	3	
Gas (acetylene, etc.)	15	
Starch, etc	60	
Sugars (cane, maple, etc.)	1,400	
Vinegar, wine, beer	50	
Various (oils, perfumes, etc.)	10	
		1,538
Fillers:		
Matches, etc	16	
Paint and varnish	4	
Rubber, also batteries, meter boxes, etc	10	
Miscellaneous	10	
		40
Fire-proofing (safes, etc.)		12
Insulation (powders and manufactured products, bricks, etc.)		650
Various minor industries		5
Total		2,300

NOTE.—The amount of diatomite used as a concrete admixture is rapidly increasing, but statistics are unavailable and are not included in the above table. It is believed, however, that 300 tons were used in Canadian concrete in 1927.

Prices in Canada

The prices of powdered diatomite imported from United States in carlots during 1927 were as follows: filtration materials, $78 to $90, depending on grade; insulation, $78; for concrete, $60; best metal polish (l.c.l.), $200. For small lots of less than quarter of a ton the prices in some cases were almost double the above.

TARIFF

Imports. Crude or ground diatomite powders at present (1927) enters Canada on the free list under Sec. 297—"Silex and crystallized quartz, ground or unground." For manufactured products such as diatomite bricks, insulation slabs, moulds, pipe-covering compounds, etc., the duty is 22½ per cent.

Exports. Diatomite exported into the United States is apparently classified with tripoli on the free list under Sec. 1675 of the Tariff Act of 1922.

1675. Stone and sand, burrstone in blocks, rough or unmanufactured, quartzite, traprock; rottenstone; tripoli, and sand, crude or manufactured; cliff stone, freestone, granite and sandstone, unmanufactured, and not suitable for use as monumental or building stone; all the foregoing not specially provided for.

In the list of imports entered for consumption into the United States for 1925, the following item appears under "Natural Abrasives and Manufactures of"[1]—Tripoli, diatomaceous earth, rottenstone—unit of quantity, ton—rate of duty, free.

[1] Foreign Commerce and Navigation of the United States for 1925. Dept. of Commerce, vol. II, No. 9, p. 67 (1926).

CHAPTER IV

WORLD'S OCCURRENCES AND PRODUCTION OF DIATOMITE

Although diatomite occurs in nearly every country in the world, it has been produced by only 14 countries during the last 10 years (*see* Table VI), as in most countries the deposits are very small and impure, or are confined to lakes or swamps which cannot be economically operated. The United States is the largest producer and the deposits in California are the largest so far discovered in the world. Large deposits but of lesser extent occur in Canada, Algeria, Germany, and Denmark.

All the large deposits of great thickness—some of which are as much as 2,000 feet—occur as dry, compact beds which were formed in the Tertiary period and are often of considerable elevation above the present level of the water. Parts of these beds are in the form of hard diatomaceous shales and in places are so chalcedonized as to be of little commercial value. Such deposits are usually of marine origin, though there are some exceptions, one of which is the extensive freshwater deposit along the Pitt river, north California.

The diatoms in all these Tertiary deposits appear to be the same types and species as those found living in the present day.

PRODUCTION

The following table gives the world's production since the beginning of the Great War.

TABLE VI

World's Production of Diatomite Since 1913[1]

(Long Tons)

—	1913	1914	1915	1916	1917	1918	1919
Algeria (b) (h)	4,100	(a)	(a)	(a)	(a)	(a)	1,219
Australia:							
New South Wales	24	24	39	235	139	20	88
Victoria	149	999	273	....	749	139	156
Canada	....	....	283	554	536	446	504
Chosen (d)	(a)	(a)	(a)	(a)	(a)	(a)	(29,543)
France	1,695	(b)	(a)	(a)	(a)	(a)	2,500
Germany (b)	....	....	....	....	....	....	(a)
Ireland (b)	153	....	....	....	....	....	6,958
Italy	3,000	3,000	3,000	3,000	100	5	15
Japan	....	....	....	....	....	....	(a)
Norway (b)	....	....	....	....	....	....	88
South Africa	....	....	....	....	....	....	....
Spain	(a)	(a)	(a)	(a)	(a)	(a)	(a)
Sweden	(a)	(a)	(a)	(a)	(a)	(a)	611
United States	5,873	9,830	(f) 4,096	(f) 2,426	(f) 2,704	(f) 2,644	38,073

TABLE VI—*Concluded*

World's Production of Diatomite Since 1913[1]—Concluded

(Long Tons)

—	1920	1921	1922	1923	1924	1925	1926
Algeria (b) (h)	1,476	1,563	3,172	9,800	8,946	8,209	7,804
Australia:							
New South Wales	388	206	481	515	564	701	911
Victoria	996	....	....	....	....	....	....
Canada	232	304	196	116	32	nil	(g) 60
Chosen (d)	(28,330)	(23,907)	(38,241)	nil	nil	nil	nil
France	3,700	4,500	4,552	4,477	2,300	4,919	(b)2,982
Germany (b)	4,864	3,360	5,123	4,030	4,256	4,482	5,824
Ireland (b)	6,203	4,161	1,879	1,654	2,441	3,343	2,975
Italy	25	861	172	413	413	413	1,200
Japan	9,500	nil	4,617	5,234	4,959	4,651	(a)
Norway (b)	74	111	80	109	66	47	57
South Africa	....	....	(e) 240	213	232	....	....
Spain	(a)	480	514	852	398	854	....
Sweden	611	590	315	685	598	806	....
United States	55,288	49,227	66,934	58,779	56,396	65,205	77,791

[1] Statistics 1913-18 calculated from U.S. Bur. of Mines "Abrasive Materials in 1923", p. 336. 1919 to date Imp. Inst. "The Mineral Industry of the British Empire and Foreign Countries", Statistical Summary (Annual). Also private information. A considerable tonnage of "moler" is mined annually in Denmark, of which no records are available.

(a) Data not available.
(b) Exports.
(c) Including re-exports.
(d) Calculated from U.S. Bur. of Mines "Abrasive Materials in 1923", p. 336. (Recent investigation has shown this to be silica sand and that practically no diatomite has been produced in Chosen).
(e) Estimated.
(f) Diatomite for special uses not included.
(g) Mined, but not shipped.
(h) For the last four years the annual Algerian production is given as 10,000 tons.

CANADA

Early History

EARLY DISCOVERIES

In the early Geological Survey reports between 1870 and 1877 Dr. G. M. Dawson records the discovery of diatomite in the Blackwater river, Tsacha and Loon lakes in the central interior plateau of British Columbia. In the latter part of the '70's some deposits in the Maritimes were also discovered, notably Pollet lake in Kings county, New Brunswick. Between 1880 and 1885 diatomite was discovered in Folly, Fountain, and Earltown lakes, and in several other localities in the Cobequid mountains in northwestern Nova Scotia; also at St. Ann, Cape Breton. In 1887 the Fitzgerald lake, N.B., deposit was located by Wm. Murdock of St. John and called the "Elderslie Silica Mine." During 1893 the diatomite in lake Michel, Chertsey township, Que., was used by the local inhabitants for whitewashing their buildings.

EARLY EXPERIMENTS

About 1879 a series of experiments as to the adaptation of Canadian diatomites to commercial uses was conducted by Dr. Hoffmann in the laboratory of the Geological Survey and the results were published in detail.[1] The samples were collected by R. W. Ells from the Pollet Lake deposit. The experiments were mainly devoted to the manufacture of light weight insulating bricks in which varying percentages of clay and lime were used as bonding material. It was noted on burning that the red colour due to iron was bleached white by the addition of lime or small proportions of magnesia. Numerous uses were suggested as follows:—

> The extreme facility with which it is dissolved by caustic alkalis (potash or soda) would suggest its advantageous employment for the manufacture of what is commonly known as "water glass" or "soluble glass" a preparation which meets with many important applications in the arts, as for instance, as a cement for the manufacture of artificial stone; for the hardening and preserving of building stones; in fixing fresco colours by the process of stereochromy; as an addition to soap in the preparation of the so-called "silicated soaps," etc.

The principal uses for diatomite at that time were as a metal polish and as an absorbent in the manufacture of dynamite, but its suggested use "as a cement for artificial stone" is of interest since its application as an addition agent for concrete has been commercialized only in the last few years.

HISTORY OF OPERATIONS

In spite of the success of Dr. Hoffmann's experiments and the many discoveries of diatomite in Canada, no mining is recorded until 1895, when the Fossil Flour Company drained Silica lake (Bass River lake) west of Folly lake, Colchester county, N.S. In the following year the company produced 624 tons valued at $9,760. During the same year the Victoria Tripolite Company was formed and produced 20 tons from Munro point, St. Ann, Victoria county, Cape Breton. They made products such as heat-protecting compositions, paste and powder polishes, bricks, etc. In 1900 the St. Ann's deposit was leased to the Premier Tripolite Company of New York. During 1901 the "Cairo Polishing Company" did some exploratory work on deposits in the vicinity of River Denys, Inverness county, Cape Breton, but no output is recorded. The Fossil Flour Company shipped their calcined product to their mill at Portland, Maine, but in 1905 their plant at Silica lake was destroyed by fire after which the "Bass River Infusorial Earth Company" was formed. However, no production was recorded until 1912, when the property was taken over by the present holders, the "Oxford Tripoli Company," who built a calcining plant at Silica lake. In the meantime only a small intermittent output was obtained from St. Ann, the last amount mined being 20 tons in 1913, though a few sales were made annually from stock until the company liquidated in 1919.

[1] Geol. Surv., Canada, Reports of Progress 1878–9 and 1879–80; Extract Geol. Surv., Canada, Ann. Rept. 1902, vol. XV, Part S (1903).

In 1909 Wm. Murdock of St. John, N.B., organized the "Boston and St. John Tripolite Company" to operate the deposit at Fitzgerald lake; a kiln was built and some material treated, but there is no record of output. In 1916 the Oxford Tripoli Company mined 3,600 tons, which constitutes a record, but as they mined on alternate years and shipped annually from stock, only 620 tons were shipped from the mill during the year to their treatment plant at Haverstraw, New York.

Distribution

Diatomite is found almost all over Canada, but mainly in the Maritime Provinces and British Columbia, and a few deposits in Ontario and Quebec. In all, over 100 occurrences are known, but the majority are shallow and small. The greatest number of these occur in the Cobequid mountains of northwestern Nova Scotia, but the largest and purest deposits so far discovered are those in the vicinity of Quesnel, British Columbia.

Diatoms

Samples of Canadian diatomites were submitted by the writer in 1924 to Dr. C. S. Boyer, A.M., F.R.M.S., of Philadelphia, who made a detailed analysis of the diatoms present. This work has been published as a separate Museum Bulletin by the Department of Mines.[1]

The eastern deposits vary considerably in the aggregate of species, of which, however, a certain number appear to be almost invariably present. Among these may be mentioned *Eunotia major*, *Cymbella ventricosa*, *Stauroneis phoenicenteron* and *Pinnularia major*. *Eunotia* and *Pinnularia* predominate in the actual number of samples and in the variations of the species. Of all the genera, *Eunotia* varies more than any other and it may be said to characterize Canadian diatom deposits. Plate I illustrates some typical Canadian freshwater diatoms.

The distribution of the samples from 51 deposits is as follows: Nova Scotia, 27; New Brunswick, 6; Quebec, 6; Ontario, 4; and British Columbia, 8. In the last named, about a dozen samples taken over an area of many square miles in the vicinity of Quesnel were found to be identical, and are treated as one deposit.

NUMBER AND TYPES OF DIATOMS IDENTIFIED

Thirty-two genera of diatoms were identified in which are represented 177 different varieties. The principal genera are: *Cymbella*, *Eunotia*, *Fragilaria*, *Gomphonema*, *Melosira*, *Navicula*, *Neidium*, *Pinnularia*, *Stauroneis*, and *Surirella*.

The most universally represented diatoms in their order of importance are as follows:—

[1] Boyer, C. S.: "List of Quaternary and Tertiary Diatomaceæ from Deposits of Southern Canada", Mus. Bull. No. 45, Geol. Surv., Canada, 1926.

TABLE VII

Principal Canadian Diatoms

Name of diatom	Reference[1]	Number on Plate I	Percentage of deposits in which diatom occurs
Stauroneis phoenicenteron	Pl. 27, f. 1	1	86
Pinnularia major	Pl. 28, f. 4	31	82
Cymbella ventricosa	Pl. 18, f. 14, 22	19	76
Eunotia major	Pl. 13, f. 1, 2	33	73
Neidium iridis	Pl. 21, f. 17	4	73
Gomphonema constrictum capitatum	Pl. 19, f. 22	25	70
Pinnularia brebissonii	Pl. 29, f. 12	34	67
Pinnularia dactylus	Pl. 28, f. 3		67
Tabellaria fenestrata	Pl. 8, f. 11, 12	21	65
Eunotia pectinalis	Pl. 13, f. 6, 7	17 (Not noted in B.C.)	63
Gomphonema acuminatum coronatum	Pl. 19, f. 7	24	60
Eunotia robusta	Pl. 13, f. 13-21	14, 15	60
Frustulia rhomboides	Pl. 17, f. 2	26 (Not noted in B.C.)	60
Cymbella cuspidata	Pl. 18, f. 17	9	53
Tabellaria flocculosa	Pl. 8, f. 9, 10	—— (Not noted in B.C.)	51
Stauroneis anceps	Pl. 27, f. 5, 7	2	50
Diploneis finnica		—— (Not noted in Ont.)	49
Pinnularia gibba		12 (Confined to Maritimes)	49

[1] Boyer, C. S.: "The Diatomaceæ of Philadelphia and Vicinity", 1916 (143 pp. and 700 drawings).

Of the different samples examined by Dr. Boyer, those of Earltown lake, Nova Scotia, (Plate XIF), Folly lake, Nova Scotia, and Fitzgerald lake, New Brunswick (Plate XIID), are the most prolific, nearly all the forms occurring in them. The most remarkable deposit, however, is that of Jacquot river, Quebec, (Plate XIIIB), containing the seed-like diatoms which are found in no other deposit in North America. The Quesnel occurrences, British Columbia, (Plates X and XI), are apparently all alike; the deposits are pure and consist almost entirely of an unusual variation of *Melosira granulata.* The diameter of these frustules, in proportion to their length, varies greatly, the smallest forms appearing as *Melosira granulata spiralis.* This species, characteristic of the massive beds, 800 feet above the river, at Quesnel, B.C., is also found under water in the Clear Lake and Brora Lake (Plate XIIB) deposits.

The diatoms in the British Columbia, Ontario, and Quebec deposits are much better preserved than in those of the Maritimes. In many of the Maritime deposits the diatoms are badly broken. The number of species found in Nova Scotia is much greater than the number occurring in New Brunswick, the deposits of which include many spicules of freshwater sponges. In many respects the eastern Canadian deposits resemble those of the eastern United States as well as those of Scotland.

Microphotographs (Plates X to XV) illustrate the general appearance of the crude diatomite from many deposits in the Dominion as well as some in the United States.

Canadian Production of Diatomite

TABLE VIII

Canadian Diatomite Production[1]

Year	Tons	Value	Year	Tons	Value	Year	Tons	Value
		$			$			$
1896........	644	9,960	1906.....	....	....	1917.....	600	18,000
1897........	15	150	1907.....	30	225	1918.....	500	12,500
1898........	1,017	16,660	1908.....	30	195	1919.....	565	11,300
1899........	1,000	15,000	1909.....	....	....	1920.....	260	8,600
1900........	336	1,950	1910.....	22	134	1921.....	341	11,268
1901........	850	15,300	1911.....	20	122	1922.....	219	5,781
1902........	1,052	16,470	1912.....	38	230	1923.....	130	3,250
1903........	835	16,700	1913.....	620	12,138	1924.....	33	838
1904........	320	6,400	1914.....	650	13,000	1925.....	....	....
1905........	200	3,600	1915.....	317	12,119	1926 (a) .	....	....
			1916.....	620	12,139	1927.....	266	6,650
							11,530	230,679

[1] Mineral Production of Canada, Annual Reports.
(a) About 60 tons mined and treated. No shipments.

Of the above production about 1,000 tons valued at $6,700 were shipped from the deposits at St. Ann, Cape Breton, and all the remainder from Silica lake, Colchester county, N.S., except that produced during 1927, which came from Rhude pond.

Principal Deposits in Canada

BRITISH COLUMBIA

The diatomite deposits of British Columbia can be roughly divided into three types: (1) those that occur at the bottoms of lakes or swamps; this is characteristic of the Quaternary deposits of the Maritimes and Ontario; (2) those that occur as a dry powder, not under water, but in the immediate vicinity of lakes and streams and at a slight elevation above them; (3) Tertiary deposits that occur as compact massive beds several hundred feet above the present rivers and lakes, and which are frequently overlain by thick beds of soil, lava flow, etc. The last-named deposits, which at present have been found only in the Quesnel and Fraser River valleys, are by far the most extensive in the Dominion, and are of considerable purity, though somewhat above the average in their lime and alumina contents. These deposits all contain a high percentage of unbroken diatoms, but their average size is smaller than those of the east. Exceptionally well-preserved diatoms occur in the following deposits: Quesnel; Stewart lake[1] near Powell River; Bear lake, Vancouver island; and Guichon creek near Mamit lake. With the exception of the diatomite in the Quesnel region, all the recorded deposits in British Columbia are small and shallow and are of doubtful commercial value, except for local use or small-scale operations.

[1] This very small deposit is the cleanest and purest natural material found in the Dominion by the writer. (*See* Table XI, analysis No. 6a.)

Ashcroft Mining Division

Pukaist Creek, Highland Valley. About 25 miles southwest of Ashcroft in the vicinity of J. M. Frazer's farm (sec. 25, tp. 18, R. 24, W. of 4th mer.) where Wood creek joins Pukaist creek, about 18 inches of dry, yellowish grey diatomite occurs in the fertile meadows under 2 or 3 feet of soil. Along the edges of the deposit the diatomite is close to the surface and in places attains a depth of 3 feet, the material being quite pure and free of organic matter. (*See* Table XI, analysis No. 1.) It appears as if the whole valley was at one time a lake, the bottom of which was covered with about 3 to 5 feet of diatomite, but that the top portion of the bed has since been washed away and filled up with vegetation. Immediately under the diatomite is a thin bed of chocolate-coloured clay which is underlain by slate-grey clay. The best area seen was close to Frazer's farm, two or more feet of the material having been excavated during the erection of his out-buildings.

The material becomes pink on calcining, and a large proportion forms into small hard lumps. The diatoms are somewhat broken, but there is a fair percentage of well-preserved *Epithema.* (Plate X A.)

The valley and meadows extend northeast for at least 6 miles and.in many places over this area test holes showed thin beds of diatomite under 2 or 3 feet of soil. The farthest limit examined was William Bose's farm where small quantities of diatomite were observed.

Although the aggregate tonnage is large, it is spread over the area as a thin bed under the soil, the maximum thickness of 3 feet being found only on the higher ground. The deposit is reached by a good but steep road from Ashcroft, the elevation of the deposit being 3,000 feet above the town.

Kamloops Mining Division

Guichon Creek, Mamette Lake. Diatomite occurs on the farm of W. H. Mathews, near Guichon creek, 18 miles south of Savona and 14 miles north of Mamette Lake P.O. Approximately 2 acres of the meadow are underlain by diatomite which occurs in layers of 1 to 3 feet of white diatomite underlain by 1 to 3 feet of brown and yellow. The average thickness is about 3 feet, the best material occupies about a quarter acre at the east end. (*See* Table XI, analysis No. 4.) Both the white and the coloured diatomites calcine to a pale pink. The diatoms are well preserved, *Epithema* and *Eunotia* predominating (Plate X B).

Probably at one time the whole valley was covered with diatomite, but in most places it has been washed away so that the diatomite remains only in the undisturbed meadows from 6 to 12 feet above the present creek bed and at an elevation of about 3,000 feet. Other patches of diatomite may occur in this region as it is only about 12 miles east of the Pukaist Creek deposit. The deposits are all of the second type.

Copper Creek. An impure diatomite mixed with volcanic silts occurs on B. Chester's farm at Red lake, 10 miles north of Copper Creek station on the Canadian National railway, and about 20 miles northwest of Kamloops.

The material, which is compact and buff in colour, has an average thickness of 13 feet over at least 25 acres and there are strong indications that it is also present in other localities on the summit of the divide between Tranquille and Criss creeks. The predominating diatom is *Melosira granulata* which is typical of the high level Tertiary deposits of Quesnel (Plate X C), and the Red Lake material may have been washed down from some large undiscovered deposits to the north, and re-deposited in its present site.

Samples tested (*see* Table XI, analysis No. 5) at the Mines Branch, Ottawa, showed that in the crude state it possesses bleaching qualities for mineral oils equal to standard *fuller's earth.* It also bleaches lard almost as well as the best Pike's Peak earth. Negotiations are now under way with a Vancouver firm to operate the property.

Quesnel Mining Division

The diatomite deposits along the Fraser and Quesnel River valleys are the largest so far discovered in the Dominion. They occur as solid, compact, cream-coloured beds up to 60 feet in thickness and in places 800 feet above the rivers. Many outcrops have been found between Alexandria (20 miles south of Quesnel) and 20 miles north of Quesnel, which is the present terminus of the Pacific Great Eastern railway. The largest exposures occur in the immediate vicinity of Quesnel, and at the Big bend of Fraser river, 10 miles farther north. The beds are exposed in landslides and in the steep banks of the river and creeks that have cut their way through the Fraser plateau. In several instances the higher deposits are overlain by porous basalt.

The diatomite beds are different from any others so far discovered in the Dominion and appear to have been laid down at an earlier period, probably Tertiary. The types of diatoms are identical in all the twelve or fifteen outcrops examined over the whole area, as well as those from samples received from more remote localities. The diatoms are almost entirely one species, *Melosira granulata*, which vary considerably in size, but for the most part are comparatively small. (*See* Plates X and XI.)

Test holes, put down between outcrops, showed the presence of diatomite under varying thicknesses of overburden. In places the beds of diatomite are thick enough to allow solid compact slabs one foot thick to be cut out.

The following is a brief description of the most important outcrops:—

Lot 906, Two Miles Southwest of Quesnel. These diatomite beds which are 700 feet above Quesnel, stand out as white cliffs plainly visible from the town. The cliffs are about 30 feet high, within which there are three exposures of diatomite over a distance of about 300 feet. The foot of the banks are covered with talus, but test holes showed that the diatomite continued down for at least 15 feet, thus proving the beds to be 45 feet or more thick. Test holes between the deposits indicated the continuity of the beds. The exposures strike north and south, parallel to the valley.

Toward the east the deposit has been denuded away by landslides, and to the west it is covered by basalt and humus. Between the main outcrops and Baker Creek canyon, two miles to the north, the diatomite was located by test holes and exposures, but the definite extent of the area was not determined.

The diatomite which is very compact and of a pale cream colour contains beds from a few inches to one foot thick. The highest grade material and the thickest beds occur over a width of 6 feet in the centre of the exposures. Thin clay seams occur at from 5 to 10-foot intervals, and near the centre of the outcrops there is a 6-inch seam of dark, highly ferruginous clay, which is exposed throughout the whole deposit and serves to indicate the degree of movement within the mass subsequent to its deposition. These beds which have a general dip of 15 to 20 degrees to the west into the gently rising hill above them, are very much faulted. In places many small local faults are visible every few inches. The main fault in the exposure shows a throw of 20 feet (Figure 7 and Plate III).

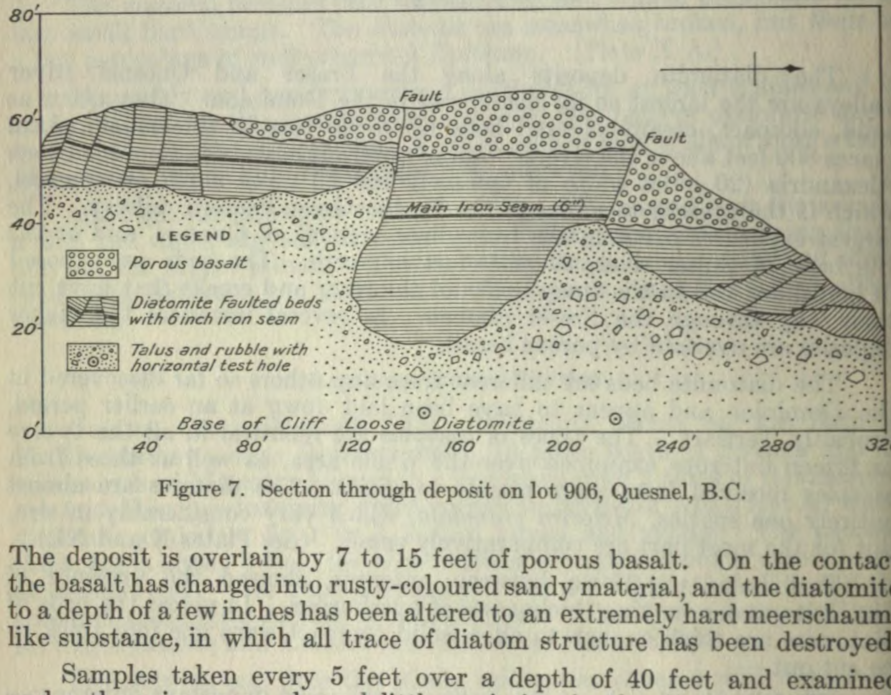


Figure 7. Section through deposit on lot 906, Quesnel, B.C.

The deposit is overlain by 7 to 15 feet of porous basalt. On the contact the basalt has changed into rusty-coloured sandy material, and the diatomite to a depth of a few inches has been altered to an extremely hard meerschaum-like substance, in which all trace of diatom structure has been destroyed.

Samples taken every 5 feet over a depth of 40 feet and examined under the microscope showed little variation in the diatoms. There is, however, a distinct tendency for the *Melosira* to decrease in size with depth. The diatoms in the upper middle beds are more like stout dotted rings than thin cylinders, also there are a few large diatoms of the oval-shaped *Tetracyclus* which are almost entirely absent lower down. The diatoms in the lowest beds are also more broken. (*See* Plate XI; for analyses, *see* Table IX, Nos. G. to N.)

Although this deposit is only two miles in a direct line from Quesnel, there is at present no means of approach except by a rough, winding trail.

Lot 385. On the north side of the old brickyard which is in the north end of the Quesnel town limits, and close to the west bank of the Quesnel river, a railway cut has revealed a bed of clay and diatomite. The latter is only about 4 or 5 feet thick and dips to the west and occurs as a lens about 15 feet long containing layers of silt, clay, and ferruginous matter, and is overlain by 2 feet of gravel. The whole mass is much disturbed and has apparently slid down from a higher level. (*See* Table IX, analysis No. A.)

Lot 1122, Three Miles North of Quesnel. This exposure is close to the west bank of Fraser river, at the telegraph crossing, and a fourth of a mile east of the road. The old placer workings and their washings near the river have formed cuttings through the low plateau, revealing several outcrops of diatomite over a distance of 500 feet along the river, and 50 feet above it. The main exposure was traced west for about 100 feet from the edge of the low bluff where it appears to be cut off by slides or washed away.

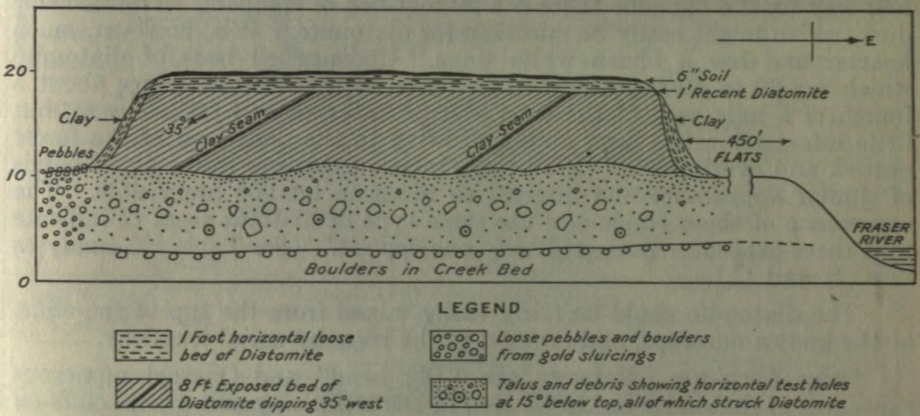


Figure 8. Section through diatomite deposit on lot 1122, Quesnel, B.C.

The beds are very similar to those of lot 906, but the bedding-planes are not more than 4 inches thick and dip 35 degrees to the west. They are immediately overlain by a more recent deposit which occurs as a horizontal loose bed of one foot thickness, and is covered by 6 inches of soil. (*See* Figure 8 and Plate IVB; Table IX, analyses Nos. D to F.) The diatoms in both the old and new beds are identical. Although only about 7 feet of diatomite are exposed above the talus, horizontal test holes at the foot of the bank, 15 feet below the top, struck the diatomite in place, and when measured at right angles to the bedding showed an original thickness of at least 35 feet of good, compact, pale cream-coloured material, with a few narrow clay bands within the mass. Auger holes between the outcrops showed the deposit to be continuous and the topography of the plateau indicates that the diatomite occurs along the river bank at this elevation for a considerable distance.

These showings, which are only 150 yards from the river and 3 miles by good road from Quesnel, are the most accessible of any of the deposits containing a large tonnage, so far discovered in the district.

Lots 41192 and 39493, "Big Bend," 8 Miles Northwest of Quesnel. The largest areal exposures of diatomite occur on the west bank of the Fraser in what is locally known as the "Big bend." Large masses of white to cream-coloured diatomite are exposed for a distance of about one mile on the tops of steep banks 50 to 150 feet high and composed of sand, gravel, volcanic dust, and variegated coloured clays. These masses of diatomite are 5 to 6 feet thick and have a general dip to the northward. (Plate IVA). In places the banks are composed of a conglomerate in which both the matrix and included pebbles are mainly diatomite.

About 500 feet above the river, towards the level of the main plateau, there are numerous pinnacles and isolated columns of highly coloured clays and volcanic tuffs, in some of which are beds of diatomite; on the top of the plateau and about 800 feet westerly from the river, diatomite is exposed as massive beds on the edges of the slides and ravines. About half way up the big slide there is a 20-foot bed of compact, white volcanic dust, which might easily be mistaken for diatomite. It is, however, much heavier and has a bluish white tinge. Undisturbed beds of diatomite which are 30 to 40 feet thick occur inland in the form of ridges about a fourth of a mile west of the river and probably extend farther west, but little information has been obtained owing to the denseness of the forest growth and overburden. In all these inland exposures iron-stained bands of similar appearance and interval to those on lot 906 are visible. The occurrence of these bands and the same type of diatoms seem to indicate that these exposures were originally one deposit. (*See* Table IX, analyses Nos. B and C.)

The diatomite could be fairly easily mined from the top of the cliffs, at the known outcrops, and lowered to the river by aerial tramway.

Other Localities. Between the "Big bend" and Quesnel numerous exposures of diatomite are to be seen in the steep clay and gravel cliffs on both sides of the river. Some of these exposures are near the surface, while others are covered by 150 feet of overburden. Figure 9 shows the Quesnel outcrops and the lots in which they occur.

Samples of diatomite have been received from the Blackwater river, near Telegraph Cabin, 7 miles west of the Blackwater crossing (*see* Table XI, analysis No. 3); it is also said to occur in large quantities in Tsacha lake, the former being 25 miles, and the latter 105 miles northwest of Quesnel. Diatomite was also found by John Webster while digging a well on his property, lot 304, 4 miles northwest of Alexandria, which is 20 miles south of Quesnel. (*See* Table XI, analysis No. 13.) The diatoms in all these occurrences are identical with those in the Quesnel deposits.

Little or no attempt has yet been made to exploit these large beds of high-grade diatomite in the Quesnel district. They may be economically worked in conjunction with the various clays, mineral pigments, and volcanic dust that exist in this region.

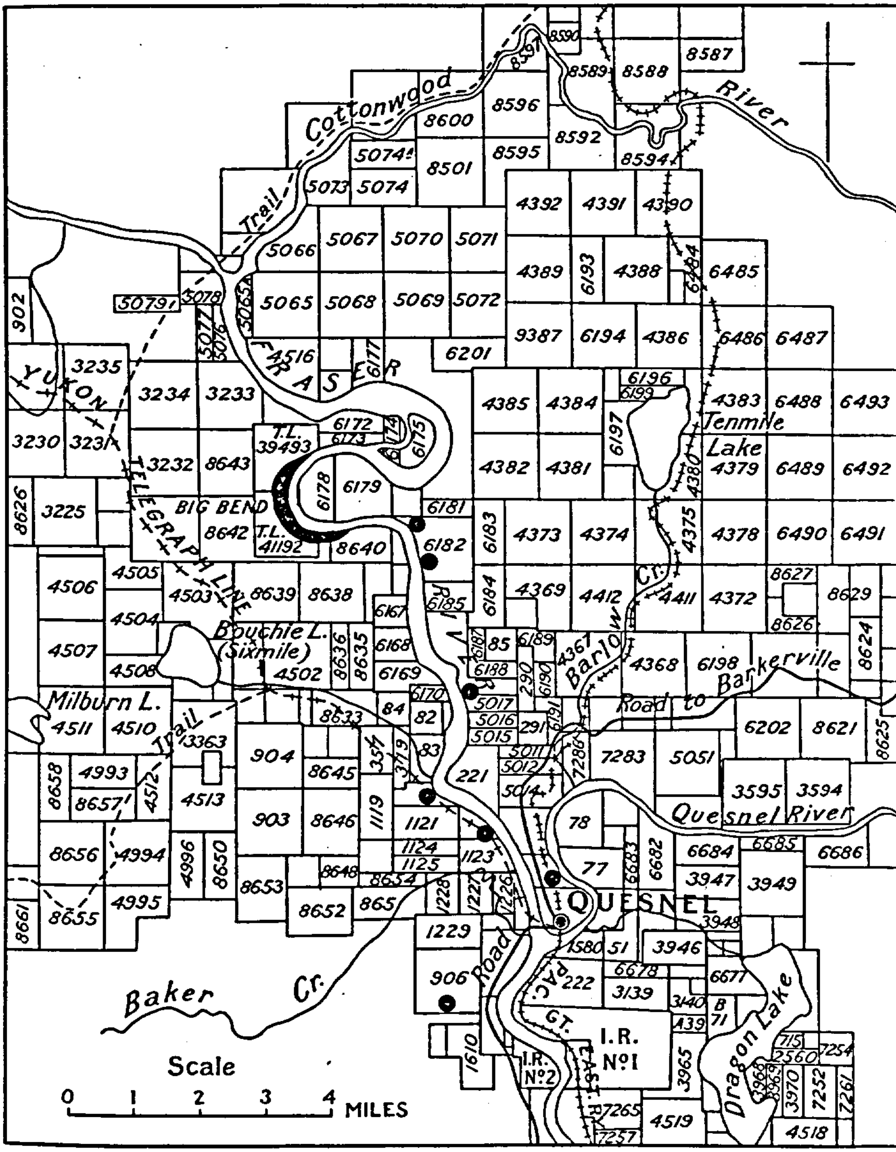


Figure 9. Diatomite occurrences in the vicinity of Quesnel, B.C.

Analyses and Tests on Quesnel Diatomite

Chemical Analyses. Table IX shows some of the analyses from the various deposits in the vicinity of Quesnel. It will be noted that all the analyses are fairly consistent, but that sample J from the centre of lot 906 is the purest.

TABLE IX

Analyses of Quesnel Diatomite (Crude Material)

No.	Deposit	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	H_2O at 105°C.	CO_2+ Org	Total	Remarks
A	Lot 385.....	76·15	7·01	3·39	0·55	2·38	0·94	0·77	7·29	0·92	99·40	
B	Big bend ..	77·90	8·24	3·16	0·21	1·45	n.d.	n.d.	6·90	1·09	98·95	Isolated masses about 100 feet above river.
C	" ..	73·40	12·38	4·78	0·98	0·50	"	"	5·38	1·45	98·87	Main deposit on plateau. Quarry Point average.
D	Lot 1122....	77·80	8·01	3·39	2·00	2·17	"	"	5·10	0·70	99·17	Average.
E	"	79·00	7·09	3·71	1·20	1·45	"	"	5·50	0·92	98·87	North end.
F	"	73·70	8·79	4·81	3·40	2·03	"	"	5·10	2·20	100·03	Recent top layer.
G	Lot 906.....	65·70	13·23	5·97	0·90	1·28	"	"	7·56	0·90	95·54	Top beds.
H	"	70·46	12·60	4·50	0·85	0·95	"	"	7·68	0·38	97·42	10 feet to 20 feet down.
I	"	76·86	7·00	3·06	0·62	0·73	"	"	7·88	0·92	97·07	20 feet to 25 feet down (best).
J	"	83·03	6·30	3·36	0·85	0·32	"	"	4·52	0·99	99·37	At 22 feet large lumps (used for concrete tests).
K	"	69·02	13·16	4·24	1·02	0·44	"	"	7·20	0·94	96·02	25 feet to 30 feet down.
L	"	73·19	8·98	4·36	0·79	1·14	"	"	6·40	1·16	95·97	30 feet to 35 feet down.
M	"	72·76	10·77	4·03	0·68	1·31	"	"	6·72	0·48	96·75	35 feet to 45 feet down.
N	"	72·44	7·91	4·03	1·24	1·05	"	"	7·12	0·62	94·41	50 feet down.

Micro-analysis

An analysis of the diatoms contained in the seven samples taken at intervals of 5 and 10 feet from lot 906 (Table IX, G to N) are as follows:—

1. *Top 10 feet*..................Beds laminated ½ to 1½ inch; evidence of clay.
   Diatoms: The dotted cylindrical forms of *Melosira granulata* of various sizes predominate but the average are larger than those below. There is an appreciable quantity of the elliptical crysalis-shaped *Tetracyclus ellipticus* as well as odd-shaped *Tetracyclus inflata.* A few broken specimens of large fan-shaped *Stylobiblium* were also noted. (Plate XF).
2. *10 to 20 feet*..................Beds 1 to 3 inches thick, less clay than above.
   Diatoms: Almost entirely well-preserved *Melosira granulata,* but average size smaller than in the top beds. Some long, thin cylindrical forms were noted as well as a few comparatively large disks of *Stephanodiscus.*
3. *20 to 25 feet*..................Solid beds one foot thick, best grade.
   Diatoms: Similar to No. 2 but better preserved. (Plate XVB).
4. *25 to 30 feet*..................Badly seamed and has many included small round pebbles, sand, and gravel.
   Diatoms: Similar to No. 2 but more broken and also contains comparatively large rings. (Plate XIB).
5. *30 to 35 feet*..................Immediately below main iron seam. Beds 1 to 2 inches thick.
   Diatoms: Similar to No. 1 but much smaller. Other species than *Melosira* uncommon. (Plate XIC).
6. *35 to 45 feet*..................Same as No. 5. (Plate XID).
7. *45 to 50 feet*..................This is the lowest bed examined and was covered by debris; appears to be similar to the 10 feet above it but more highly laminated. The diatoms are also similar.

Physical Properties of Quesnel Diatomite

Tests made on samples from lot 906 showed that blocks or bricks can be cleanly and easily cut from the centre beds and that, with reasonable care, they can be handled without breaking. The average weight per cubic foot of the dry block is 34 pounds or an apparent density of 0·544 and the loosely packed powder is 18 pounds per cubic foot, or 0·287. The average water absorption of a dry block is 120 per cent of its weight which is about 65 per cent of its volume. When immersed, water is absorbed very readily and is accompanied by the rapid release of air bubbles. On standing a few hours in the water, the blocks disintegrate.

The high iron content mentioned above (*see* Table IX) causes the diatomite to become deep pink on calcination. If previously treated with sodium carbonate the reduction in colour is comparatively slight, but when calcined with 5 to 8 per cent of common salt it becomes a good white colour. According to British Patent No. 229021, salt also increases the porosity of a diatomite. Care should be taken not to calcine at too high a temperature.

Possible Uses for Quesnel Diatomite

It has already been stated that the Quesnel diatomite contains very small but well-preserved tough diatoms; that it has a higher apparent density and higher iron and alumina content than the average, and that it can be readily cut out in solid blocks from the deposit. Taking these properties into consideration it should make a good insulating brick both in its natural state as well as bonded and burned, particularly for the higher temperatures. It should be suitable for making bonded lightweight roofing tiles, etc.. The small tough diatoms would make an exceptionally good metal polish, and cubes for finger nail polish. Tests have shown that it makes a good admixture for concrete.

On the other hand, it is not entirely suitable for sugar and other filtration purposes, owing to the small diatoms, density, and impurities. The high alumina and iron content would eliminate its use in those industries in which the purest diatomite is required which mainly applies to use in solutions, but should be satisfactory for almost all other purposes.

Ownership of Deposits

Several of the Quesnel diatomite deposits have been staked with a view to future operations. Some of the owners are W. A. Laming of the Canadian Diatomite Company, Victoria, B.C.; H. Turner of the British Columbia Refractories, Ltd., Vancouver, B.C.; A. W. Elliott of the Supreme Oil Company, Victoria, B.C.; H. Stevens, Kamloops, B.C.; and others.

Burnt Clay Deposit

About half a mile south of Quesnel a steep railway cut has exposed a bluff, one hundred feet high, of hard, pink and yellow-coloured material. This was believed to be altered diatomite but no diatom structure can be found. It appears to be a clay deposit that has been burnt or baked through the influence of a lava flow or by internal hot gases. The affected area is about 300 feet across and continues easterly from the Fraser river for over a mile. To the north and south it gradually merges into unburnt natural grey plastic clays, which, however, have been largely denuded away leaving the hard burnt clay in the form of a ridge. The predominating colour is yellow, but the innumerable breaks are coated a deep brown-red. Throughout the mass there are lenses and balls of blue-black and of chocolate-coloured material, the centres of which are in the form of radiating, hard and brittle needles and have the general appearance of highly coloured contusions all over the face. There are also thin, horizontal seams of pure white material.

It has not been determined to what depth the area has been burnt, but the bottom of the exposure appears to be as much affected as the top, though in the latter there are slightly more colour variations. Although the diatomite deposit with the lava capping on lot 906 is immediately opposite, about a mile to the west on the other side of the Fraser valley, there are no visible remnants in the immediate vicinity under discussion.

The burnt clay has been successfully used locally for road material.

The following is an analysis of the various coloured portions of the deposit:—

—	SiO_2	Fe_2O_3	Al_2O_3	CaO	MgO	K_2O	Na_2O	CO_2+ Org. matter	H_2O at 105° C.	Total
Thin white bands	25·52	1·86	59·44	5·65	0·47	0·51	4·02	0·76	1·64	99·87
Pink	58·22	3·21	29·59	0·57	0·10	n.d.	n.d.	1·08	5·40	98·17
Yellow	58·30	2·61	31·65	0·74	tr.	0·99	5·16	0·28	0·72	100·45

—	SiO_2	Fe_2O_3	FeO	Total iron
Black	1·68	87·49	1·31	62·26
Chocolate	16·44	67·45	0·31	47·46

Vancouver Island

Although many deposits of diatomite occur in southern Vancouver island, in nearly every case they are shallow and contaminated by silts.

A small, but easily accessible, deposit of fair purity covering an area of about 1 acre occurs on H. T. Oldfield's farm at the head of Prospect lake, in the Highland district, 2 miles by road west of Prospect Lake station.

The diatomite, which is buff in colour, is 18 inches to 2 feet thick, underlain by yellowish clay, and extends over an area 100 by 600 feet, in the centre of which is a small creek (Figure 10). The bed of this creek is below the bottom of the deposit.

About 200 tons are said to have been taken out in 1921 and from an examination of the pit it would appear that an appreciable amount of the underlying clay, which the diatomite somewhat resembles, was also extracted and shipped, thereby lowering the grade.

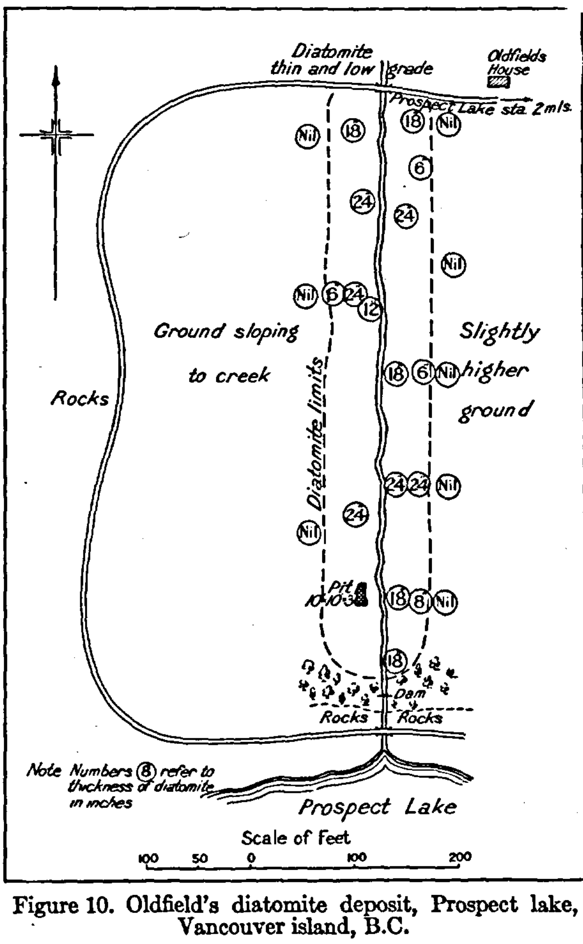
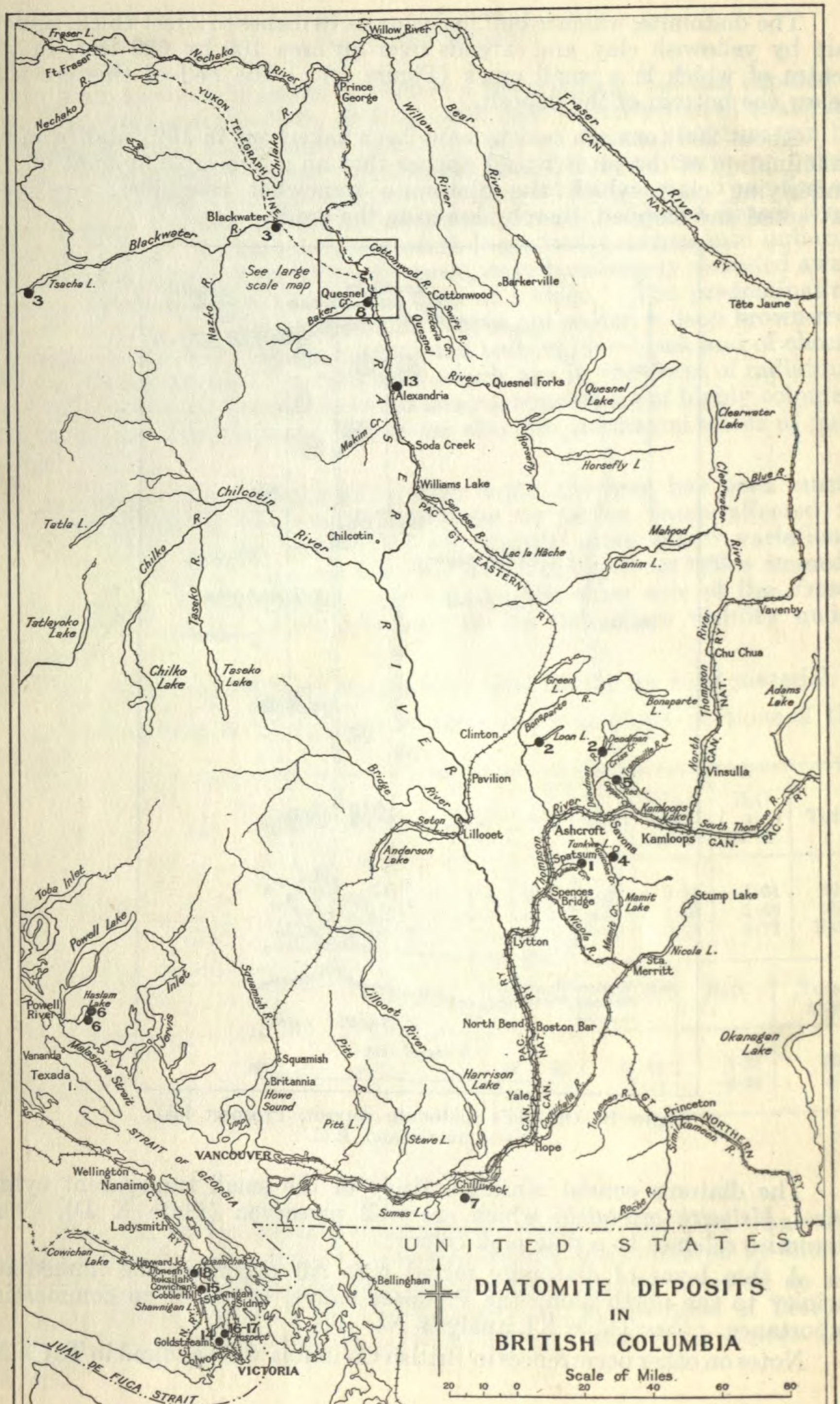


Figure 10. Oldfield's diatomite deposit, Prospect lake, Vancouver island, B.C.

The diatoms consist almost entirely of the small transparent cylindrical *Melosira granulata* which are well preserved (Plate X D). The diatomite calcines to a pale pink colour.

A thin layer of diatomite mixed with silt occurs in the immediate vicinity to the north along the Prospect valley, but is of no commercial importance. (*See* Table XI, analysis No. 16.)

Notes on other occurrences in British Columbia will be found in Table X.



(For reference Nos., see Table X.)

Figure 11. Diatomite deposits in British Columbia.

MARITIME PROVINCES

All the known deposits of diatomite in the Maritimes occur under water or in marshy ground. They rarely attain a thickness of more than 6 feet and are usually mixed with carbonaceous matter. Many of the deposits are covered with about 6 inches of mud, soil, vegetable matter, etc., and rarely the covering exceeds 3 feet. In others, the white material is visible at the bottoms of lakes under the water and is not covered with mud. Some of the deposits are underlain by a very fine plastic blue or red clay, others by sand, and some others rest immediately on the stony or gravel bottoms of the lakes. Most of the deposits occur as distinct layers which vary in colour and compactness, for example, there are many deposits in which a compact white diatomite is underlain by one of a softer cinnamon colour, which in turn is underlain by a soft, dark brown material, often resembling an ooze. All these layers are diatomite; when dry they have almost the same degree of whiteness, have the same species of diatoms; and, when calcined, have approximately the same chemical composition. The dense white variety, however, usually contains a higher percentage of alumina, whereas the layers at lower depths are higher in carbonaceous matter. Generally, the cinnamon-coloured diatomite proves to be the purest after calcining. This colour, however, is not due to iron oxides, which when present appear as rusty streaks or impart a reddish brown colour. Rarely, if ever, have any of the eastern diatomite deposits, so far discovered, been found to occur underlying sand or clay, but some deposits contain occasional thin bands of clay within them.

In all the deposits the diatoms are much broken up, only a comparatively small percentage of them being perfect. (*See* various microphotographs.) An outstanding exception is a small deposit, 4 miles west of Morden, Kings county, N.S., (Plate XII A), in which the diatoms are clean and very well preserved, but it is too small to be of commercial importance. (*See* Table XI, analysis No. 72.) In the Digby Neck deposits, as well as in those near East New Annan, N.S., the diatoms are less broken than in the average deposit. Sponge spicules are present in most of the Maritime deposits, particularly in those of New Brunswick. The average lime content is about 0·5 per cent, which is lower than that of the average of the deposits of the other provinces.

The Maritime diatomites can be used for most purposes after they have been calcined, though the iron content is somewhat high. For most purposes the grit also would have to be removed. Samples from a large number of deposits have been tried out as filter media by sugar refiners, but so far none has been found to be as satisfactory as the imported product. This is probably due to the impurities present and to the small fragmentary nature of the diatoms.

Approximately eighty occurrences of diatomite are known in the Maritimes, the majority are, however, confined to the lakes of the Cobequid mountains in Pictou, Colchester, or Cumberland counties in northwest Nova Scotia. The purest material usually occurs in the higher altitudes, spring-fed lakes, and sources of rivers, where the deposition of the diatoms has not been disturbed or contaminated by freshets.

The purest deposits in the Maritimes, of possible economic size, which contain 80 per cent silica or over in the crude material, are: Pollet lake (83 per cent), Flood lake, and Stannard lake, N.B.; and the following in Nova Scotia: Brora lake, Clear lake, New Annan lakes, Silica lake, Loon lake, Little River in Digby neck, and Trout lake. The New Annan lakes are now being worked by the Oxford Tripoli Company, and the Digby Neck deposit by the Scotia Diatom Products Company.

A few of these deposits contain comparatively large depths of highly diatomaceous mud, which besides silica and volatiles (contained water, CO_2 and organic matter, all of which can be eliminated by calcining) contain only 4 to 8 per cent impurities.

Amongst those which differ somewhat from the usual mode of occurrence is the Digby Neck deposit which occurs in a variety of layers, the topmost being a dark brown peat, which when dry is a grey colour. It burns readily leaving a white ash almost wholly composed of diatoms. Under this a medium compact grey diatomite is followed by a brownish diatomite ooze.

A deposit occurring at an unusual depth below the surface has, until recently, been worked by the Oxford Tripoli Company at Silica Lake bog, N.S., where 5 feet of a pure cinnamon-coloured (when wet) diatomite is overlain by 6 feet of peaty material.

A detailed list of all the types of diatoms in each of the deposits examined will be found in the recently published Museum Bulletin.[1]

Nova Scotia

Victoria County

Munro Point, St. Ann Harbour. Work was first started in this area about 1895 by the Victoria Tripoli Company. The property was taken over by the Premier Tripoli Company of New York in 1901, who continued operations until 1917. The company went into liquidation in 1920.

Some of the lakes worked were Torrance lake, elevation 600 feet, on Mill creek; Peter Brook lake, at the source of Peter brook; McLeod lake, 3 miles southeast of Baddeck lake; and a small lake one mile west of Tarbot, south of the Barasois river. (*See* Table XI, analysis No. 27.)

A small mill for treating the material was erected on the property near Munro point. The Victoria Tripoli Company shipped about 600 tons, and the Premier Tripoli Company intermittently shipped 20 to 30 tons annually. Approximately 1,000 tons, valued at about $6,000, were shipped from these deposits. About 30 years ago the Cairo Polishing Company produced a small amount of diatomite from River Denys, Inverness county.

Many other deposits occur in Cape Breton (*see* Table X) but they do not appear to be of commercial importance at present. (*See* map in pocket.)

[1] Boyer, C. S.: Museum Bull. No. 45, Dept. of Mines, Canada (1926).

Colchester County

Clear Lake. This lake, of about 20 acres, is 10 miles south of Tatamagouche, or 4 miles south of Central New Annan, 3 miles of which is by a steep trail.

The area occupied by the available diatomite is about 8 acres, with an average thickness of 1½ feet of white material (*see* Table XI, analysis No. 31) which, however, on calcining turns pink and a proportion forms into small, hard lumps.

The following gives the results of the test holes which are shown in the accompanying rough sketch (Figure 12):—

Hole No.	Depth of water	Thickness and sequence of diatomite layers	Nature of bottom
	Feet		
1	5	1 ft. white	Stony.
2	6	1½ " "	"
3	5	1 " " ; 1 ft. black	"
4	9	2 " " ; 8 " "	Mud.
5	10	1½ " " ; 1½ " "	"
6	8	½ " pink; 2 " "	"
7	6	Nil. 5 " "	Red clay.
8	3	3 ft. white	Stony.
9	5	1½ " "	"
10	4	Nil.	"
11	8	½ ft. pink; 3 ft. black	Red clay.
12	15	Nil, over 6 ft. black	Mud.

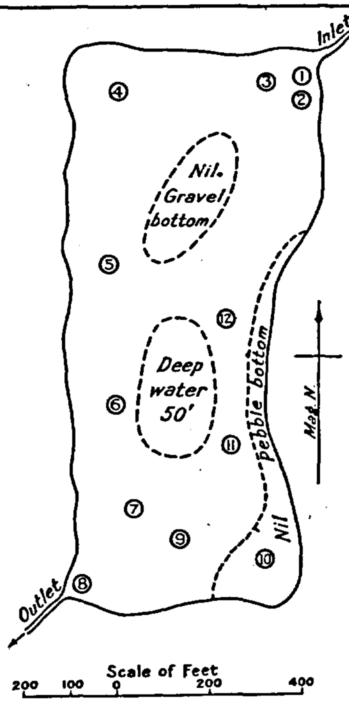


Figure 12. Clear lake, Colchester county, N.S., showing location of bore-holes.

Folly Lake. The lake comprises about 200 acres and is situated on the north slope of Cobequid mountains, near Folleigh station on the Intercolonial railway. The diatomite occurs in patches on the lake bottom, the best material occurring in a small bay near the southeastern shore where in places it attains a depth of 6 or 7 feet, but is usually impure and gritty. The material turns pink on calcining and has a tendency to form into small, hard lumps. The Folly Lake diatomite is remarkable for the large variety of diatoms present but they are considerably broken. (*See* Table XI, analysis No. 38.)

The lake is a watering place for the railway, and many summer cottages are situated along its shores. As it is in places very deep, it could not be drained without great expense and the deposit is probably of no economic importance.

In the Folly River meadows, one-half mile south of the lake, one foot of good, compact white diatomite covered by 6 inches of vegetation occurs over a considerable distance along both banks of the inlet into Folly lake. The deposit extends 20 to 25 feet inland from the edge of the creek. (*See* Table XI, analysis No. 39.) The diatoms are better preserved than in the lake.

Little Gummel Lake. Two or three feet of a pure white diatomite occurs around the shores and in the small creek flowing out of Little Gummel lake, situated a quarter of a mile east of Castlereagh. The material is very similar to that of the Folly River meadows. The quantity of the best grade is very limited as it occurs only in the immediate vicinity of the creek and is only a few feet wide. It is overlain by about 2 feet of peaty material and underlain by 6 inches of clay on a gravel bed. The diatoms are badly broken, and it calcines to a pale pink colour with the formation of small hard lumps. (*See* Table XI, analysis No. 41.)

At *Big Gummel Lake,* a few hundred yards to the north, the diatomite occupies a larger area, but is of much lower grade.

Silica Lake. This lake, 4 miles northwest of Castlereagh and covering an area of about 30 acres, was first drained and operated in 1895 by the *Fossil Flour Company* and later worked by the *Bass River Infusorial Earth Company.* In 1905 it was taken over by the *Oxford Tripoli Company,* during which year the treatment mill was destroyed by fire but was afterwards rebuilt. The diatomite of good quality varied from 1 to 8 feet in thickness with an average of 6 feet. (*See* Table XI, analysis No. 45.) After extracting the best material, amounting to about 10,000 tons valued at approximately $210,000, it was abandoned and the water was allowed to return. In 1922 the company then started operations in a bog a quarter of a mile to the north of the lake, in which 4 to 5 feet of good cinnamon-coloured diatomite (Table XI, analysis No. 46) occurs overlain by 6 feet of peat and vegetable matter and underlain by 2 feet of yellowish grey clay or gravel. The swamp is heavily timbered and is of large extent, but bore-holes showed only local distribution of the underlying diatomite. The working area was small and covered only a few acres, from which about 300 tons of diatomite were extracted. The water was drained from the pit by means of a bucket elevator, and a bucket grappler was used to dump the material into a train of small, horse-driven cars which ran on wooden rails and conveyed it to the calcining plant at the edge of Silica lake.

During 1926 the company acquired about 600 acres on which there are 4 or 5 ponds close to the Truro road, 10 miles south of Tatamagouche, and 30 miles east of their old workings at Silica lake. A brief description of these ponds follows:—

Rhude Pond. Area, 3 acres containing from 3 to 16 feet of diatomite, the top two feet being cinnamon-coloured. The average depth of water is 3 feet but the deposit is only partly covered. It has been drained by trenches and the material is recovered by shovelling direct to small cars, a wooden-railed track being laid out onto the deposit from their calcining plant one mile to the north. This is the only deposit at present being worked (1927). (Plate IIB). The diatoms are comparatively well preserved.

Lockerby Pond. Half a mile northwest of Rhude pond. It is about 2 acres in extent, only a small portion being under water, and has an average depth of 8 feet of cinnamon-coloured to very dark brown diatomite. It is very difficult to drain.

Conkey Pond. One mile northeast of Rhude pond. This pond of about one-half acre is covered by 2 feet of water and contains 2 to 3 feet of almost pure white diatomite. It is easy to drain.

Gard Pond. Half a mile north of Conkey pond. About four acres covered with 4 feet of water and contains an average thickness of 8 feet of dark to light cinnamon-coloured diatomite. It is fairly easy to drain.

The Oxford Tripoli Company is a subsidiary of the Oxford Tripoli Sales Company, Haverstraw, New York. It owns the Mining Rights of many lakes in northwestern Nova Scotia and has produced over 90 per cent of the total Canadian diatomite output. The present calcining plant is on the roadside about one mile north of Rhude pond. The calcined material is bagged and sent to the treatment plant at Haverstraw, New York, but the company contemplates erecting a plant at the deposit in the near future.

Slack Lake. This is a small lake of about 6 acres, situated a quarter of a mile west of the Folly Lake road and one and one-half miles southwest of the south end of the lake.

The following is the result of the test holes which are shown in the accompanying rough sketch (Figure 13).

Hole No.	Thickness and sequence of diatomite layers
1	8 ft. black diatomaceous mud.
2	¾ " grey-brown.
3	4 " " "
4	½ " dense, white; 5 ft. muddy diatomite.
5	1 " " " ; 7 " " "
6	8 " dark muddy diatomite.
7	1 " yellowish diatomite under 3 ft. peat.
8	2 " good grade " " 7 " "
9	3 " yellowish diatomite under 2 to 4 ft. of peat.
10	4 " " " " "
11	3 " yellow, 1 ft. sandy " "
12	3 " " " "
13	2 " " (limit of deposit) " "

Parts of the lake are barren, but in some places 6 to 7 feet of dark brown diatomaceous mud occur. In the centre there is an average of 1 foot of a good dense white diatomite, and some fairly good material occurs in the swamp in the south end of the lake. The lake is shallow having an average depth of 5 feet. (*See* Table XI, analysis No. 48.)

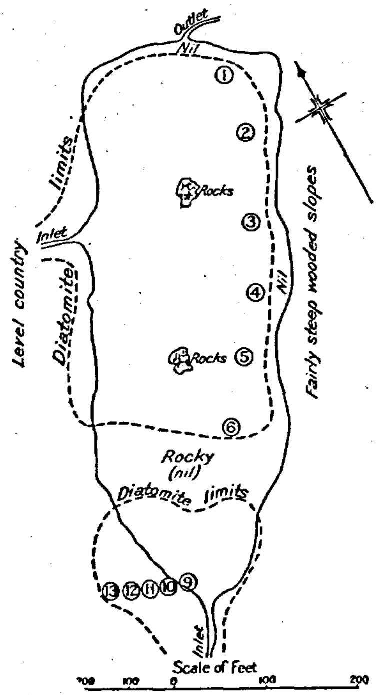


Figure 13. Slack lake, Colchester county, N.S., showing location of bore-holes.

Trout Lake. This lake is a long, narrow lake of about 40 acres, many parts of which are rush-covered. It is approached by rough trail 4 miles northeast of Folleigh station on the Intercolonial railway.

The deposit, which covers about two-thirds of Trout lake, is one of the best in the region. As will be seen from the analysis Table XI, analysis (No. 52 d) the diatomaceous mud at the north end contains 62 per cent silica and 33 per cent volatiles, so that on calcining a good grade material should be obtained from an area over 20 feet in depth. About three-quarters of the lake is shallow, with some deep pools in the centre. For about 70 feet all around the lake, except the north end, is a stony bottom barren of diatomite. (*See* Table XI, analyses Nos. 52a to 52d.) The material from most of the lake calcines to a pink colour with the formation of small, hard lumps; but the calcined mud is free of lumps and has the most unbroken frustules.

The following shows results of the test holes which are indicated on the accompanying sketch (Figure 14):—

Hole No.	Depth of water	Thickness and sequence of diatomite layers	Nature of bottom
	Feet		
1	On land	15 ft. dark, soft diatomite	Gravel.
2	3	Over 21 ft. " "	Not found.
3	4	" 20 " " "	"
4	8	" 16 " " "	"
5	12	" 12 " " "	"
6	10	10 ft. dark, soft diatomite	Gravel.
7	6	3 " pure white with iron streaks	"
8	7	2 " " " ; 3 ft. soft, dark	"
9	3	3 " light grey	"
10	4	2 " " 6 ft. soft, dark	"
11	5	2 " " 3 " "	"
12	3	1 " pure white	"
13	4	3 " pure white with iron stains; 5 ft. grey	"
14	4	3 " " " ; 5 " "	"
15	3	2 " white, bottom foot iron-stained	"
16	3	2 " white, with green stains	"
17	4	1 " white; 7 ft. soft, dark	Red clay.
18	5	2 " white; 4 " "	"
19	3	1 " fairly white	Gravel.
20	2	1 " "	"
21	2	3 " "	"
22	4	1 " dense, white with green stains	"
23	4	4 " " " and iron stains	"
24	5	4 " " " " " ; 1 ft. dark	"

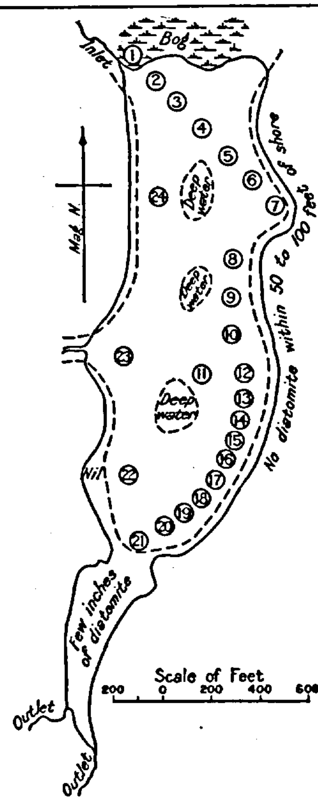


Figure 14. Trout lake, Colchester county, N.S., showing location of bore-holes.

Digby County

Little River, Digby Neck. In the vicinity of Little River near the southern end of Digby neck there is a series of large swamps. One of these swamps of about 100 acres, which is the remains of an extinct lake, has been drained, thereby producing fertile meadows rich in hay grass.

Immediately under the grass roots there is an average of 4 or 5 feet of grey-brown diatomaceous peat which when dry readily ignites and smoulders away until the process of combustion throughout the whole mass is completed, leaving a white fluffy powder containing 84 to 94 per cent silica in the form of diatoms (Plate XV A). This crude peat contains approximately 50 per cent carbonaceous matter and volatiles. Underlying this there is 1 to 8 feet of a fairly compact grey diatomite which in the crude state contains 83 per cent silica and 11 per cent volatiles. (*See* Table XI, analyses Nos. 63 a, b, c.) This in turn is underlain by varying quantities of diatomaceous ooze up to 20 feet or more in thickness. Most of the layers calcine pink.

The following gives the result of the test holes made by the writer in 1923 and are shown in the accompanying rough sketch (Figure 15), which, however, is not to scale as the meadow was not surveyed, and merely indicates the approximate position of the holes.

Hole No.	Self-calcining peat	Dense, grey diatomite	Diatomite ooze	Red clay	Total depth bedrock
	Feet	Feet	Feet	Feet	Feet
1	3	2	2	Nil	7
2	3	1	2	"	6
3	3	1	2	"	6
4	4	8	5	"	17
5	7	5	7	1½	20
7	6	3	6	1½	16
8	6	3	7	½	16
9	7	3½	5	½	16
10	4	4	5	1	14
11	5	1	7	Nil	13
12	5	Nil	Over 20	?	Not found
13	4	4	2	½	10
14	4	1	10	1	16
15	4	Nil	Over 20	?	Not found
16	5	2	8	1	20
17	4	Nil	Over 20	?	Not found

The total thicknesses of the diatomite as determined in 1927 by test holes put down at intervals of 200 feet are also shown in the sketch. The average over the 100 acres is approximately 13 feet of which about 5 feet consists of the diatomaceous peat. A thin layer of red clay usually occurs immediately above the bedrock and underlies the diatomite.

A microscopic examination showed that the peat contains 18 species of diatoms having 47 varieties; the grey contains 14 species with 27 varieties, and the ooze, 21 species with 48 varieties. The diatoms in the lower beds are somewhat broken but those in the peat, which mostly consist of long, thin, bone-shaped *Tabellaria* and large *Pinnularia*, are better-preserved than in most of the Maritime deposits. (Plate XV A.)

There are probably between three and four hundred thousand tons of commercial diatomite in this meadow, and at least as much again in the three other marshes and ponds which occur along a distance of 3 miles to the south. Although these have not been surveyed, the nature of the material is similar and test holes put down at random have shown the diatomite to be over 20 feet thick in places.

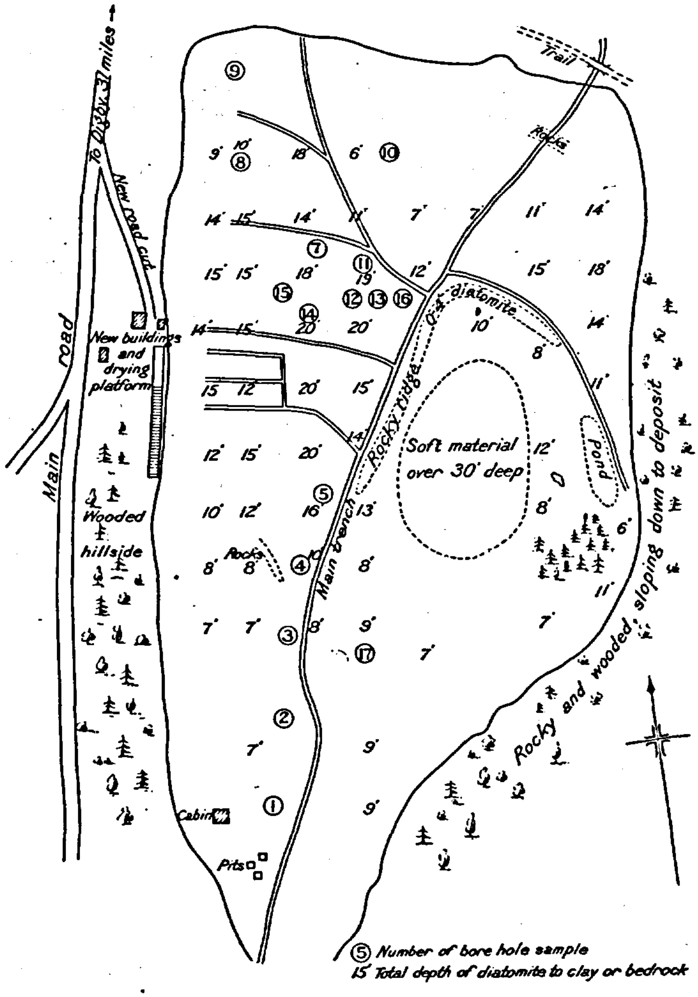


Figure 15. Little River diatomite deposit, Digby neck, N.S. Area, approximately 100 acres.

These deposits are the largest so far discovered in eastern Canada.

The property was, until recently, owned by George Wightman of Digby, who drained the field and dug some pits in the southern end exposing the peat and diatomite (Plate II A).

During 1927 the mining rights of the whole area were purchased from Mr. Wightman by R. E. G. Burroughs who formed the Scotia Diatom Products Company of Montreal. Work was started in August when areas were laid out by trenching, and a drying-platform, outbuildings, and a small trial calciner were erected. The steep hill-side abutting the edge of the marsh affords a good site for a mill from which the finished material can be economically conveyed by a good road to the Government wharf at Little River on St. Mary bay, 2 miles to the north.

Some of the diatomite was used for the recent concrete tests (*see* Table XI, analysis No. 63d) undertaken by the Public Works Department, which are described later. Calcination experiments are described on page 118.

Salmon River. About 1 mile north of Sigogne siding there are extensive meadows on the east bank of the Salmon river, owned by Edmond Robicheau. From 2 to 4 feet of gritty, grey diatomite, high in alumina, occur under the grass roots for a considerable distance along the river and extend inland for 50 to 70 feet. The highest grade material observed occurs 300 yards east of the bridge across the river; the diatoms are, however, badly broken. (*See* Table XI, analysis No. 65.) A further examination of the meadows, farther up the river, has revealed larger deposits, but samples recently received by the Mines Branch, Ottawa, were found to be very gritty and contained a low proportion of diatom silica.

About 4 miles southwest of the above and half a mile north of the Salmon river, at Mayflower, a small alder swamp of half an acre, containing about 2 feet of a pale grey-brown diatomite, occurs on the top of the hill on Louis Saulnier's farm. About 18 years ago a few tons of this material was taken out and sun-dried, some of which was made into a polishing powder for local use by Mr. Blackadar of Yarmouth. The deposit is, however, too small and impure for commercial purposes. (*See* Table XI, analysis No. 64.) Diatomite is also said to occur in several lakes in the vicinity, particularly in Bony lake, 1 mile east of Hectanooga. It also occurs in several meadows in the vicinity of Maxwellton.

All the above Salmon River deposits are of a peaty nature and are subjected to floods, consequently they are badly contaminated with silt and other impurities.

Halifax County

McQuade Lake. This lake of about 12 acres is situated in the hilly woods, 8 miles northwest of Halifax and about 3 miles west of Kearney lake. A greyish diatomite up to 3 feet in thickness occurs in the bottom of the lake. The best material is on the south and southwest end under 8 to 12 feet of water. The deposit is pockety and very thin on the north end. In the centre of the lake the water was too deep to test the thickness of the diatomite. The material is underlain by blue clay.

The lake was partly drained in 1922 and some material extracted by Messrs. T. R. Hyland and Normandin of Halifax. It is, however, somewhat high in iron and alumina and burns to a dark pink colour. (*See* Table XI, analysis No. 69.) The diatoms are also badly broken.

Kings County

Factory Dale. There are several deposits of diatomite in the river meadows and swamps, 3 to 5 miles south of Nicholsville and Factory Dale.

Diatomite overlain by 1 to 3 feet of vegetable matter occurs in a swamp on the West Branch of the South Annapolis river, one-quarter of a mile below Beech Hill dam. The deposit varies in depth over an area of 2 or 3 acres, but averages 3 feet, the top half of which is of a dense, white material. (*See* Table XI, analysis No. 70.) The diatomite is of good quality but the deposit appears to be small and would be difficult to drain. On calcining, the white material turns pale pink in colour with a tendency to form into small hard lumps.

During 1919 Lloyd Johnson of Aylesford dug two or three small pits exposing the diatomite and made up a polishing material for local use. The deposit is reached by rough trail one mile south of the old Johnson farm.

Another small deposit occurs in the Horseshoe meadows on the East Branch one mile above Shinglemill falls. A deposit of fairly good grade but of small extent and from 1 to 2 feet in thickness occurs on the same branch, 2 miles west of the road and about 3 miles south of Factory Dale.

Morden. About one-half mile northeast of Jim MacGarvie's farm on the top of North mountain, 6 miles north of Aylesford, a small pond and alder swamp contain 1 to 2 feet of a greyish diatomite, some of which is of excellent quality. The pond was drained many years ago and about a ton of the diatomite extracted. It was used locally as a polish and was also tried out as a fertilizer.

Although the diatomite is very high grade (*see* Table XI, analysis No. 72) and calcines to a pure white fluffy powder, the deposit is too small and shallow to be of commercial value. It is, however, of scientific interest because of its variety of diatoms which are exceptionally well preserved, and in this latter respect it is superior to any other Maritime deposit examined by the writer. (*See* Plate XII A.)

Pictou County

Brora Lake. This shallow lake of about 60 acres is situated in the undulating cultivated country, 8 miles due south of Barney River station, 20 miles southeast of New Glasgow. Diatomite of various colours and textures up to 13 feet in depth occurs almost all over the lake, and the deposit is one of the most promising so far discovered in Nova Scotia.

The lake can be fairly easily drained as in no place is the water more than 5 feet deep. The east end, which in the dry season is covered with rushes, weeds, and lily pads, is more in the nature of a bog with an average of 8 feet of dark diatomaceous mud assaying 62 per cent silica and 33 per cent volatiles. (*See* Table XI, analysis No. 77c.) In the centre there are about 12 feet of a good cinnamon-coloured diatomite (analysis No. 77b). At the southwest end there is a 1- to 2-foot layer of dense white which contains about 82 per cent silica and 12 per cent volatiles (analysis No. 77a). About 40 acres of the lake bottom are covered with the diatomite.

As will be seen from the analyses all of the samples contain 93 to 95 per cent of silica and volatiles, so that after calcining good material may be expected throughout the total depth of the diatomite deposits. The mud calcines to a pale brick-red colour and the rest to a very pale pink. The diatoms are rather badly broken, but those in the mud are in the best state of preservation.

The Mining Rights are owned by Maud Sutherland of New Glasgow.

The following gives the results of the test holes which are shown in the accompanying rough sketch (Figure 16).

Hole No.	Thickness and sequence of diatomite layers	Nature of bottom
1	8 ft. soft, dark	Blue clay.
2	10 " "	"
3	8 " "	Stony.
4	1½ " fairly white; 5 ft. soft, dark	Blue clay.
5	1½ " white showing iron stains	Stony.
6	½ " fairly white, iron and greenish stains	"
7	Nil	"
8	2 " grey with green stains; 1½ ft. dark grey	Gravel.
9	2 " white with green stains; 3 ft. dark grey	"
10	1½ " white	Stony.
11	3 " white; 8 ft. soft, dark	"
12	1½ " pure, dense, white; 5½ ft. very dark and soft	"
13	Nil	"
14	3½ ft. dense, light grey	"
15	8 " soft, light grey (top portion dense)	"
16	1½ " soft, cinnamon	"
17	9 " " "	"
18	13 " " "	"
19	13 " " "	"
20	7 " " " but paler in colour	"
21	3 " dense, white; 3 ft. darker and softer	"
22	4 " " " ; 1 " " "	"
23	10 " soft, dark	Blue clay.
24	3½ " " "	Stony.

About a quarter of a mile northeast of the lake a small marsh of about half an acre lies on the roadside just below Robert Johnson's farm. A maximum depth of 3 feet of good grade but somewhat gritty diatomite occurs under the grass roots. (*See* Table XI, analysis No. 78.) The diatomite tapers down to a few inches around the edges of the deposit the outline of which can be traced owing to a difference in the shade of the green of the vegetation (hay grass). A few tons were taken out a few years ago and the crude material sent to the St. Lawrence sugar refinery, Montreal, but unless treated this material would be too impure for sugar refining. Johnson's marsh would probably yield from 500 to 600 tons of dry diatomite. It calcines almost white and has a large variety of diatoms that are well preserved. (Plate XII B.)

Queens County

Loon Lake, Liverpool River. Loon lake is an expansion of Liverpool river, about half way between Kejimkujik lake to the north and lake Rossignol to the south, and is about 9 miles west of Caledonia.

Diatomite up to 4 feet in thickness occurs in many places on the east shore of the lake and river as well as on Loon Lake island at the southern extremity of Loon lake.

Probably at one time when the waters were at a higher level, the diatomite deposit covered a large and unbroken area, but subsequent changes and cutting down of the river bed caused the washing away of the greater part of the deposit leaving only small remnants in sheltered bays unexposed to currents and spring freshets. Consequently there now remain isolated patches, several of which are connected by narrow remnants a few feet in width along the banks. These remnants have been traced over a length of about 2 miles from the north of the lake to below the southern end of the island.

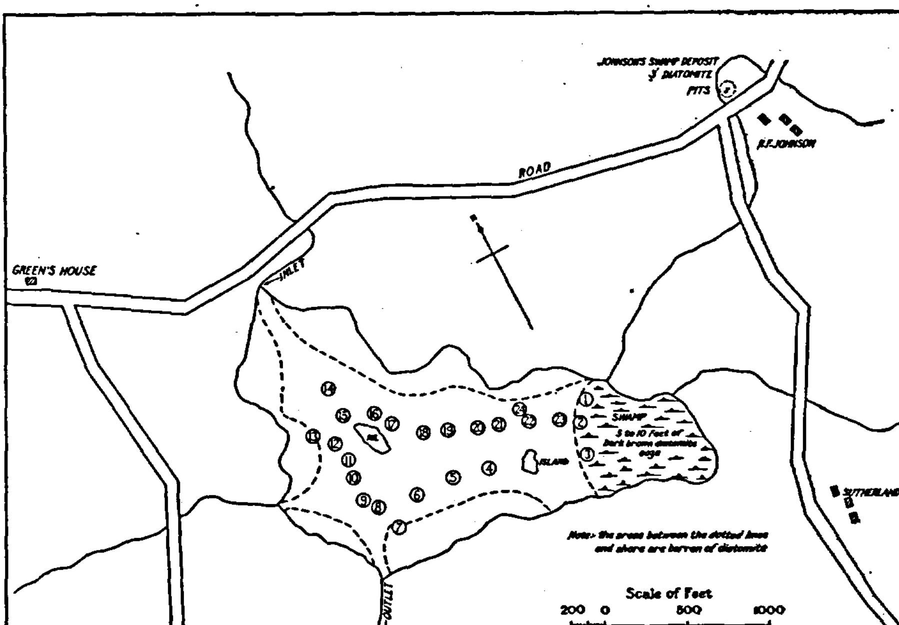


Figure 16. Brora lake, Pictou county, N.S., showing location of bore-holes.

The diatomite is usually of a greyish colour and tinged with iron stains, but occasionally is of a good white. It averages 18 inches, with a maximum of 4 feet. The centre to the north end of the island is rocky and timber-covered and no diatomite occurs, but towards the south end it is found around the edges, and in places extends 15 to 20 feet inland. On the mainland, on the eastern shores of the lake and river, the first occurrence is an isolated remnant on the north end of the lake near the inlet rapids and extends 20 feet inland. No other deposits were found until immediately opposite the north end of the main island, in the vicinity of a small creek, where there is an impure patch of 8 inches thick overlain by 1 foot of soil; the next occurrence being in the meadows below Loon Lake falls. The best material, which is of a good white colour, occurs opposite the centre of the island and reaches a depth of 3 feet under 4 inches of soil. Two hundred yards farther south, in the vicinity of the old road to West Caledonia, some good quality diatomite is also found.

The crude diatomite is exceptionally low in carbonaceous matter (*see* Table XI, analyses Nos. 88a to 88c) and it calcines to a pale pink colour. The diatoms, which are mostly thin and long, are fairly well preserved, although a considerable amount of sponge spicules is present.

The deposit is far from transportation and, although in the aggregate it contains a large tonnage of diatomite, it is spread over too large an area and is too shallow to be of commercial importance.

Patches of diatomite have been reported from localities farther south, down the river, and a larger and more concentrated deposit may yet be found.

The Loon Lake area was examined and surveyed by E. R. Faribault in 1915[1], and the map of the deposits compiled by him, with additional notes made by the writer in 1923, is shown in Figure 17.

New Brunswick

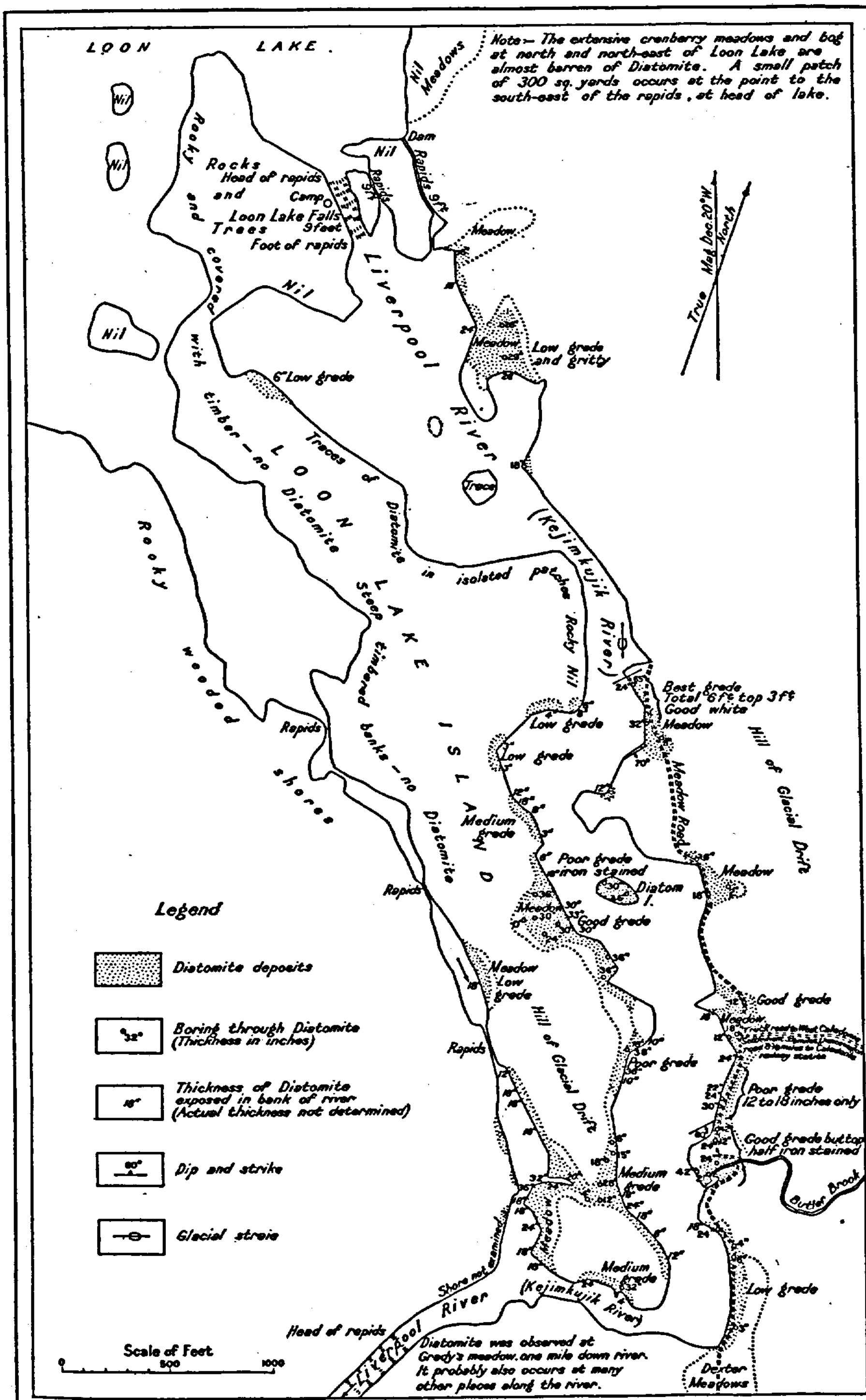
The known diatomite deposits in New Brunswick are confined to the southern part of the province. The diatoms are more broken and more sponge spicules are present than in the Nova Scotia deposits.

Albert County

Stannard Lake, Hillsborough. This lake of about 11 acres is situated on Caledonia mountain, elevation about 1,000 feet, 3 miles southwest of Albert Mines, and is approached by a rough trail 4 miles west of Milton's farm.

The diatomite which is of good quality has an average depth of 4 feet over an area of about 7 acres and is covered by 5 to 6 feet of water. The material calcines to a pale pink colour. The diatoms are badly broken, and sponge spicules fairly abundant.

[1] Faribault, E. R.: Geol. Surv., Canada, Sum. Rept. 1915, pp. 189-192.



Surveyed by E.R. Faribault, 1915
Geological Survey, Canada

Figure 17. Diatomite deposit, Loon Lake island, Liverpool river, Queens county, N.S.

The following gives the results of the test holes which are shown in the accompanying rough sketch (Figure 18). (*See* Table XI, analyses Nos. 92a to 92c.)

Hole No.	Depth of water	Thickness and sequence of diatomite layers	Nature of bottom
	Feet		
1	5	1 ft. white	Gravel.
2	5	1½ " white	"
3	5	1 " dark; 2½ ft. cinnamon	8 inches red clay on gravel.
4	5	½ " mud; 4 ft. cinnamon; ½ ft. dark	6 " " "
5	5	Nil	Gravel.
6	5	½ ft. mud; 3 ft. cinnamon; 3 ft. dark	12 inches red and brown clay on gravel.
7	6	½ " mud; 2½ ft. cinnamon; ½ ft. dark	Red and brown clay.
8	6	1 " very white; 1½ ft. black	Red clay on gravel.
9	6	½ " mud; 5½ ft. cinnamon and dark mixed	8 inches red clay on gravel.
10	5	5 " cinnamon with dark specks	8 " " "
11	5	3 " good pale cinnamon; 3 ft. darker cinnamon	8 " " "
12	5	½ " cinnamon	Stony.
13	1	2 " good white; 1½ ft. dark	6 inches red clay on gravel.
14	6	3 " good pale cinnamon; 2 ft. darker	6 " " "
15	6	4 " " " ; 1½ " "	6 " " "
16	6	4 " " " ; 1 " "	8 " " "
17	6	2 " " " ; 4 " "	4 " " "
18	5	2 " good, dense, white, tapers to nothing towards shore	Stony.

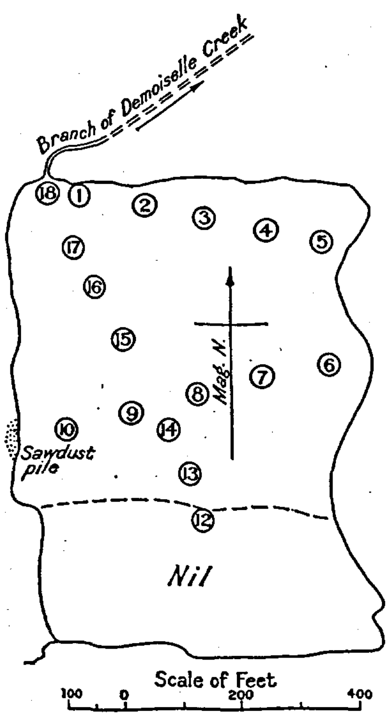


Figure 18. Stannard lake, Hillsborough, Albert county, N.B., showing location of bore-holes.

Kings County

Pollet Lake, Mechanic Settlement. This shallow lake of about 75 acres is reached by good road one mile south from Mechanic Settlement, or 12 miles south of Penobsquis station. The diatomite, which covers the whole surface of the lake bottom, is dense and white in colour but gradually becomes darker as the centre of the lake is approached. Toward the west end, the diatomite is exceptionally compact and white to a depth of 2 feet, and is underlain by a soft, dark diatomite. The same material occurs under the marsh at the west end for at least 300 feet inland from the shoreline. The greatest depth of water is about 7 feet with an average of 4 feet.

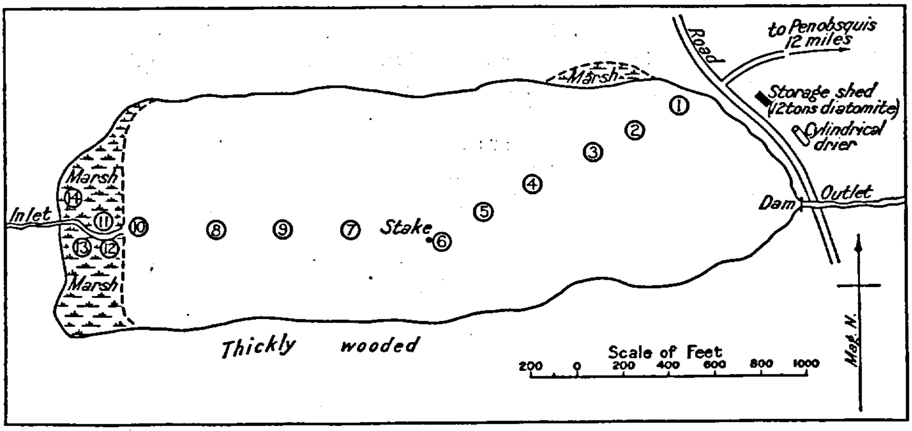


Figure 19. Pollet lake, Kings county, N.B., showing location of bore-holes.

The Pollet Lake deposit was known as far back as 1877 being amongst the first recorded discoveries of diatomite in the Maritimes. The lake was partly drained about 25 years ago, and about 10 carloads are said to have been taken out, some of which were sold to paint manufacturers in the United States. The material was treated in a cylindrical drier and stored in a shed at the east end of the lake, and in which 10 or 12 tons of the material remained at the time of the writer's visit. About $20,000 are said to have been expended in cutting the drain and making a dam at the north end. The drain is now partly filled in, and if the deposit were worked, a ditch would have to be cut down to about 15 feet below the water-level, since the maximum thickness of the diatomite is 7 feet with 7 feet of water.

All the diatomite calcines to a pale pink colour and analyses show that when calcined all have approximately the same silica content. The diatoms are, however, rather badly broken and sponge spicules are present. (Plate XII C.)

The deposit, which is one of the largest in New Brunswick, contains some high-grade diatomite. (*See* Table XI, analyses Nos. 96a to 96d.)

The mining rights are believed to be owned by Messrs. John Webster and H. B. Bailey of Fredericton, N.B.

The following gives the results of the test holes which are shown on the accompanying rough sketch (Figure 19).

Hole No.	Depth of water	Thickness and sequence of diatomite layers	Nature of bottom
	Feet		
1	3	4 ft. good white; 2 ft. darker	Gravel.
2	3	1½ " good white with iron stains; 2½ ft. grey	3 inches blue clay on gravel.
3	3	1 " very iron-stained, dense, white	Gravel.
4	3½	3½ " good pale cinnamon	Blue clay.
5	6	½ " " " ; 2 ft. dark	"
6	6	1 " mud; 5 ft. dark brown	"
7	6	1 " " 5 " " "	"
8	4	1 " " 3½ ft. dark cinnamon	"
9	2	1½ " very dense, white; 2 ft. darker	Gravel.
10	Bog	1 " mud; 2 ft. very dense, white	"
11	"	1 " " 2 " " "	"
12	"	2 " " 2 " " " ; 1 ft. dark	"
13	"	2 " " 1½ " white; 1 ft. dark	"
14	"	2 " " 1½ " " ; 4 " "	"

Flood Lake. This lake of about 10 acres is situated in a hollow surrounded by densely wooded hills on the Hammond-Waterford boundary, 6 miles south of Chambers Settlement and 16 miles southeast of Sussex. It is approached by a rough overgrown trail one mile east of the Shepody road, near Foster Croft. The greater part of the lake is over 25 feet deep and was not examined.

The diatomite is mostly of a good quality, pale cinnamon in colour near the shores, but is of darker colour near the centre, and where examined was 6 to 8 feet in thickness. Towards the west end there is some very dense, white diatomite. (*See* Table XI, analysis No. 93.) The material is low in iron and calcines white.

About 300 feet farther down from the northeast end of the outlet the ground falls rapidly and it should be easy to drain off that part of the lake containing 6 or 7 feet of water.

The following gives the results of the test holes which are shown in the accompanying rough sketch (Figure 20).

Hole No.	Depth of water	Thickness and sequence of diatomite layers	Nature of bottom
	Feet		
1	6	8 ft. dark cinnamon	6 inches clay and gravel.
2	7	1 " " " ; 3 ft. lighter, 2 ft. dark	6 " " "
3	6	2 " " " ; 3 " "	Stony.
4	7	Over 12 ft. dark cinnamon	Not found.
5	7	2 ft. dark cinnamon; over 10 ft. pale cinnamon	"
6	5	2 " " " ; 4 ft. pale cinnamon	Iron-stained clay.
7	4	1 " dark; 1 ft. dense, white	Gravel.
8	2	4 " dark and very dense	"
9	....	Over 20 ft. of mud	Not found.

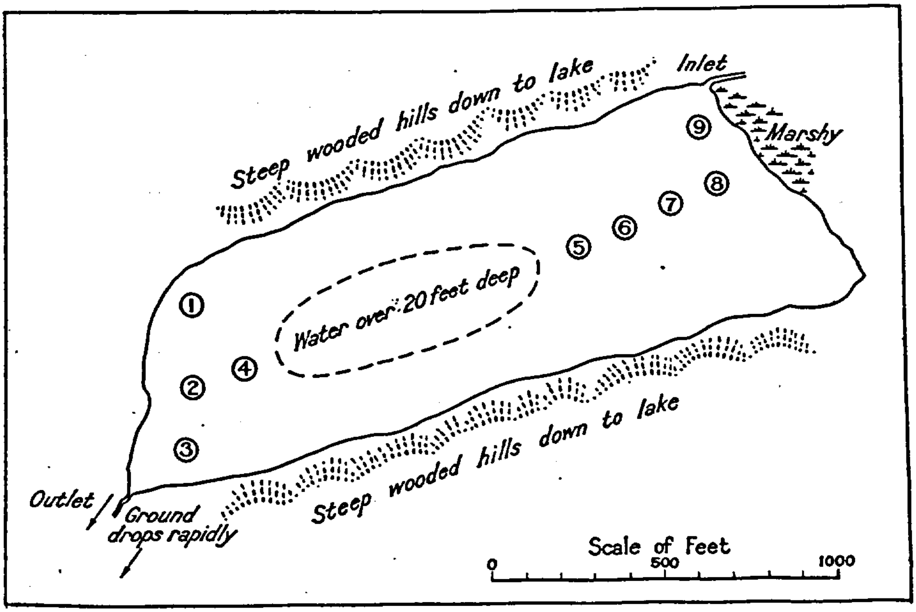


Figure 20. Flood lake, Kings county, N.B., showing location of bore-holes.

Long Lake. This shallow lake of about 15 acres is situated in a hollow at the foot of the southern slopes of Telegraph hill, at an elevation of about 300 feet, and is 1 mile west of Bayswater, and 8 miles northwest of St. John.

In places the lake contains over 15 feet of low-grade diatomaceous mud, and isolated patches of 2 to 5 feet of a good cinnamon colour and a few places where there are 2 feet of a dense, white colour. The diatoms are, however, much broken up and the deposit contains a large quantity of sponge spicules. (*See* Table XI, analysis No. 97.) The white calcines pale pink and the mud to a pale brick-red colour. The lake is at present a privately owned summer resort.

The following gives the results of the test holes which are shown in the accompanying rough sketch (Figure 21).

Hole No.	Depth of water	Thickness and sequence of diatomite layers	Nature of bottom
	Feet		
1	2	Over 15 ft. of mud containing diatoms............	Not found.
2	5	" 12 " " " " "	"
3	8	" 10 " " " " "	"
4-8	8	" 10 " " " " "	"
9	5	5 ft. dark mud; 1 ft. cinnamon..................	1 ft. clay on sand.
10	6	½ " " ; 5 " good cinnamon; 2 ft. dark...	Blue and purple clay.
11	5	2 " good cinnamon; 3 ft. dark..................	6 inches stony clay.
12	4	1½ " white; 2½ft dark........................	Gravel.
13	5	2½ " " ; 2½ " "	Clay.
14	5	2 " " ; 7 " "	"
15	3	4 " " ; 2 " "	"
16	5	1 " mud ; 9 " "	"
17	2	1 " " ; 11 " "	"
18	2	2 " dense, white with iron stains................	Gravel.

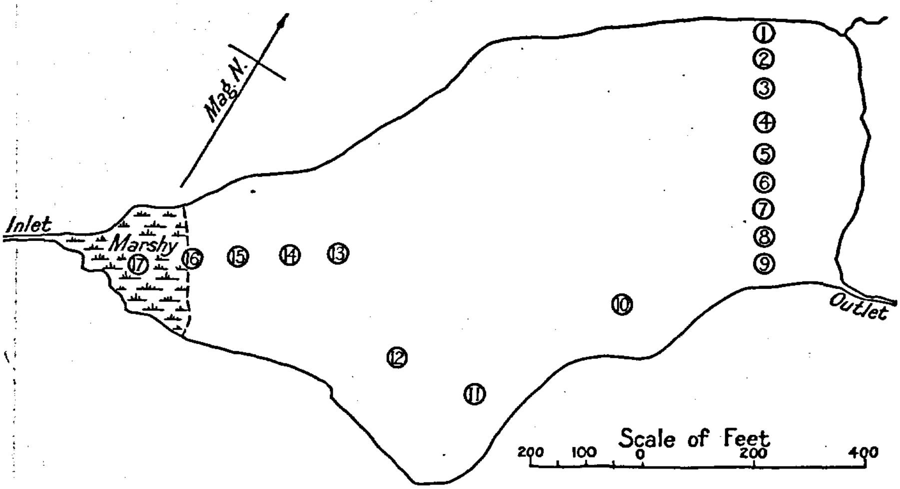


Figure 21. Long lake, Kings county, N.B., showing location of bore-holes.

St. John County

Fitzgerald Lake. This so-called "lake" of about 70 acres, which has an elevation of about 200 feet, is situated 8 miles east of St. John, and is a few hundred yards northwest of Latimer lake, the present water supply of the city of St. John. Fitzgerald lake was drained about 30 years ago by Messrs. W. and G. Murdock, of St. John, the present owners. The lake is now a marshy meadow and the overflow from Latimer lake flows into the northeast corner and keeps it from becoming quite dry. The diatomite is of a uniform dark grey colour throughout with small light-coloured spots within the mass. The depth of diatomite over about 60 acres varies from 2 feet near the edges to 12 feet around the centre, with 6 inches to 2 feet of overburden consisting of moss and peat. The bottom is covered with a dense, plastic, red clay.

The diatomite is very uniform in texture and of a medium grade. (*See* Table XI, analysis No. 98.) It is a little gritty and dries to a pale grey, but calcines to a pink colour. A large variety of diatoms are present which are not so badly broken as in the other deposits. (Plate XII D.)

About 12 years ago a Mr. Everson erected a drying plant and pebble mill on the north shore and treated a few hundred tons of material from the north end.

The following gives the results of test holes which are shown in the accompanying rough sketch (Figure 22).

Hole No.	Thickness of diatomite	Hole No.	Thickness of diatomite
	Feet		Feet
1	5	11	4
2	9	12	4*
3	9	13	4
4	6	14	5
5	6	15	6
6	12	16	7
7–9	9	17	9
10	7	18	8

NOTE.—The bottom is red clay with the exception of * which is gravel.

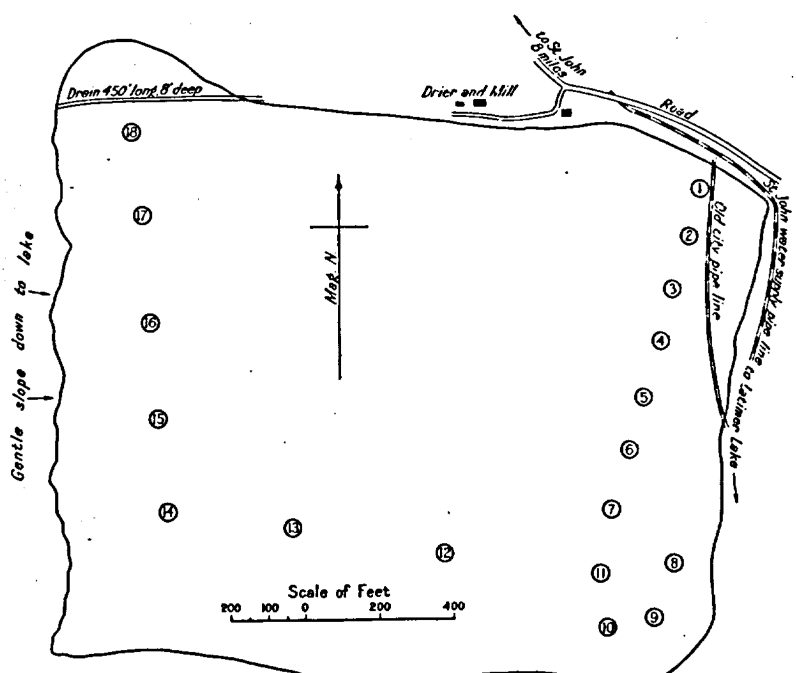


Figure 22. Fitzgerald marsh, St. John county, N.B., showing location of bore-holes.

ONTARIO AND QUEBEC

Only a few occurrences of diatomite are known in Ontario and Quebec. In Ontario they are all confined to the Muskoka region (though samples have been received from north of Cobalt) and are either lake or marsh deposits similar to those of the Maritimes. Unlike most of the latter they are remarkable for the high percentage of perfect, unbroken diatoms, and the number of species is also considerably less than in the average of the Maritimes. The known deposits are small and shallow and the diatomites are high in alumina, though after calcining some of the muds or peats would give a good product. The Spence Lake deposit is about the largest and purest at present known in the district. It is more than probable that a considerable number of diatomite deposits exist in the Muskoka region since the conditions appear favourable to the past and present deposition of the diatoms.

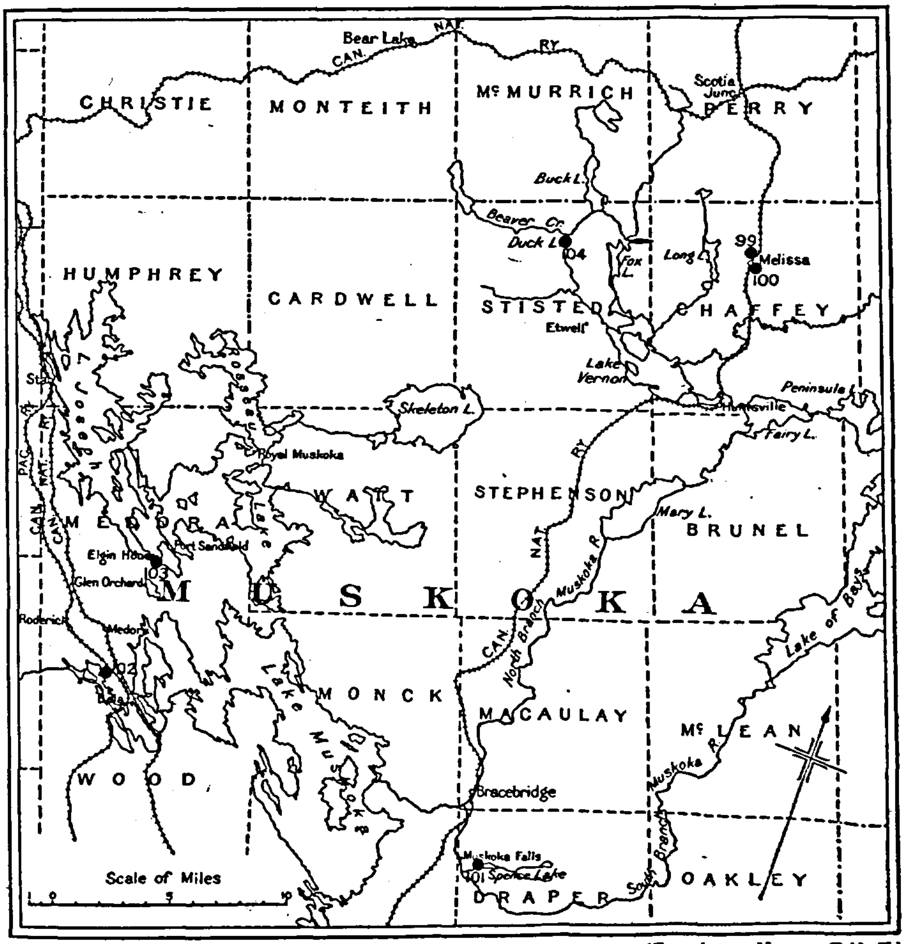
The Quebec deposits are very variable. The deposit near lake Simon appears to be the most recently formed so far found in the Dominion, since masses of spongy flocculent diatomite occur on top of the water as well as on the bottom of the lake. The diatomite has a depth of 5 feet and is not covered by mud. On the other hand, some of the deposits appear to be older than those known in the Maritimes, since the diatomite is found as a dry powdery material at a considerable elevation above the present rivers or lakes. In some cases these older deposits have been washed down from higher elevations thereby becoming mixed with mud and gravel, the original deposit having been either completely washed away or not yet discovered. The deposit occurring on the Jacquot river (*see* Table XI, analysis No. 109) is of scientific interest since it is almost entirely composed of minute seed-like diatoms of *Fragilaria undata,* and on this account resembles no other deposit in North America. (*See* Plate XIIIB.)

Ontario

Muskoka

Medora Township, Concession D, lot 11. Diatomite occurs on the farm of Albert H. Edwards, on the bottom of a small bay of the Moon river near its junction with the Muskoka river, 2 miles northwest of Bala. The deposit extends over about half an acre and has a thickness of about one foot. It is covered with about one foot of mud and underlain by sand resting on blue clay. The diatomite is of a good white colour, but is badly contaminated with silt, only about 6 inches being fairly pure. It is quite high in silica but is also high in alumina. (*See* Table XI, analysis No. 102.) The diatoms are mainly rod-shaped (*see* Plate XIIF), a type well suited for filtration purposes.

Concession IV, lot 19. On the bottom of a small bay of lake Joseph near Glen Orchard, greyish brown diatomite covers about 10 acres to a depth of 3 to 5 feet. The material can be obtained only by dredging as the bay can not be drained. A few tons were dug many years ago and sold for polishing purposes by Thomas Orgill of Glen Orchard. (*See* Table XI, analysis No. 103.) The diatoms are quite clean and fairly well preserved.



(*For reference Nos., see Table X.*)

Figure 23. Diatomite occurrences in Ontario.

Chaffey Township, Concession X, Lots 19 and 20. Grey-white diatomite, 6 inches to 1 foot in depth, occurs over 3 or 4 acres of high marshy ground, a few hundred yards north of Little East river, on Tynan's farm, 7 miles north of Huntsville. The material is in places mixed with sand and covered with peat and vegetable matter, but in some places comparatively clean though somewhat gritty material may be obtained. The deposit contains well-formed, unbroken diatoms but is high in alumina. (*See* Table XI, analysis No. 99.) Mr. Tynan intends working the material in conjunction with a silt deposit which occurs alongside.

About half a mile farther west, on Harry Southby's land locally known as the Beaver meadows, about 50 acres of swampy ground are covered with long grass and a few alders. The swamp contains 4 to 6 feet of dark brown diatomaceous peat underlain by silt or sand. The dry peat is self-calcining, leaving a pink and gritty residue containing diatoms and sponge spicules. (*See* Table XI, analysis No. 100.)

Draper Township, Concession X, Lots 3 and 4. Diatomite occurs on the west end of Spence lake some 2 miles east of Muskoka Falls and 5 miles south of Bracebridge. Swampy meadows about a quarter of a mile wide and half a mile long extend on either side of the outlet. A small area of grey-white diatomite which in places is 18 inches thick, but averages 1 foot, and is underlain by blue-grey silt, is exposed in the banks and bed of the creek. This deposit contains about 200 tons of the only natural white diatomite so far found in this locality. However, a considerable area of grey-brown mud occurs, which in places varies from 6 to 10 feet in thickness. The calcined mud is pure white in colour and consists almost entirely of well-preserved rod and oval-shaped diatoms. (Plate XIIE). When calcined it appears to be of better quality than the burnt white material which assumes a slightly pink tinge. Almost 250 tons of the dry mud or 200 tons of the calcined would be produced per acre for each foot in thickness. (*See* Table XI, analyses Nos. 101a to 101c.)

The deposit is larger, and the calcined diatomite is better, than any other so far found in this region. The diatom structure is such that it should be suitable for all purposes including sugar refining. Recent power developments by the Ontario Hydro-Electric Company have flooded this area, so that the deposit can not be drained and the material can now be recovered only by dredging. The mining rights have been taken up by J. H. Widdicombe of Bracebridge.

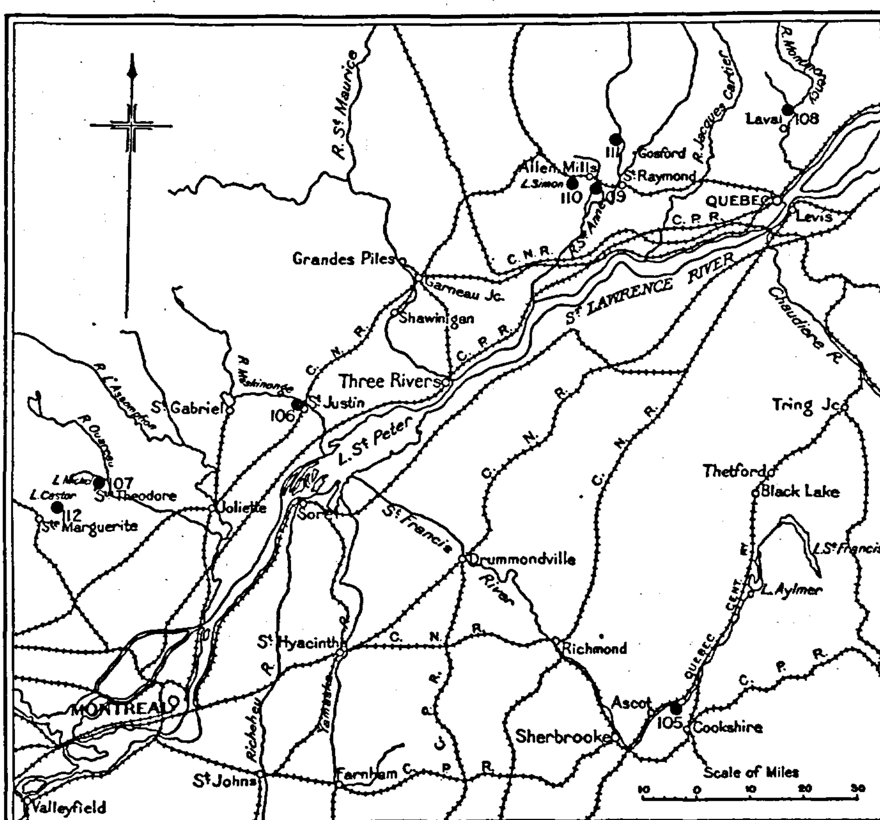
Stisted Township, Concession XI, Lot 19. About 12 miles northwest of Huntsville, a diatomaceous peat, 2 to 15 feet in thickness, and covering about 50 acres, occurs on the north and west sides of Duck lake on Hodge's farm. The swamp extends for some hundreds of feet back from the north edge of the lake and the dried peat is somewhat similar to that from Beaver Meadows, but contains less carbonaceous matter. The proportion of grit appears to increase with depth, but the best material occurs from 1 to 3 feet below the surface. The pink residue after calcining is gritty and high in alumina. About 200 to 250 tons of the calcined diatomite would be produced per acre for each foot in thickness. (*See* Table XI, analysis No. 104.) The diatoms are well preserved.

The deposit has been leased by the Canadian Diatomite and Silica Company of Toronto.

Quebec

Montcalm County

Chertsey Township, Range V, Lot 16, Lake Michel. Lake Michel is a spring-fed lake about 20 acres in extent, 3 miles north of St. Theodore (Chertsey) and 12 miles northwest of Rawdon. The diatomite occurs under a swamp at the east end of the lake and covers about 4 acres to a depth of 1 to 1½ feet. It extends about 60 feet on each side of the outlet, which enters into a branch of the Ouareau river. The deposit is in most



(For reference Nos., see Table X.)

Figure 24. Diatomite occurrences in Quebec.

places covered with 6 inches of moss and peat and underlain by 2 to 3 feet of dark brown mud. The swamp widens out a few hundred yards at the east end of the lake and the diatomite can be traced along the edges of the outlet for at least a quarter of a mile. Diatomite is said to occur on the bottom of the lake, but was not seen at the time of the writer's visit. The lake is in places over 20 feet deep.

The diatomite is light grey in colour, fairly dense but gritty and calcines to a pale brick-red colour. The diatoms are rather badly broken and sponge spicules are present. (*See* Table XI, analysis No. 107; and Plate XVE.)

The deposit was discovered about 35 years ago and the material was used locally for whitewashing houses and barns. The diatomite used for concrete tests by the Department of Public Works, Ottawa, during 1920 and 1922, was obtained from this deposit. The deposit occurs on Mr. Morin's land and is staked by Mr. Paradis of Rawdon.

Portneuf County

Colbert Township, Range IV, Lot 43, Lake Simon. A pure white diatomite occurs in a small spring-fed pond and swamp north of lake Simon, between it and the Canadian National Railway track, 3 miles west of Allen's Mills station. The creek from the pond flows east and joins the outlet from the lake. Over the surface of the pond, which is about an acre in extent, the diatomite is in a semi-suspended state in the form of whitish spongy, flocculent masses. On the bottom it is, in places, 6 feet thick with an average of 4 feet, and extends over about 2 acres. (*See* Table XI, analysis No. 110.) The bottom foot or two of the deposit is denser and much iron-stained. The east end of the pond is marshy and covered with reeds and alders under which diatomite also occurs, but it is not so thick or of such good quality as in the open water.

The pond, which is situated on the land of Mr. Elie Frenette, is the only one so far known in the Dominion in which the diatomite is found in a flocculent condition. The deposit though small, is thicker than the average in Ontario or Quebec, and contains diatomite of good quality. It is almost entirely free from dirt, the diatoms being exceptionally clean and well preserved. (*See* Plate XIIIA.) On account of the flatness of the surrounding country the pond would be difficult to drain, but the material might be dredged. It is very close to rail transportation.

Other occurrences in Ontario and Quebec with analyses of the material will be found in the Tables X and XI, Nos. 99 to 112.

TABLE X

Canadian Diatomite Occurrences

BRITISH COLUMBIA

Ref. No.	County or Mining Division	Locality	Nature and Extent of Deposit	Reference	Remarks
1	Ashcroft	Pukaist creek, Highland Valley, 25 miles southwest of Ashcroft. Elevation 4,000 feet.	6 inches to 3 feet of grey-white diatomite along creek valley.	*See* Report; *also* geology, Geol. Surv., Can., Sum. Rept., 1915, p. 85; 1916, p. 53.	Six miles of rich alpine meadows. A deposit of 6 inches occurs in numerous places covered by 2 feet of peat, but on rising ground near edges it is 3 feet with little overburden. Underlain by chocolate and grey clay.
2	"	Deadman river, 27 miles north of Savona. Loon lake, 25 miles north of Ashcroft. Elevation, 2,820 feet.	Small deposit of shell marl full of diatoms, on east side of river between Snohoosh and Skookum lakes, Deadman river.		The diatomite marl bed which is a few feet thick is about 15 feet above bed of creek between the lakes. Reported high-grade diatomite in Loon lake.
3	Cariboo	Blackwater river and Tsacha lake, 25 and 105 miles northwest of Quesnel.		Geol. Surv., Can., 1876-7, p. 79.	Reported occurrences, said to be extensive, covering Tsacha lake; also on the Blackwater, near Telegraph Cabin.
4	Kamloops	Guichon creek, Mamit lake, Mathew's farm.	Two acres covered by 2 to 6 feet of white and brown diatomite.	*See* Report	Similar to and about 12 miles east of the Pukaist Creek deposit (No. 1).
5	"	Copper creek, B. Chester's farm, 10 miles north of Copper Creek Sta.	Several acres underlain by about 10 feet of yellow, impure diatomite.	*See* Report	This material is a fuller's earth possessing good bleaching qualities for oil and lard.
6	Nanaimo	Haslam and Stewart lakes, 4 miles east of Powell River.	Bottom of some bays covered with diatomite ooze, and several acres of 2 or 3 feet in other lakes and swamps.		Some bays on the east of Haslam lake contain 10 feet of yellow-brown diatomite ooze. About 2 feet of grey, gritty diatomite occurs in Duck lake and swamps to the east. At Stewart lake, 1 mile north, there is a very pure streak of a few inches of white diatomite in which diatoms are exceptionally well preserved. Deposits examined are not commercial.

TABLE X—Continued

Canadian Diatomite Occurrences—Continued

BRITISH COLUMBIA—*Continued*

Ref. No.	County or Mining Division	Locality	Nature and Extent of Deposit	References	Remarks
7	New Westminster	Williams' farm, 6 miles south of Chilliwack. Elevation, 650 feet.	Small swamp above S. H. Williams' farm. Deposit 18 inches of gritty diatomite over an area of 20 square yards.		Deposit small and impure.
8	Quesnel	Lot 906, near Fraser river, 2 miles southwest of Quesnel. Elevation, 2,250 feet.	Three exposures over a distance of 300 feet. Beds 50 feet in thickness of compact diatomite overlain by porous basalt.	*See* Report; *also* Geol. Surv., Can., Mem. 118, p. 76 (1920).	Diatomite, pure and hard, can be cut into blocks; 700 feet above the present river level. The largest deposits so far found in the Dominion.
9	"	Lot 385, Quesnel town limits. Elevation, 1,550 feet.	Remnant about 15 feet in length and 5 feet thick of white diatomite exposed in railway cut in the brickyard north of the town.	*See* Report	Mixed with clay and silt.
10	"	Lot 1122, Fraser river, 2 miles northwest of Quesnel. Elevation, 1,650 feet.	Several outcrops revealing compact diatomite beds dipping 35 degrees west. Exposed for 7 feet in thickness, overlain by 1-foot bed of more recent diatomite.	*See* Report	These beds form a small plateau 25 feet above Fraser river. At right angles to bedding the thickness is about 40 feet.
11	"	Lots 41192 and 39493, "Big bend," 8 miles northwest of Quesnel.	Large masses of diatomite exposed for about 1 mile along steep, west bank of Fraser river and 50 to 100 feet above it. Also other masses 800 feet higher up.	*See* Report	For a distance of almost a mile, bodies of diatomite 30 to 40 feet thick occur as ridges on the plateau on the west bank, 800 feet above the river.
12	"	Various localities in vicinity of Quesnel.	Small masses and exposures along banks of Fraser and Quesnel rivers.		Diatomite exposures seen on lot 1226 west bank of Fraser, lots 5017 and 5018 on east bank, 4 miles north of Quesnel, where 5 to 6 feet are visible under 150 feet of clay and gravel. Three or four exposures on lot 6182 on east bank near the "Big bend".

13	"	Lot 304, Alexandria, 20 miles south of Quesnel. Elevation, 1,700 feet.	Several feet of good, white, compact diatomite under 20 feet of overburden.		Discovered in digging a well on Webster's ranch, 1 mile west of Fraser river. No further information.
14	Vancouver Island (South)	Goldstream, Highland dist., 4 miles north of Colwood.	Small deposit. One foot of gritty diatomite on George Aikman's farm covering about 1 acre.		In various places in small meadow chiefly on edges near rising ground. Probably at one time completely covered with diatomite but now washed away, leaving the edges only.
15	"	Bear lake and river, Hillbank station. Elevation, 150 feet.	Six to eight inches of impure diatomite extends for considerable distance along creek and the Bear River valley under 1 foot of peat. Isolated pure white patch under bridge at outlet of Bear lake.		The diatomite is mixed with silt, but covers a large area. Too impure and thin for commercial use. The pure white is only a remnant a few square feet in area.
16	"	Prospect Lake valley, north of the lake.	Six inches of impure diatomite under soil.		Exposed in the Government ditch. Mixed with soil and silt underlain by blue clay. Covers large area but too shallow and impure for commercial use.
17	"	Prospect lake, H. T. Oldfield's farm, 2 miles west of Prospect Lake. Elevation, 160 feet.	Covers an area of 1½ acres; 2 feet of fair grade.	*See* Report; *also* Geol. Surv., Can., Mem. 36, p. 137.	About 200 tons extracted in 1921. Deposit, though small, is near transportation and best grade so far found in district.
18	"	Quamichan lake, 1 mile east of Duncan. Elevation, 110 feet.	One to two feet of impure and gritty diatomite occurs over an area of 6 acres on E. P. Hassel's and Hadwin's ranches, on west and northeast end of lake.		The diatomite probably occurs in numerous places around the lake but about 10 or 12 feet above the present highwater mark. It is gritty and high in alumina.

NOVA SCOTIA

19	Antigonish	Beaver meadows, Addington forks, 3 miles south of James River.	Only a very thin layer underlain by grey-blue clay.		Reported occurrence on Duncan MacRae's land was found to be mostly clay.
20	"	Cameron lakes, 9 miles southeast of James River.	Small		Reported to occur in these lakes, which are small and very deep and are not likely to be of commercial value.
21	"	Lake St. Joseph, 4 miles southeast of James River.	Quality said to be good		Reported deposit, small but good quality.

TABLE X—Continued

Canadian Diatomite Occurrences—Continued

NOVA SCOTIA—*Continued*

Ref. No.	County	Locality	Nature and Extent of Deposit	References	Remarks
22	Antigonish	Lochaber lake, 4 miles east of southwest corner of county.	Small, near edge of lake only	Geol. Surv., Can., vol. XV, pt. S, p. 25 (1903).	Occurs as small patches over lake, mainly at north and south ends, under bog. Large lake and could not be drained.
23	Inverness	River Denys	Shallow deposit under marshes in vicinity of post office and 6 miles north up the river on D. Cameron's farm near Ashfield.	Geol. Surv., Can., vol. XV, pt. S, p. 25 (1903).	Reported occurrences. No information as to extent.
24	Cape Breton	Grand lake, 2 miles north of Louisburg.	Deposit pockety and iron stained.		Numerous grades and layers of diatomite, somewhat gritty. The lake is deep and has numerous farms on its shores and could not be economically drained.
25	"	Catalone lakes, Mira bay	Numerous lakes all contain diatomite. Mostly small shallow deposits much iron stained.		Two of the smaller lakes contain the purest material, but tonnage small. At present staked by Joseph Salter of North Sydney.
26	"	South shore of East bay, 15 miles southwest of Sydney.	Small		Two lakes reported to contain small quantities of fairly pure diatomite. Owner George Hacket, North Sydney.
27	Victoria	Munro pt., St. Ann (Premier Tripolite Co.)	Several lakes drained and operated by company. Material good quality but scattered in small quantities over various lakes.	*See* Report; *also* Geol. Surv., Can., vol. XV, pt. S, p. 26 (1903); Mines Branch Sum. Rept., 1914.	Deposits were operated between 1896 and 1917. Small treatment plant at Munro point.
27a	"	Ingonish, Stevens pond	Several ponds in vicinity of Ingonish contain diatomite.		
28	"	Bras d'Or peninsula	Small deposits of diatomite occur 2 miles north of South gut and farther north 1 mile southeast of Blackstone pt. and near New Harris forks.	Geol. Surv., Can., vol. XV, pt. S, p. 26 (1903).	Reported occurrences, all said to be small.

29	Colchester	British lake, 9 miles north of Lower Economy village.	Small		Low grade—no commercial value.
30	"	Chain lakes, 6 miles east of Folleigh station.	Quantity large but low grade		The most northerly lake has best deposit, but is at present remote from transportation and grade is poor.
31	"	Clear lake, 4 miles south of Central New Annan, 10 miles south of Tatamagouche.	Average of 2 feet of good diatomite covering 8 acres.	*See* Report	Deposit somewhat pockety over about one-third of lake bottom. Lake deep in centre.
32	"	Black lake, ½ mile east of Clear lake.	Small		Reported occurrence, small but of good quality.
33	"	Conkey, Gard, Hackerby, and Rhude ponds, 2 to 3 miles due east of Black lake (Oxford Tripoli Co.)	Rhude pond, 2 acres of lake bottom covered by 3 to 16 feet of varying coloured diatomite. Other ponds, 3 to 8 feet diatomite.	*See* Report	Three ponds are now being operated by the Oxford Tripoli Co. Diatomite is good grade.
34	"	Depert lake, 3 miles south of Annandale.	Several feet of good diatomite at north end.		Lake very deep and only shallow near north end. Difficult to drain.
35	"	Earltown lake, 2 miles south of Earltown. Elevation, 435 feet.	Two feet of hard, white, and in places 12 feet of darker and softer diatomite in various pockets over lake bottom.	Geol. Surv., Can., vol. XV, pt. S, p. 26 (1903).	No diatomite near shore. Best deposit southeast end of lake. Lake is too large to drain economically.
36	"	Earltown lake. Swamp on Taylor's farm. Elevation, 460 feet.	About 2 feet of good quality white diatomite over ½ acre.		Small swamp at northeast corner of lake and source of creek flowing into it. Sandy bottom. Well-preserved diatoms.
37	"	Economy lake, 4 miles west of Castlereagh.	A large lake, but diatomite occurs only in very small quantities in various places on lake bottom.	Geol. Surv., Can., vol. XV, pt. S, p. 25 (1903).	Deposit small and lake difficult to drain. The diatomite is of good quality.
38	"	Folly lake, on I.C. Ry., 10 miles north of Glenholme. Elevation, 605 feet.	6 to 7 feet of diatomite in places, but very pockety.	*See* Report; *also* Geol. Surv., Can., vol. XV, pt. S, p. 25 (1903).	Best material southeast and southwest ends. Lake large and impractical to drain.
39	"	Folly River meadows, ½ mile south of Folly lake.	One foot of dense, white diatomite extends for a considerable distance along inlet of lake.	*See* Report	Diatomite good quality but deposit very shallow—could be used for local consumption on small scale.
40	"	Farm lake, 5½ miles south of Central New Annan.	Small and pockety		Lake is fed from Clear lake, 1 mile to the north. Diatomite similar to that lake, but less quantity and not so good.
41	"	Little Gummel lake at Castlereagh.	Two to three feet of pure white diatomite, area small. Larger deposit but low grade in Big Gummel lake.	*See* Report	Edge of lake and along inlet under cranberry marshes. Very high in silica.

TABLE X—Continued

Canadian Diatomite Occurrences—Continued

NOVA SCOTIA—*Continued*

Ref. No.	County	Locality	Nature and Extent of Deposit	References	Remarks
42	Colchester	Hart lake, 2½ miles north-east of Folleigh station.	Deposit small and shallow		The diatomite is impure and is also too small to be of commercial value.
43	"	Lily pond, 1 mile north of Simpson lake. Head-waters of Economy river. Elevation, 746 feet.	Four feet over about 4 acres. Deposit high grade.		This deposit, though small, is high in silica and might be economically worked.
44	"	Moose lake, 5 miles west of Silica lake. Headwaters of Economy river.	Two to three feet of hard and dense diatomite over an area of about 6 acres.		Grade of diatomite reported to be good.
45	"	Silica lake (Oxford Tripoli Co.), 4 miles northwest of Castlereagh. Elevation, 700 feet.	Three to eight feet of good grey-white diatomite. Area 20 acres. Deposit now worked out.	*See* Report; *also* Geol. Surv., Can., vol. XV, pt. S, p. 26 (1903); *also* Mines Branch Sum. Rept., 1914.	Worked for many years and the crude diatomite was calcined in the mill on edge of lake and then shipped to Haverstraw, N.Y., for final grading.
46	"	Silica Lake bog (Oxford Tripoli Co.), ½ mile north of Silica lake.	Six feet of good diatomite under 6 feet of peat over a few acres.	*See* Report	The deposit is small, but grade is good and during 1923 to 1925 formed the company's source of supply; was treated in their old mill on Silica lake.
47	"	Simpson lake, 7 miles west of Silica lake. Elevation, 736 feet.	Deposit small and low grade		Reported occurrence said to be of no commercial value.
48	"	Slack lake, 2 miles south-west of Folleigh. Elevation, 600 feet.	In places 6 to 7 feet—total area about 6 acres.	*See* Report	Deposit very pockety, some of which is good grade.
49	"	Snare lake, 5½ miles north-east of Folleigh.	Fairly large deposit, somewhat shallow and impure.		Lake difficult to drain and deposit too low grade to be of commercial grade.
50	"	Toad lake	Deposit said to be large but very low grade.		Reported occurrence.
51	"	Big Totten lake, 4½ miles west of Folleigh.	One to two feet of good diatomite in places over an area of 6 acres.		Lake of about 12 acres and difficult to drain.

52	"	Trout lake, 4 miles northeast of Folleigh.	Deposit variable. North end 20 feet of diatomite mud. In other places 3 to 9 feet of white and grey diatomite. Area of deposit, about 25 acres.	*See* Report	40-acre lake of good quality diatomite and is amongst the best prospects in this region.
53	"	West Branch lake, 1 mile north of Simpson lake, 7 miles west of Silica lake.	Small, shallow deposit of low grade.		No commercial value.
54	Cumberland	Duck pond and Goose pond, 4½ miles north of Castlereagh.	Both these ponds have a small quanity of low-grade material.		Deposits too small to be of commercial value. Goose pond is ½ mile west of Duck pond.
55	"	Fountain lake, 4 miles north of Castlereagh. Elevation, 670 feet.	A considerable quantity of high-grade diatomite in south end.	Geol. Surv., Can., vol. XV, pt. S, p. 25 (1903).	Lake is large and deep and very difficult to drain.
56	"	Irving lake	Small deposit of about ½ acre, and contains 2 to 6 feet of fair grade diatomite.		Lake, 110 by 125 feet, over half of bottom contains diatomite from 2 feet at edges to 6 feet in centre.
57	"	Little lake, 4 miles north of Sutherland lake, 1 mile west of lat. 63° 40′.	Twelve-acre lake containing an average of 2½ feet of low-grade diatomite.		Shallow lake of less than 4 feet of water, but diatomite is too low grade to be of commercial value.
58	"	Newfound and Isaac lakes, 1 and 2 miles south of Little lake.	Deposits small and low grade.		These lakes are below Little lake and deposits are too low grade to be of commercial value.
59	"	Otter lake, 2 miles west of Sutherland lake, 3 miles northeast of Castlereagh. Elevation, 640 feet.	Deposit is very large covering whole lake.		Whole of southern half of lake is marshy containing impure diatomite mud. Deposit is low grade.
60	"	Springhill Reservoir, South Branch of Maccan river, 6 miles south of Springhill.	Small deposit but very pure.		The Springhill water supply filters through the diatomite which forms a natural purifier and therefore could not be utilized for other purposes.
61	"	Sutherland lake, 5 miles northwest of Castlereagh. Elevation, 740 feet.	Deposit very pockety and low grade.		Large lake, impractical to drain and deposit too low grade for commercial use.
62	"	Webb lake, 2 miles north of Sutherland lake, 6 miles northeast of Castlereagh.	One foot of high grade, underlain by 1 to 2 feet of medium grade underlain by impure diatomite mud. Covers 2 acres.		Approached by rough trail 1½ miles northeast of Westchester Lake road. Deposit mainly confined to east end of lake at inlets.
63	Digby	Digby neck, 1 mile south of Little River (31 miles south of Digby).	Two to four feet fairly compact diatomite and diatomite peat underlain by 4 to 8 feet of grey diatomite underlain by 6 to 8 feet of diatomite ooze—area several hundred acres.	*See* Report	Partially drained extensive meadows. In places over 20 feet of various grades of diatomite. The peat is self-calcining. One of the largest and most accessible diatomite deposits in the province. Now being operated by the Scotia Diatom Products Company.

TABLE X—Continued

Canadian Diatomite Occurrences—Continued

NOVA SCOTIA—*Continued*

Ref. No.	County	Locality	Nature and Extent of Deposit	References	Remarks
64	Digby	Salmon river, 1 mile east of Mayflower.	One to two feet of impure, grey diatomite in alder swamp of ½ an acre on Louis Saulnier's farm.	*See* Report; *also* Geol. Surv., Can., vol. IX, pt. A, p. 93 (1896).	A few tons extracted and made into polishes. Too small for commercial use.
65	"	Salmon river, 1 mile north of Sigogne.	Two to four feet of gritty diatomite occur for ½ mile along the Salmon River meadows.	*See* Report	Probably considerably more diatomite may be found in these meadows.
66	Halifax	Caribou lake, 1½ miles west of Middle Porter Lake,	About 2 feet of fairly pure diatomite under 3 feet of moss and peat covering about ½ an acre.		The diatomite occurs in south end of lake, but deposit is small and lake difficult to drain.
67	"	Paint lake, 2½ miles north of Head of Chezzetcook.	Small.	Geol. Surv., Can., Mem. 20, pt. E, p. 300.	Reported occurrence, said to have been used for whitewashing barns.
68	"	Dartmouth lakes, 1 mile east of Dartmouth.	Very thin and impure patches of diatomite in various parts of lake close to shore.	Mines and Minerals of N.S., 1880, p. 15.	This large lake is the city of Halifax water supply and could not be drained. No commercial importance.
69	"	McQuade lake, 8 miles northwest of Halifax. Elevation, 300 feet.	In places up to 3 feet of greyish, medium grade diatomite.	*See* Report	Deposit pockety over the 12-acre lake. Best grade south and southwest end. Once partially drained in an attempt to extract the diatomite.
70	Kings	Factory Dale, Beech Hill dam, 5 miles south of Nicholsville.	Two to three feet of good, dense white diatomite in alder swamp, overlain by 1 to 3 feet of vegetable matter. Covers an area of 2 to 3 acres.	*See* Report; *also* Geol. Surv., Can., 1920, pt. E, p. 15.	Occurs in the stillwaters and swamps of the West Branch of the South Annapolis river. Some material extracted and used for polishes.
71	"	Factory Dale, Horseshoe meadows, Shinglemill falls.	One to two feet of fair grade diatomite over several acres.	*See* Report; *also* Geol. Surv., Can., 1920, pt. E, p. 15.	Occurs in the stillwaters and swamps of the East Branch of the South Annapolis river. Deposit too shallow to be of much commercial value.

72	"	Morden, 6 miles north of Aylesford.	One to two feet of grey diatomite. Deposit very small but of good quality.	*See* Report	In alder swamp on top of North mountain. Some material extracted, but too small and shallow to be of commercial value. Contains the best preserved diatoms so far found in the province.
73	Lunenburg	Sabody pond, Middle river, 2 miles north of Chester basin.	One to two feet of good grade grey-white diatomite near south shore. Deposit small.		Small lake covered with rushes at south end where diatomite is visible as a white material under 6 to 8 feet of water.
74	"	North river, Sarty meadows, 8 miles north of New Germany.	A few inches to 1 foot of greyish diatomite.		Occurs in backwaters and islands of North river. Deposits small and mixed with silt.
75	Pictou	Black lake, 1 mile west of Eden lake.	Deposit small and shallow		Reported occurrence said to be small.
76	"	Upper Black brook	Deposit fairly large but low grade.	Geol. Surv., Can., vol. XV, pt. S, p. 26 (1903).	Far from railway transportation. Also reported from McKay Brook lake, 2 miles southeast.
77	"	Brora lake, 8 miles south of Barney River station.	Deposit variable. In places 3 to 13 feet of good diatomite and in others 2 feet of pure white. Area of deposit 40 acres.	*See* Report	60-acre shallow lake contains very pure diatomite and is one of the best deposits so far found in the province.
78	"	Johnson's marsh, ½ mile northeast of Brora lake.	Two to three feet fair grade somewhat gritty diatomite over ½ acre.	*See* Report	Small marsh on R. Johnson's farm. A few tons extracted.
79	"	Calder lake, 8 miles south of New Glasgow.	Small deposit of diatomite said to occur in centre of lake.	Geol. Surv., Can., vol. XV, pt. S, p. 26 (1903).	Reported occurrence. None seen at north or south ends. Could be easily drained from north end through Calder's farm.
80	"	Cluness marsh, 5 miles south of Barney River Station.	About 1 foot of good white diatomite but somewhat gritty. Covers about ½ acre.		About 2 carlots extracted by George Cluness and used locally as a fertilizer carrier.
81	"	Eden lake	Small scattered deposits of diatomite, best at southeast end. None found under marshes at south end.	Geol. Surv., Can., vol. XV, pt. S, p. 26 (1903).	The lake is too large to drain and deposit not commercial.
82	"	Finlay's meadows, 5½ miles south of Barney River Station.	Very little diatomite found in Robertson's lake but several patches along meadow to the east.		Stillwater pond and swamp one mile east of lake contain over 20 feet of diatomite ooze, not covered with water; worthy of further investigation.
83	"	Forbes lake	Small quantity of impure diatomite.	Geol. Surv., Can., vol. XV, pt. S, p. 26 (1903).	Lake used as reservoir for New Glasgow and could not be drained. No commercial value.

8474—7

TABLE X—Continued

Canadian Diatomite Occurrences—Continued

NOVA SCOTIA—*Concluded*

Ref. No.	County	Locality	Nature and Extent of Deposit	References	Remarks
84	Pictou	Grant lake, 10 miles south of New Glasgow.	Three to eight feet of muddy and somewhat gritty diatomite. Mostly near west side and around islands.	Geol. Surv., Can., vol. XV, pt. S, p. 26 (1903).	Deposit impure but lake could be easily drained.
85	"	Indian lake, 7 miles south of Barney River Station.	Small deposit of poor quality		Lake very deep, far from transportation and difficult to drain.
86	"	Sutherland lake, 5 miles south of Barney River Station.	Deposit small and low grade		No commercial value.
87	"	Sutherland marsh, 1 mile north of Laggan; 5 miles southwest of Barney River Station.	Small deposit of ¼ acre mixed with clay and silt.		Small marsh near J. Sutherland's farm. Some material extracted and used as fertilizer carrier. No commercial value.
88	Queens	Loon lake, Liverpool river, 9 miles west of Caledonia.	A few inches to four feet of grey and white diatomite. Deposits occur in numerous patches over a wide area.	*See* Report; *also* Geol. Surv., Can., 1914, p. 106; Geol. Surv., Can., 1915, pp. 189-193.	Diatomite occurs in marshes, on edges of both shores of river and island. Traced for 2 miles.
89	Shelburne	Horse island, Roseway river, 2 miles north of Middle Ohio.	One to two feet of medium grade gritty diatomite in small island.		Several patches of impure, shallow beds of diatomite along shores and island of the Roseway river. No commercial value.
90	"	Jordan river, 1 mile north of John lake.	Good quality white diatomite	Geol. Surv., Can., 1919, pt. F, p. 7.	Occurs in marsh bordering eastern side of stillwater above John lake. Extent and thickness not known. Far from transportation.
91	"	First lake on west branch of Jordan river, 4 miles north of John lake.			Reported occurrence staked by John Bell of Jordan Falls. At present too remote to be of economic importance.

52474—7½

NEW BRUNSWICK

92	Albert	Stannard lake, 3 miles southwest of Albert Mines. Elevation, 1,000 feet.	Deposit variable. In places 1 foot of good white but mainly 3 to 5 feet of yellowish. Area of deposit about 7 acres.	*See* Report	Shallow lake of about 11 acres and worthy of further investigation.
93	Kings	Flood lake, 6 miles south of Chambers Settlement, 16 miles southeast of Sussex.	Two to eight feet of dark brown diatomite, but in places dense, white. Area about 10 acres.	*See* Report	Good grade deposit and worthy of investigation.
94	"	McNair lake, Mechanic Settlement.	Small, shallow deposit which in places is fairly white and of good grade.		5-acre lake. This appears to be the only one of the New Ireland lakes that contains diatomite.
95	"	Pleasant lake, 2 miles north of Flood lake.	Very small deposit, not more than ½ acre of fair grade.	Geol. Surv., Can., vol. XV, pt. S, p. 27 (1903).	Most of lake has gravel bottom containing no diatomite. Owned by a fishing club. No economic importance.
96	"	Pollet lake, 1 mile south of Mechanic Settlement, 12 miles south of Penobsquis station.	Deposit variable. In places 2 feet of very dense, white diatomite, other 2 to 5 feet of soft yellowish and grey. Area, 70 acres.	*See* Report; *also* Geol. Surv., Can., vol. XV, pt. S, p. 27 (1903); Geol. Surv., Can., 1914, p. 106.	Shallow lake and easy to drain. Deposit at one time operated and 11 carlots shipped. One of the best diatomite deposits so far discovered in the province.
97	"	Long lake, 1 mile west of Bayswater, 8 miles northwest of St. John. Elevation, 300 feet.	In places over 15 feet of mud containing diatoms; 2 to 3 feet of good yellowish diatomite and isolated patches of 2 feet dense, white.	*See* Report	Shallow lake contains only a few small patches of good grade diatomite, but contains a high percentage of sponge spicules.
98	St. John	Fitzgerald lake, 8 miles east of St. John. Elevation, 200 feet.	Four to nine feet of grey diatomite. Deposit very consistent in grade. Area, 70 acres.	*See* Report; Geol. Surv., Can., vol. XV, pt. S, p. 27 (1903); 1913, p. 242, G.S. of N.B. Pub. No. 983; Mines Branch Sum. Rept. 1914, p. 56.	Originally a lake; drained 30 years ago. Was once operated and material calcined and shipped.

TABLE X—Concluded

Canadian Diatomite Occurrences—Concluded

ONTARIO

Ref. No.	County	Locality	Nature and Extent of Deposit	References	Remarks
99	Muskoka	Chaffey tp., con. X, lots 19-20, Tynan's farm, 7 miles north of Huntsville.	About 1 foot of slightly gritty diatomite, under 1 foot of peat covering 4 acres.	*See* Report	Small swamp on fairly high ground above Little East river. Small amount sold locally as silver polish.
100	"	Chaffey tp., con. X, lot 18, Southby's farm, Beaver meadows.	50-acre marshy meadows containing 4 to 6 feet of dark brown diatomite peat.	*See* Report	The diatomite contains considerable grit and calcines dark pink in colour.
101	"	Draper tp., con. X, lot 4, Spence lake, 1 mile east of South falls.	About 1 foot white diatomite covering ½ acre, also large area of diatomite mud 6 to 10 feet in depth.	*See* Report	The mud calcines to a very white, good quality diatomite. Deposit encouraging.
102	"	Medora tp., con. D, lot 11, Moon river, 2 miles northwest of Bala.	About 1 foot of white, somewhat gritty diatomite. Area, ½ acre.	*See* Report	Small sheltered bay of Moon river, on farm of Albert H. Edwards.
103	"	Medora tp., con. IV, lot 19, lake Joseph, Glen Orchard.	Three to five feet of grey-brown diatomite. Area, 6 acres.	*See* Report; *also* Ont. Dept. of Mines, 1911, p. 45.	In bay of lake Joseph. Some material extracted by dredging. Impossible to drain.
104	"	Stisted tp., con. XI, lot 19, Duck lake, Hodge farm, 12 miles northwest of Huntsville.	From 2 to 15 feet of diatomite peat covering 30 to 50 acres. Somewhat gritty.	*See* Report	The peat is self-calcining, leaving a pink gritty diatomite residue high in Al_2O_3 and iron. Diatoms well formed.
104b	"	Stisted tp., cons. I and II, lots 24, 25, Slocum lake near Martin siding, 5 miles south of Huntsville; also Round lake at Martin siding in Stephenson tp.	About 8 feet of black diatomite ooze. Area, 70 acres in Slocum lake. About 3 feet of gritty black diatomite. Area, 200 acres in Round lake.		Both deposits are high in organic matter and iron. They shrink considerably on drying and calcine dark pink. Best material in Slocum lake where diatoms are very well preserved.

QUEBEC

105	Compton	Westbury tp.	No information	Cat. Col. and Ind. Exhib., London, 1886, p. 159.	Reported occurrence. Material said to have been refined and put up into packages for polishing powders many years ago.
106	Maskinonge	Three Rivers tp., 2 miles north of St. Justin.	Nil	Geol. Surv., Can., vol. XV, pt. S, p. 27 (1903).	Small remnant found about 25 years ago on top of 60-foot sand bank above creek. Now completely washed away.
107	Montcalm	Chertsey tp., range V, lot 16, lake Michel, 12 miles northwest of Rawdon.	One to two feet of fairly dense, light grey diatomite covering about 4 acres.	*See* Report; *also* Geol. Surv., Can., vol. XV, pt. S, p. 28 (1903).	Extends under marsh 75 feet on both sides of outlet. Occurs on Mr. Morin's land. Staked by M. Paradis of Rawdon.
108	Montmorency	Laval Settlement, Coté de Beaupre, 9 miles north of Quebec.	Nil	Geol. Surv., Can., vol. XV, pt. S. p. 27 (1903).	Reported occurrence in Bras river at its junction with the Montmorency river. All deposit now washed away leaving high bank of bluish grey clay interstratified with fine yellow sand.
109	Portneuf	Bourglouis seig., range V, 2 miles south of Allen's Mills, Jacquot river.	One foot of white, gritty diatomite underlain by sand. Area, a few square yards.		Remnant washed down from some higher level. No commercial value but mainly of scientific interest, being the only occurrence in North America containing such a large percentage of seed-like diatoms of "*Fragilaria*". Occurs on property of Pheliar Walman, Allen's Mills.
110	"	Colbert tp., range IV, lot 43, lake Simon, 3 miles west of Allen's Mills.	Four to six feet of pure flocculent diatomite. Area, 2 acres.	*See* Report	Small pond north of lake Simon. Diatomite masses floating on top of water, and is the only recorded instance of this in the Dominion. Deposit small. Owned by Elie Frenette, Allen's Mills.
111	"	Gosford tp., range VIII, lot 2, north branch of St. Anne river, 10 miles north of St. Raymond.	Two feet of diatomite mixed with gravel and sand along small creek in river valley; area very small.		The diatomite appears to have been washed down from some higher level. Occurs on Ferdinand Lorette's land.
112	Terrebonne	Wexford tp., con. V, lot 23, Castor lake, 2 miles south of Masson lake.	About 4 acres along south edge of lake bottom is covered by several feet of diatomite mud underlain by grey diatomite.		Deposit not examined, but samples show many types of exceptionally well-preserved diatoms (Plate XV F).

NEWFOUNDLAND

113	St. John's	Oxen, Parkert, Long, and McIsaac ponds and Virginia Water in vicinity of St. John's.	One to three feet of white and grey diatomite.	No information	Samples submitted by A. English, St. John's. Oxen Pond sample is white and appears to be the best grade. Diatomite occurs in nearly all the lakes and ponds in the vicinity.

TABLE XI

Analyses of Canadian Diatomites Indicating Number of Diatom Varieties in Each

BRITISH COLUMBIA

Ref.[1] No.	Name of Deposit	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	H_2O (at105°C)	CO_2+ Organic	Total	Diatoms present: No. of species	Diatoms present: No. of varieties	Remarks
1	Pukaist Creek......	81·00	6·23	2·37	1·20	1·21	7·00	0·11	99·12	15	27	
2a	Deadman...........	24·20	0·35	0·24	38·31	1·61	6·50	28·64	99·85	5	7	Diatomaceous marl.
2b	Loon Lake..........	80·30	9·01	3·55	nil	1·21	6·00	n.d.	100·07	6	12	Consists almost entirely of cylindrical *Melosira granulata* diatoms.
3	Blackwater River..	70·90	17·24	3·16	nil	1·08	7·40	0·53	100·31	9	13	
4	Guichon Creek.....	81·10	6·03	2·07	1·49	0·37	6·22	1·77	99·05	17	30	Average 3 feet, white. Numerous types of well-preserved diatoms, mostly *Epithemia.*
5	Copper Creek.......	61·08	18·76	2·96	1·41	0·95	12·00	0·56	97·70	....	....	Fuller's earth containing diatoms similar to those in Quesnel.
6a	Powell River.......	90·64	1·57	0·98	1·28	0·29	4·30	0·57	99·63	....	....	Stewart lake, white, exceptionally well-preserved diatoms.
6b	" "	61·18	4·98	1·26	1·41	0·54	10·88	14·78	95·03	....	....	Mud from Haslam lake.
7	Chilliwack..........	68·90	14·67	2·53	2·20	1·44	9·11	0·09	98·94	12	30	Mainly *Gomphonema puiggarianum*
8	Quesnel, Lot 906....	76·86	7·00	3·06	0·62	0·73	7·88	0·92	97·07	6	12	Across 5 feet at centre.
9	" " 385....	76·15	7·01	3·39	0·55	2·38	7·29	0·92	97·69	6	12	All the Quesnel deposits are almost entirely composed of numerous varieties of *Melosira granulata.*
10	" " 1122....	79·00	7·09	3·71	1·20	1·45	5·50	0·92	98·87	6	12	Average across lower deposit.
11a	" "Big bend".	72·97	11·99	4·89	1·02	0·50	6·33	0·92	98·62	6	12	Quarry point, 800 feet above river.
11b	"	86·60	3·76	1·74	0·30	1·05	3·42	1·93	98·80	6	12	Southern end of deposit.
13	Alexandria	78·00	10·89	3·01	nil	1·81	5·32	1·38	100·41	6	12	
14	Goldstream.........	69·10	15·90	5·10	3·80	2·53	2·00	0·79	99·22	....	....	Diatomaceous silt.
15a	Bear Lake..........	79·10	1·72	0·79	5·92	nil	9·96	2·79	100·28	10	19	Pure white, under bridge.
15b	"	37·50	1·51	1·49	2·60	0·94	20·51	34·19	98·74	10	19	Brown diatomite mud.
16	Prospect Lake......	65·60	14·43	1·87	1·80	1·27	13·10	1·70	99·77	16	35	
17	Oldfield............	77·69	10·83	2·27	2·20	0·74	6·30	0·10	100·13	16	35	
18	Quamichan Lake..	79·50	6·26	1·74	0·85	0·91	7·01	2·29	98·56	14	25	Mainly cylindrical diatoms of *Melosira granulata.*

NOVA SCOTIA

27	Munro Point........	72·10	n.d.	0·51	n.d.	n.d.	10·70	6·30	....	....	....	
27a	Ingonish...........	83·62	0·75	0·75	0·40	0·54	8·16	0·20	94·42	....	....	
31a	Clear Lake.........	79·30	3·68	0·78	0·44	0·41	n.d.	13·74*	98·35	16	36	Average sample.
31b	"	82·50	3·22	0·78	0·50	0·37	"	11·76*	99·13	16	36	White grade.
33	Rhude Pond........	93·70	0·85	0·05	0·50	n.d.	4·80	....	99·90	....	....	Calcined. (Analysis furnished through Oxford Tripoli Company).
35	Earltown Lake.....	78·20	2·82	0·71	0·71	0·26	n.d.	14·30*	97·86	21	72	White material.
36	Taylor.............	73·74	6·90	0·78	0·66	0·55	"	14·30*	96·93	21	72	
38a	Folly Lake.........	64·90	10·51	2·69	0·60	1·81	11·01	7·69	99·21	....	....	Average grade.
38b	"	71·80	10·92	0·78	0·82	0·76	n.d.	14·84*	99·92	15	61	Best grade.
39	Folly Meadows.....	80·00	6·09	0·47	0·55	0·62	"	11·66*	99·39	21	52	
41	Little Gummel.....	80·10	4·00	1·00	0·39	0·73	"	12·80*	99·02	11	37	
45	Silica Lake.........	81·30	n.d.	0·38	n.d.	n.d.	9·34	0·82	....	19	42	
46	Silica L. bog........	81·30	2·44	0·16	nil	1·03	15·02	n.d.	99·95	13	37	
48a	Slack Lake.........	82·01	2·41	0·79	nil	1·30	10·50	2·22	99·23	19	56	Dense, white.
48b	"	67·64	3·58	0·78	0·77	0·68	n.d.	26·62*	100·07	....	....	Medium grade, south end.
51	Totten Lake........	69·66	8·44	1·90	0·72	0·73	"	16·44*	97·89	12	33	
52a	Trout Lake.........	80·00	6·43	0·47	0·39	0·44	"	11·88*	99·61	....	....	4 feet of dense, white, west centre.
52b	"	74·10	4·69	0·31	0·27	0·50	"	17·62*	97·49	....	....	Average grade, 5 feet grey.
52c	"	78·40	3·10	0·60	0·35	0·32	"	17·60*	100·37	12	38	3 feet white near south end.
52d	"	62·02	3·32	0·78	0·61	0·51	"	32·82*	100·06	....	....	Average of 20 feet diatomite mud.
63a	Digby Neck........	43·50	1·97	0·63	0·20	0·36	19·21	33·79	99·66	....	....	Diatomite peat, crude, 4 feet.
63b	"	84·00	4·92	3·48	2·20	1·38	2·21	0·59	98·78	18	47	Diatomite peat, self-calcined.
63c	"	82·65	2·09	1·11	0·30	1·96	9·20	1·92	99·23	14	27	Average over 8 feet from 5 feet in depth.
63d	"	94·11	2·04	1·55	0·86	0·28	0·14	0·42	99·40	....	....	Peat calcined, used in concrete tests.
63e	"	79·10	7·14	1·16	nil	nil	12·10	0·90	100·40	21	48	Average over 10 feet of mud from 10 feet in depth.
64	Salmon River, Mayflower.	75·90	7·82	1·58	0·60	"	12·00	2·01	99·91	10	18	
65	Sigogne............	68·10	16·55	4·05	1·30	1·81	6·03	0·27	98·11	10	20	Diatoms scarce, mostly silt and sponge spicules.
69a	McQuade Lake.....	74·55	9·76	2·84	nil	nil	11·10	1·74	99·99	12	32	Average grade.
69b	"	76·00	8·13	2·67	"	0·55	8·93	2·89	99·17	....	....	Best grade.
70	Factory Dale......	76·32	6·34	1·26	"	1·43	9·50	3·00	97·85	13	31	
72	Morden............	82·00	2·57	0·63	"	nil	13·80	0·20	99·20	9	23	Diatoms exceptionally well preserved.
73	Sabody Pond.......	85·80	2·74	1·26	"	0·68	3·20	4·64	98·32	12	22	

* Total loss on ignition and includes combined water.

[1] All samples collected by the author and analysed at the Mines Branch, Ottawa, Canada.

TABLE XI—Concluded

Analyses of Canadian Diatomites Indicating Number of Diatom Varieties in Each—Concluded

NOVA SCOTIA—*Concluded*

Ref.[1] No.	Name of Deposit	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	H_2O at 105° C	CO_2+ Organic	Total	Diatoms present		Remarks
										No. of species	No. of varieties	
74a	North River........	77·20	7·59	2·21	nil	0·65	9·80	0·70	98·15	12	31	Grey diatomite.
74b	"	46·60	3·99	2·21	"	2·53	21·00	23·70	100·03	12	31	Diatomite mud.
77a	Brora Lake.........	82·00	2·82	0·78	0·50	0·37	n.d.	12·16*	98·63	19	50	Dense, white diatomite.
77b	"	76·60	3·20	1·10	0·50	0·37	"	15·90*	97·67	19	50	Average grade.
77c	"	62·20	1·12	2·52	0·80	0·43	21·00	12·00	100·07	19	50	Average of 6 feet of diatomite mud
78	Johnson..............	79·50	5·33	1·27	0·40	0·49	11·50	1·45	99·94	....	....	
80	Cluness Marsh......	74·90	2·65	0·95	0·55	0·52	n.d.	19·36*	98·93	6	17	Mainly diatoms of *Eunotia major*.
82	Finlay Meadows....	50·14	6·60	1·30	0·93	0·87	"	40·30*	100·14	....	....	Average 20 feet diatomite ooze.
88a	Loon Lake..........	83·70	4·66	1·74	nil	1·09	6·50	1·20	98·89	11	19	South end of island, contains much sand.
88b	"	77·00	10·23	2·37	"	1·89	6·10	0·34	97·93	5	12	Average 3 feet opposite centre of island, contains much sand.
88c	"	81·30	4·06	1·74	"	1·59	7·70	1·15	97·44	....	....	Average of 2 feet south end.
89	Horse Island........	83·75	6·30	1·10	"	0·35	6·10	1·22	98·82	....	....	Nearly all sand and sponge spicules.

NEW BRUNSWICK

Ref.[1] No.	Name of Deposit	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	H_2O at 105° C	CO_2+ Organic	Total	No. of species	No. of varieties	Remarks
92a	Stannard Lake......	76·50	8·03	0·78	0·50	0·62	n.d.	13·68*	100·11	....	....	Best grade; sponge spicules abundant.
92b	"	63·08	8·70	0·94	0·61	0·62	"	26·48*	100·43	13	33	Average grade, yellowish, abundant.
92c	"	79·44	5·40	0·10	0·55	0·64	"	10·60*	97·73	13	33	Good white, abundant.
93a	Flood Lake.........	82·56	1·50	0·50	0·20	0·30	"	14·10*	99·16	14	30	Dense, white.
93b	"	60·00	6·76	0·94	0·61	0·44	"	51·50*	100·25	....	....	Dark brown.
96a	Pollet Lake.........	80·00	3·19	1·11	0·55	0·88	"	12·28*	98·01	21	45	Sample from storage shed.
96b	"	82·62	5·43	0·67	0·39	0·73	"	10·58*	100·42	21	45	Dense, white, at south end.
96c	"	61·80	4·76	1·10	0·77	0·44	"	30·70*	99·57	....	....	Average 5 feet dark brown.
96d	"	77·50	3·98	0·78	0·39	0·47	"	15·80*	98·92	....	....	Average 4 feet white, north end.

97a	Long Lake.........	76·00	5·85	0·78	0·44	0·30	n.d.	14·10*	97·47	9	17	Dense, white, contains mostly sponge spicules.
97b	"	61·60	5·59	2·51	1·51	1·39	15·13	12·39	100·12	....	....	Brown diatomite mud.
98	Fitzgerald Lake....	70·50	2·72	2·10	0·55	0·26	n.d.	20·54	96·67	19	48	
	ONTARIO											
99a	Tynan..............	70·60	12·73	2·67	1·65	1·00	n.d.	8·20*	96·85	....	......	Average sample.
99b	"	79·30	10·00	0·54	0·93	0·85	"	5·16*	96·78	4	8	Selected sample.
100a	Southby...........	52·10	11·44	2·46	2·16	1·00	"	27·50*	96·66	....	......	Beaver meadows, crude peat.
100b	" -.........	76·64	14·34	2·76	2·71	1·31	"	0·66	98·42	....	......	Beaver meadows, calcined peat.
101a	Spence Lake........	70·00	4·56	1·30	0·73	0·56	"	22·40*	99·55	....	......	Crude mud.
101b	"	87·46	6·94	1·46	1·88	0·91	"	1·60	100·25	....	......	Calcined mud, diatoms well preserved.
101c	"	79·90	6·64	1·30	0·85	0·56	"	9·88*	99·13	....	......	Crude, white.
102	Moon River.........	66·80	14·00	3·90	2·63	0·70	"	8·78*	96·87	11	27	Calcined, white.
103	Lake Joseph........	75·94	6·04	1·10	0·93	0·88	"	13·26*	98·15	13	31	
104a	Hodge..............	41·74	4·28	1·46	0·80	0·50	"	50·08*	98·86	....	......	Crude peat.
104b	"	74·70	14·50	2·76	2·33	1·22	"	0·94	96·45	16	41	Calcined mud.
	QUEBEC											
106	St. Justin...........	74·00	11·02	3·46	1·27	1·62	n.d.	6·61*	97·98	6	13	Almost entirely 2 species of diatoms, owner's sample.
107	Lake Michel........	77·06	8·50	1·20	1·32	0·73	"	10·10*	98·91	16	40	
109	Jacquot River......	72·12	14·33	2·51	1·10	0·88	"	3·08*	94·02	11	27	A unique deposit of *Fragilaria* diatoms.
110a	Lake Simon........	79·80	5·44	1·30	0·48	0·22	"	11·64*	98·88	12	31	Average sample.
110b	"	64·50	10·92	3·64	1·10	1·13	"	18·00*	99·89	....	....	Bottom, iron stained.
111	Gosford............	75·50	7·07	1·73	2·53	0·88	"	12·46*	100·17	11	23	
	NEW FOUNDLAND											
113a	Oxen Pond..........	83·13	4·27	1·72	0·44	0·56	7·81	1·67	99·60	....		Samples submitted by Mr. A. English, St. John's, Nfld.
113b	Parkert Pond.......	71·50	10·01	1·89	0·34	0·40	8·92	4·48	97·54	....		
113c	Long Pond..........	63·64	17·67	2·63	0·57	0·66	9·60	1·36	96·13	....		
113d	McIsaac Pond......	68·60	10·60	2·26	2·26	2·34	9·40	4·46	99·92	....		

* Total loss on ignition and includes combined water.

[1] All samples collected by the author and analysed at the Mines Branch, Ottawa, Canada.

UNITED STATES

The United States is the world's largest producer of diatomite. Most of the material comes from the western states, particularly from California where some of the diatomite beds are 1,000 feet thick and are spread over many square miles. The western states from which diatomite is now being produced are California, Oregon, Washington, Nevada, and Arizona; while those in the east are New Hampshire, Connecticut, Florida, and New York. The largest and most of the western deposits are of marine origin, but the eastern are all of freshwater origin and occur as comparatively shallow underwater deposits more or less contaminated with carbonaceous matter, silt, etc. During 1926, there were eighteen producers, all except three being in the west.

The Lompoc diatomite beds in California comprise the largest known commercial deposit in the world. The purest of these are being worked by the Celite Company. Another very extensive deposit, which is a comparatively recent discovery, is on the Pitt river near mount Shasta, in northern California. This deposit was operated for the first time in 1926. A pure deposit occurs on the Des Chutes river near Terrebonne, Oregon. The eastern deposits are small and are similar to those in the Maritime Provinces of Canada.

Diatoms

The typical California marine diatoms are those of the "discus" type of which there are many species. Perhaps the commonest is the *Coscinodiscus* which under the microscope has the appearance of a golf ball and varies greatly in size, some being even visible to the naked eye. Another common type is the long needle-shaped *Nitzschia* and *Synedra*. It is largely due to a mixture of these two types of diatoms that the Californian material is so well suited for sugar refining. (*See* Plates XIII C, D, and XV C.) A large variety of interesting and well-preserved freshwater diatoms of a different type to the marine Californian, are found in the Des Chutes River deposit near Terrebonne, Oregon. Here the diatoms vary in different beds, but the bottom bed consists entirely of a rare type of very large cylindrical *Melosira* which, when dry, will float on water for long periods. Some deposits are very similar to those of Quesnel, Canada, in that they almost wholly consist of *Melosira granulata*. Amongst these are the deposits at Carlin, at Virginia City, and at Reno, Nevada; the top beds at Burke, Washington; some of the Mount Shasta beds, California; and in Harper county, east Oregon. (*See* Plates XIII and XIV).

WESTERN UNITED STATES

California

Diatomite occurs along the coast from the extreme south to about 100 miles north of San Francisco, as well as in some counties of the interior including Imperial, Inyo, and Shasta counties. Between Los Angeles and San Luis Obispo the deposits are almost continuous, with the greatest concentration in Santa Barbara county in which Lompoc is the centre of production. The greater part of the material occurs in the Monterey

(Middle Miocene) formation.[1] In these deposits diatomite of every grade is found, including: soft, fluffy, white material; compact yellow and grey diatomaceous shales; and hard, grey and black flint. The beds are said to be 1,500 feet or more thick in places. All the deposits are tilted at various angles in conformity with the beds of the Lower Monterey formation. Although they vary considerably in purity, they have the same predominating types of diatoms, the round *Coscinodiscus* being typical. Thin seams of clay and occasionally volcanic dust, also hard flint bands, occur at various intervals between the diatomite beds. Many of these seams and bands, which have certain characteristics, are useful in locating horizons and portions of individual diatomite beds over large areas. Fossil remains of fish, some of which are well preserved, are not uncommon.

The deposits near the Nevada boundary are entirely different both in their mode of occurrence as well as in their type of diatoms. The largest of these deposits occurs on the Pitt river in Shasta county.

The first recorded production of diatomite from California was in 1889, but regular production did not start until 1902, when there was an output of about 420 tons, after which a few thousand tons were obtained annually. In 1914 production reached 12,800 tons, an output which has steadily risen to the present figure of over 87,000 tons. The annual production from California is about 95 per cent of that of the United States (Table VI) and is therefore not given separately.

Santa Barbara County

The Celite Company, formerly the Kieselguhr Company of America, produces between 80 and 90 per cent of the total United States diatomite. The company operates a part of the deposit 2 miles south of Lompoc in the Santa Ynez mountains between San Miguelito and Salsipuedes creeks. The beds, which are usually thinly laminated (*see* Plate VIIA), are tilted in different directions at low angles and are reported as being up to 700 feet thick.[2] The character and purity of the material vary in different parts of the beds, although they do not vary greatly in their chemical analyses. A careful study is, however, made of the diatoms, since the percentages of broken needle-shaped and discus types vary in the different beds, and it is highly important that they be properly selected for each specific use. (Plate XIII C, D.) Upwards of 30 different quarries have been opened up in various parts of the deposit.

Analyses of the material from different parts of the deposit give the following results:—

—	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	H_2O at 105° C.	CO_2 + Org.	Total
No. 16 quarry (filter).......	88·40	2·05	1·13	0·34	0·52	6·08	0·31	98·83
No. 38 quarry (filter).......	86·24	3·05	1·02	0·18	0·65	5·62	1·20	97·96
Natural brick quarry.......	80·40	6·88	2·12	0·86	1·17	6·12	0·61	98·16

For other analyses *see* Table XII.

[1] Arnold, R., and Anderson, R.: U.S. Geol. Surv., Bull. 315, pp. 438–447 (1907).
[2] Gardner, E. D.: U.S. Bur. of Mines Repts., Investigations, No. 2431 (Jan. 1923).

The company's very extensive plant (Plate VII) consists of numerous brick kilns, the treatment mill, offices, laboratories, etc., over 5 acres of warehouse space, as well as a considerable number of outlying buildings and several hundred houses. The railroad siding, which connects with Lompoc and thence with the Southern Pacific railroad at Surf, can accommodate 100 freight cars. There are also over 20 miles of high tension wires, 25 miles of roadways, and various aerial tramways linking up the quarries with the brick plant and mill.

Owing to the variation of the different beds, the company is producing raw material and manufactured products suitable for almost every purpose for which diatomite is used.

Other Operators at Lompoc. At different times, a large number of smaller operators have also worked in the area. At present (1927) *The Featherstone Company* of Los Angeles is working a quarry which borders the Celite Company on the east. The material is very similar to the above. The beds of diatomite, which are about 300 feet thick overlying hard, brown siliceous shales, strike east with an average dip of 30 degrees south. The top 20 feet furnish filtration material and below this there is a 25-foot bed used for insulation and other purposes. Several quarries have been opened up in the various strata. The material is all shipped to the company's plant at Covina near Los Angeles.

The National Magnesia Manufacturing Company (Silica Products Company) of San Francisco is producing a good grade of diatomite from the hills north of the Surf Road, 4 miles west of Lompoc. This material is shipped to the Redwood city plant where it is bonded with asbestos and made into insulation coverings for pipes, etc.

Los Angeles County

The Featherstone Company is operating a deposit in the foothills north of the San Jose hills near Covina, 30 miles east of Los Angeles. The best grade diatomite occurs on the top of the hills overlain by 1 to 5 feet of soil. The beds are fairly compact, thin and laminated with sand and clay seams. (The deposit is almost flat, but towards the east it comes up against an andesite dyke and the beds become vertical). The top beds are the purest and the clay content increases with depth, the total thickness being about 600 feet. The deposit is not so pure as at their Lompoc deposit, and the material is now rarely used for insulation and filtration powders, the main uses being for concrete admixtures, bricks, and tiles. For the latter purpose the underlying clay beds, which also contain a small percentage of diatoms, are utilized as the necessary bond.

San Luis Obispo County

The Incello Company (U.S. Refractories Company) have been operating a deposit on the south side of Los Osos valley, 2 miles south of Moro bay and 10 miles west of San Luis Obispo. The beds dip steeply to the north and are not so thinly laminated as those at Lompoc. The deposit is in most places somewhat gritty, and contains small sand streaks, and has a distinctly saline taste. Outcrops of the diatomite ridge are exposed at intervals for over a mile.

The material is hauled to the storage bins from the bottom of a small gulch by means of a Clyde hoist up 400 feet of inclined tramway. The diatomite is trucked to the plant at San Luis Obispo where it is pulverized, bonded, and baked into insulating bricks.

Monterey County

Extensive beds of diatomite, probably about 800 feet thick, are now being worked on the southern border of the county, east of Bradley near the junction of the San Antonio and the Salinas rivers. The timberless, fairly rugged hills are cut by a number of canyons in which the diatomite is exposed. The workings are at an elevation of about 1,000 feet. Other deposits which were operated in 1926, are in the vicinity of Monterey, 60 miles northwest of Bradley.

California Kieselguhr Company, Inc. The company owns between 300 to 400 acres, 4 miles southwest of Bradley. The diatomite forms a long range of hills and dips about 60 degrees to the northeast. The material has considerably less moisture than the Lompoc deposits, is more compact, and in many places the thin beds or laminations are absent. The diatoms which are of the usual "discus" type are somewhat broken, but the proportion of long, slender frustules is very small, though in the best pure white beds they are more in evidence. The high-grade white material is now obtained from underground stopes.

The diatomite from the mine is trucked to the company's mill at San Miguel, 14 miles to the southeast, where it is pulverized and separated into three products by air cyclones. The moisture content is so low that air-drying is not necessary.

Buttle Properties, Inc. This company's property is a southerly continuation of the above, and about a mile from it. The diatomite is also similar to that of the adjoining property. Several ledges of hard flint occur between the beds, and in most cases the best material occurs immediately above the flint. Fossil imprints, especially that of the scallop shell, are fairly abundant. The diatoms are nearly all discus-shaped, much broken, very few of the needle-shaped being present.

A few open-cuts and tunnels have been made, one of the latter penetrating right through the hill parallel to the bedding. A small mill using cyclone air separators is on the property, but the company has started to enlarge the plant and is installing up-to-date machinery. The material which is known as "Pacatome" is largely used for concrete admixtures.

Monterey Products Company (formerly Monterey Insulation Brick Company). This company has about 4,000 acres under lease. The main workings are to the south of the Canyon del Rey, 5 miles southeast of Monterey. .The diatomite is obtained from the western slopes of a small gulch, and the beds dip 45 degrees into the hill. The deposit is said to be 300 feet thick, but all the bottom beds contain many parallel seams of flint and clay and are too low grade. The best material, which is somewhat high in alumina, is on the top of the hill. In Cat canyon, about one mile to the east, the diatomite is of much better grade, but the deposit has not been opened up. The beds dip about 30 degrees to the north. The diatoms are well preserved and are discus-shaped as well as needle-shaped, whereas those of the present workings are more broken and the needle-shaped diatoms are almost absent.

The diatomite which is mined by the open-cut bench method is dropped through wooden chutes into the mill bin at the foot of the deposit. A conveyer belt takes the material to the mill where it is pulverized and put through cyclones. The mill was remodelled in the fall of 1926. The finished diatomite, which goes under the trade name of "Calatom", is largely used for cement admixtures, also for filtration, insulation, fillers, and polishes.

Shasta County

Mt. Shasta Silica Company. An interesting and very extensive diatomite deposit occurs on Pitt river, north of Burney, and about 50 miles due east of its junction with the Sacramento river. The material occurs over a distance of several miles on the steep north bank, with a few isolated patches on the south bank and extends inland for about half a mile. The diatomite beds appear to be horizontal, are devoid of stratification, but show sand or bench seams at intervals of 5 to 20 feet. The beds are underlain and overlain by volcanic lavas and tuffs, and in some cases there are several alternate successions of lavas and diatomites overlying each other. In some parts of the deposits, particularly at the west end, the diatomite is said to be 1,500 feet thick. The material is very friable and very quickly disintegrates when moistened—this may be due to soluble salts present. The hollow, dotted, cylinder-shaped variety, *Melosira granulata,* is by far the commonest and the majority of the beds are almost entirely composed of this species, although they all have a small but varying proportion of circular radiating diatoms *(Stephanodiscus).* (*See* Plate XIII F.) A different type which mainly consists of circular *Cyclotella,* occurs more inland towards the north. It does not disintegrate with moisture and is capable of standing a higher pressure.

Since all the diatoms are found in fresh water, it is to be concluded that these Pitt River deposits are of freshwater origin.

The Mt. Shasta Silica Company has acquired about 13,000 acres, almost 75 per cent of which is said to be underlain by diatomite. There are 15 or 20 open-cuts and tunnels in the various deposits. A light railway, which is used for logging and construction work by the Pacific Gas and Electric Company, who are building a series of dams along the Pitt river, runs through the property. Local diatomite was used in the concrete of at least one of these dams and the results are said to have been highly successful. The Mt. Shasta Silica Company intends to erect a mill near the west end (where the best and thickest material occurs) and take advantage of the ease of disintegration by hydraulic mining and water separation.

Oregon

Diatomite occurs in lake beds in Baker county, near Whitney; in Grant county, near Austin on the John Day river; in Klamath county, near Linksville; in Wasco county, at Mosier on the Columbia river; in Union county, near Elgin on Indian creek; in Malheur county, at Harper on the Malheur river; also in Crook county. The largest and purest deposit and the only one in the state that is at present being operated occurs in Jefferson county, near Terrebonne.

Atomite Company. The company's deposit occurs at Lower Bridge on Des Chutes river, 7 miles west of Terrebonne, and occupies a basin-shaped area, 3 or 4 miles in circumference, surrounded by lava hills. The diatomite is unstratified and occurs in horizontal beds, 1 to 5 feet thick, between which are occasional black sand seams. The greatest thickness of the deposit is at the south end where it is 45 feet and it retains an average of 30 feet until it tapers to nothing on the north and west circumference. The diatomite has a light overburden of soil and rests directly on yellow tuffs.

The deposit, which is exceptionally pure, contains a very large variety of well-preserved freshwater diatoms. (*See* Plate XIV A.) Samples taken from top to bottom showed that there are at least eight layers in which the diatom species differ from one another. In several of the beds the *Cyclotella* predominates, which is characteristic of the Mount Shasta high pressure beds. The bottom layer of 18 inches consists almost entirely of very large cylindrical *Melosira,* which will float on water and can thus be easily separated from all the other diatoms.

The quarry, which is about 800 feet by 200 feet and 20 feet deep, is worked in benches (Plate VIII B) by means of a steam shovel. The diatomite, which has an average moisture of 16 per cent, is sun-dried to 6 per cent. The mill has a capacity of 25 tons per day.

Washington

Diatomite does not occur so extensively in Washington as in the states to the south. The only deposits, upon which reliable information is available, are near the centre of the state on both sides of the Columbia river. From a close study of the diatoms it appears that these deposits are of freshwater origin.

Kittitas County

Great Western Silica Company's deposit occurs 20 miles southeast of Ellensburg, between the Columbia and the Yakima rivers. The diatomite beds, which are horizontal, are from 8 to 15 feet thick and are overlain by soil and lava flows. The material occurs in various places over an area of several square miles. It has a yellow tinge when moistened and the best beds are about 5 feet below the top layer. Yellow-green banded flint seams occur near the top.

The diatoms, which are somewhat broken up, almost wholely consist of medium-size, circular, dotted *Melosira undulata* and a few cylindrical *Melosira granulata.* (*See* Plate XIVB.)

The company has several small pits and quarries distributed over the area. Their mill at Roza, 7 miles to the west, having been burned, the diatomite is now trucked to Kittitas, near Ellensburg, where a new mill was built in the fall of 1926.

Another deposit in this vicinity was at one time worked by the Majestic Diatomaceous Earth Company with a treatment plant at Wymer.

Grant County

J. Webley of Quincy is working a series of small deposits near Burke, 2 to 4 miles east of the Columbia river and about 12 miles north of Beverley station. The diatomite was originally deposited in the hollows and crevices on the surface of ancient lava beds and at a later period the whole area was again covered with a fresh lava flow. At the present period, erosion has left numerous isolated exposures of diatomite, some of which partly underlie the undulating lava-capped hillocks. The deposits vary in thickness from a few feet to at least 40 feet. The original top beds have been converted to a hard, yellow opalescent flint and throughout the deposits there are numerous nodules and ledges of the flint. For a considerable depth the diatomite is broken up and streaked vertically with iron-stained material. However, in places, the diatomite is exceptionally white and pure. (*See* Table XII, analysis No. 19.)

The diatoms almost entirely consist of the small spotted cylindrical *Melosira granulata,* similar to those at Quesnel, B.C. However, in the bottom beds the diatoms are nearly all circular *Melosira undulata* such as occur in the Kittitas deposit.

Several small quarries were opened, but at present the diatomite is obtained by means of tunneling and stoping. The material is shipped in the crude state to buyers in Seattle.

Other deposits occur near Puget sound and north of Big lake in west central Skagit county.

Nevada

Diatomite has been reported as occurring in almost every county in the state. Some of the deposits that have been either worked or prospected are as follows: *Churchill county,* near Jessup in the northwest corner, and near Eastgate in the southeast corner of the county, the latter being stated to be several miles in extent and 300 feet thick; *Elko county,* near Carlin, which is described below; *Esmeralda county,* near Goldfield; also another deposit about 40 miles to the north near Millers, worked during 1925 by the Silicon Products Company; *Mineral county,* at Basalt, once worked by the U. S. Diatom Company; *Nye county,* near Black Spring, worked in 1923 by the Nature Products Company; *Pershing county,* in the Velvet district; *Storey county,* near Virginia City and near Reno which are described below; *Washoe county,* numerous deposits on banks of the Little Truckee river between Pyramid and Winnemucca lakes, also west of Reno.

Three deposits worked in 1926 are as follows:—

Elko County

The Tri-o-Lite Company is operating a deposit near Vivian, 4 miles east of Carlin, and about 1 mile north of the railway track. The diatomite occurs as a stratified, basin-shaped mass 15 feet thick, and tilted at 35 degrees to the southeast. The beds, which have numerous local faults, are overlain and underlain by a friable calcareous rock. Close to the contacts many seams of clay and hard, iron-stained, calcareous material occur. The central 10 feet, which is the only part that is mined, is divided by a band of the calcareous rock. The best grade diatomite occurs for about 5 feet under this band. The beds outcrop at intervals in the low hills of the basin for several miles. The deposit tapers down into a thin hard seam which is visible at the southern edge, but in most places the periphery of the original basin has been eroded away.

The diatoms consist almost entirely of well-preserved and fairly uniformly-sized cylindrical *Melosira granulata,* and are very similar to, but slightly larger than, the average diatoms at Quesnel, B.C. (*See* Plate XIVC.)

The diatomite which contains 15 to 20 per cent moisture, after a preliminary air-drying is trucked to the mill where it is pulverized and graded by cyclones.

Approximately 2,000 tons of diatomite are mined annually, over three-quarters of which are for insulation purposes as it is claimed that the best grade material will stand an exceptionally high temperature without shrinkage. A good insulation brick is made using magnesium chloride as a binder. It does not make a good cane-sugar filter medium as the diatoms are too small, but the coarsest is used for beet sugar and molasses, also for clarifying dirty oils from crank-cases, etc. It makes an excellent silver polish and is also used in finger-nail polishes and tooth pastes, as well as for fillers, etc.

Storey County

The Electro-Silicon Company, which has been operating for about 30 years, owns a diatomite deposit at Chalk hills at the head of Long valley, 9 miles northeast of Virginia City. The top part of the deposit is closely interbedded with seams of rhyolite and andesite conglomerate of varying thickness, but farther down are beds of fairly compact, almost pure white diatomite, below which it becomes more laminated. Throughout the larger part of the deposit are numerous minute cross seams of iron-stained material. Towards the west end the beds dip flatly, parallel to the side of the hill, but towards the southeast they are crumpled and faulted. In the last-named locality there is a large open-cut which is entered by a tunnel, the beds are almost vertical on the hanging-wall, but flatten out towards the foot-wall.

The diatoms are mainly cylindrical *Melosira granulata,* but they are considerably more broken and smaller than those at Carlin. Some layers contain broken needle-shaped diatoms.

The material mined, which amounts to about 100 tons annually, is carefully hand-sorted, sacked, and shipped to the company's head office in Cliff street, New York City, where it is pulverized and graded. Almost the whole output is marketed in the form of the well-known "Electro-Silicon" silver polish.

Washoe County

The Rock Products Company is mining a "burnt" impure diatomite near Verdi close to the California boundary, 9 miles west of Reno. It occurs in strata of hard and compact material of red and pink and occasionally yellow and purple colours. Originally, it was probably a diatomaceous clay, but has been burnt and coloured by the overlying lava flows. This deposit somewhat resembles the highly coloured "burnt" clay occurring in the railway cut south of Quesnel, B.C. The diatoms, which are mainly cylindrical with some discus-shaped are very much broken up and in most cases the diatom structure has disappeared. The company uses the product for tiles, glazing, and various artificial building materials sold under the trade name of "Rockada."

Compact diatomite outcrops on the road 1 mile south of the property and again 5 miles west of Reno, where 300 feet of beds with clay bands are exposed, dipping 35 degrees east.

EASTERN UNITED STATES

General Distribution

Almost all the known diatomite deposits in the east are very similar to those in eastern Canada as they occur in freshwater lakes, ponds, and marshes and are all small compared with those in the west. The south-eastern deposits are mainly peat bogs, but the diatoms are well preserved and of somewhat different type to those occurring in the north.

There are no records of deposits being operated in any of the more central states, but in *South Dakota* it occurs in the high slopes of the hills near Hermosa, Custer county, and has been mined at Argyle and Fairburn.

Brief descriptions of the eastern deposits that have been operated are as follows:—

Connecticut, near Stepney, a small rather gritty deposit was taken over from the Connecticut Infusoria Company by W. R. Davis; the material is used in "Cinco" metal polish; *Florida*, in the peat bogs near Eustace and Clermont, Lake county; *Maine*, at Bluehill and Surrey in Hancock county, and at South Beddington in Washington county; *Maryland*, beds of Miocene diatomite several hundred feet in thickness and mixed with clay occur in several counties, from Herring bay on the west side of Chesapeake bay to Popes creek on the Potomac river, and it was at one time mined for metal polish at Lyons creek on the Patuxent river, Anne Arundel county; *Massachusetts*, at Framingham in Middlesex county; *New Hampshire*, in lakes in the northern part of the state, and Laconia in Belknap county; Bernis lake, Stamp Act island, Tamworth and Wolfborough in Carroll county; Fitz William in Cheshire county; Lake Umbagog and Starke in Coos county; Orange, Livermore, and Littleton in Grafton county; *New Jersey*, Drakeville in Morris county and at Andover in Sussex county; *New York*, at Wilmurt in Herkimer county and at Coldspring Harbor, Long island, in Suffolk county; *South Carolina*, at Salters Depot in Williamsburg county; *Vermont*, occurs in several localities including Peacham, Caledonia county; *Virginia*, at Wilmont in King George county, also continuation of the Maryland Miocene deposits, principal outcrops being near Richmond and Petersburg.

At present (1927) there are three recorded eastern producers.

Florida

Lake County. Several deposits of diatomaceous peat and mud occur in the vicinity of Eustis and Clermont. A 20-acre marsh having 5 to 15 feet of diatomite is now being worked by the Florida Diatomite Company at Clermont. The material is dredged up and conveyed by sluice boxes to settling vats. The calcined product, in which the diatoms are well preserved, is very fluffy and white, the long boat-shaped frustules predominating. (*See* Plate XIV D.)

Diatomaceous peat was at one time mined at Dora lake, 5 miles south of Eustis. The water was mechanically pressed out after which the material was sun-dried and calcined.

New Hampshire

The New England Minerals Company is operating a shallow pond of about 23 acres at Orange, Grafton county. The diatomaceous mud, which is said to be up to 20 feet in thickness, is dredged out, dried, calcined, and treated in a Raymond impact pulverizer with a blower attachment.

New York

The Adirondack Diatomaceous Earth Company is operating a shallow lake at Wilmurt, Herkimer county. The material is dredged with an orange-peel bucket and is then pressed under power into cakes, air-dried on racks and then calcined. It is then bagged and shipped to J. A. Wright and Company at Keene, N.H., who air-separate it and make it up into silver polish cream under their own name. Approximately 200 tons of calcined diatomite are produced annually. The diatoms are well preserved, both the long slender and stout frustules being present.

The Oxford Tripoli Sales Company has a treatment plant at Haverstraw, about 30 miles north of New York City, but is operating the deposits in Nova Scotia, Canada, already described.

TABLE XII

Analyses of United States Diatomites[1]

No.	State	Locality	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	H_2O at 105° C.	CO_2+ Org.	Total	Remarks
1	California.....	Lompoc......	88·40	2·05	1·13	0·34	0·52	n.d.	n.d.	6·08	0·31	98·83	Celite Co., No. 16 filter quarry.
2	"	"	86·24	3·05	1·02	0·18	0·63	"	"	5·62	1·20	97·96	" No. 38 Super-Cel"
3	"	"	80·40	6·88	2·12	0·86	1·17	"	"	6·12	0·61	98·16	" main brick quarry.
4	"	"	82·62	5·05	0·81	0·79	0·48	"	"	7·60	0·72	98·07	" used for concrete tests.
5	"	"	88·20	6·55	0·81	0·57	1·22	"	"	....	0·80	98·15	" average (calcined).
6	"	"	90·50	3·71	1·29	0·28	0·70	......	......	0·56	0·18	97·22	" Super-Cel (calcined).
7	"	"	93·70	0·72	0·64	0·28	0·26	3·13	1·27	0·28	0·32	100·60	" Hyflo-Super-Cel (calcined).
8	"	Covina.......	82·80	6·06	1·94	0·51	0·92	n.d.	n.d.	5·88	tr.	98·11	Featherstone Co., for gasoline.
9	"	Bradley......	84·11	3·55	1·29	1·24	0·86	"	"	5·12	0·88	97·05	Calif. Kieselguhr Co., best grade
10	"	"	82·64	5·23	1·61	0·74	0·70	"	"	6·00	0·30	97·22	Buttle Properties, mill product.
11	"	Monterey.....	77·88	6·80	1·90	0·33	0·13	3·37	2·02	5·20	2·56	100·19	Monterey Products Co., top beds.
12	"	"	78·40	6·76	1·04	0·51	0·64	n.d.	n.d.	7·76	1·30	96·41	Monterey Products Co., mill product.
13	"	"	78·72	5·60	1·90	0·51	0·04	5·28	1·57	5·70	1·06	100·38	Monterey Products Co., Cat Canyon.
14	"	Mt. Shasta...	88·35	3·24	0·84	0·37	0·45	nil	nil	5·74	0·88	99·88	Pitt river, No. 2 camp.
15	Oregon........	Terrebonne...	86·74	4·64	1·46	0·85	0·37	"	"	5·80	0·40	100·28	Des Chutes river, best grade.
16	"	" ...	85·83	3·98	2·19	1·25	0·41	n.d.	n.d.	4·68	0·73	99·05	" " , filter product
17	"	" ...	84·32	5·20	2·42	1·53	0·39	"	"	3·92	0·70	99·51	" " , concrete product.
18	"	" ...	92·49	0·89	1·46	0·63	0·46	"	"	3·08	1·01	100·02	" " , bottom bed, large tubular diatoms.
19	Washington...	Burke........	93·15	1·04	1·24	0·50	0·31	"	"	3·09	0·41	99·74	J. Webley deposit, best grade crude.
20	" ...	Kittitas......	86·60	2·62	2·58	0·57	0·56	......	......	5·08	0·12	98·13	Great Western Silica Company, average grade.
21	Nevada.......	Carlin........	81·13	7·42	3·03	1·79	0·31	......	......	4·86	0·62	99·16	Tri-O-Lite Co., average grade.
22	"	Virginia City.	91·45	2·60	0·83	0·70	0·35	......	......	3·41	0·97	100·51	Electro-Silicon Co., silver polish grade.
23	"	Reno.........	74·83	14·98	6·02	1·26	0·60	......	......	0·98	0·21	98·88	Main highway, 2 miles west of Reno.

[1] All samples collected by the author and analysed at the Mines Branch, Ottawa, Canada.

AFRICA

Kenya Colony

Many dried-up lakes in the Rift valley, province of Naivasha, District of Masai reserve, contain diatomite. Although some of the material is white, it is, however, mostly of a buff colour and contaminated with clay and is iron-stained. Part of the area examined by V. H. Kirkham, Government Analyst, contained 620,000 tons of diatomite. Building tiles made from this material by the Imperial Institute[1] were reported as being satisfactory. Details and results of these tests are briefly outlined under "Manufacture of Diatomite Products", Chapter V.

Algeria and Tripoli

It is from the deposits at Tripoli that the name tripolite originated, but little detail as to the extent of these deposits is available.

Algeria is the second largest world's producer of diatomite having an annual output of about 10,000 tons. Small quantities are exported to the eastern United States for use in metal polish, but most of the output is taken by England and France. The greatest production is obtained from the deposits at Ouillis and St. Lucien in the Department of Oran and from large deposits in the district around St. Denis-du-Sig.

Transvaal

It is only in recent years that diatomite has been mined from South Africa. The African Insulators, Ltd., have been operating a large deposit about 35 miles east of Ermelo in East Transvaal. The diatoms said to be mainly of the large type, *Surirella,* are especially suitable for filtration purposes.[2] Other deposits occur in the Amsterdam district of East Transvaal; also near Krugersdorp (Transvaal) and in Griqualand West and at Gordonia (Cape Province).

ASIA

Dutch East Indies

Diatomite occurs in various parts of the west coast of Sumatra near Buitenzorg, also at Tapenoeli in the east, and at Samsir on the southwest.

A small output was maintained three or four years ago from a fairly large deposit near Cheribon in Java, the material being principally used as an anti-vermin powder. Apparently this diatomite is not suitable for sugar refining as it is not being used for this purpose.

[1] Imp. Inst. Bull., vol. XIX, p. 306 (1921).
[2] South Africa Min. Jour., p. 787, Sept. 8, 1922.

Japan

The diatomite deposits in Japan that have been operated during the last 7 years are scattered, but mainly occur in the Kiushiu in the extreme south of the Empire. Other localities are on the mainland of Honshiu, particularly at Aomori, Niigata, as well as at Okayama and Gifu, the two latter being 50 miles west and 50 miles northeast of Kobe. There are also other deposits on Oki island, and several extensive but unworked occurrences on Yezo in the extreme north. In the latter, the diatomite occurs as lenticular deposits in tuffs. They are up to 60 feet thick and in places are covered with columnar basalt. Some of the principal diatoms in each of these Yezo deposits have been listed by the Geological Survey of Japan. *Coscinodiscus* and *Cocconeis* appear to be the predominating types.[1]

At present almost the entire area of production is confined to the Kiushiu where the material occurs in sand and gravel. It is also obtained from Saga and Oita in the north where it is underlain by augite-andesite; from Fukushima and Kumamoto in the centre, and from Kagoshima in the south where the beds are underlain by augite-andesite or perlite and are overlain by volcanic dust.

During 1925, the last year in which statistics are available, about 2,800 tons were obtained from Miyagi, 18 miles southwest of Oita, which latter had an output of 420 tons and was, until recently, the field of largest production. About 700 tons came from Kagoshima; 520 tons from Saga; 60 tons from Fukushima; and 140 tons from Shimane on Oki island.

AUSTRALIA

New South Wales

There has been a small but steadily increasing production of diatomite from New South Wales. The important deposits occur in intimate association with a series of lava flows and tuff beds of the Tertiary age and are in many cases overlain by basalt and volcanic tuffs. In this respect they are similar to the Quesnel deposits in British Columbia, Canada, and to some extent to those in northwestern United States. The commercial diatomite beds of New South Wales are, however, very thin, being seldom more than 10 feet and are often overlain by 100 or more feet of basalt. The diatomite is mainly used for filtering, as a metal polish, and in the process of the manufacture of gelatine.

The largest output (427 tons in 1926) is now maintained by the Davis Gelatine Company, Ltd., from their deposits at Bugaldi, Coonabarabran Division. The deposits occur near the top of Chalk mountain at an elevation of 2,000 feet above sea-level, and are overlain by olivine-basalt. The diatomite, which is finely laminated, varies from 10 to 25 feet in thickness, but not more than 10 feet are suitable for commercial use. (*See* Table I, analysis No. 16.)

Another deposit in this division occurs in Wantialable creek, 8 miles east of Torraweenah in Gowen county. Several beds of 3 to 4 feet of diatomite are interstratified with a series of trachyte tuffs and clay and are overlain by at least 20 feet of trachyte.

[1] Denzō Satō: "Diatom-earth in the Hokkaidō", Imp. Geol. Surv., Japan, No. 12 (1922).

Until recently most of the production has been obtained from near Bunyan, Cooma Division, where the material occurs in stratified layers of hard and soft diatomite, quartz fragments, and diatomite slate up to 10 feet in total thickness. A small quantity of diatomite has been obtained from the Lismore Division, where deposits of a hard and stony nature extend over a considerable area and are overlain by vesicular basalt. The first production of diatomite from the state was obtained from these deposits in 1895. A Tertiary deposit of 6 to 9 feet of diatomite occurs in the Nandiwar ranges, north of Barraba township, and is overlain in places by 100 feet of volcanic tuffs and basalt. In the same district, at Bells mountain, Cobbadah parish, Murchison county, the bottom beds of 6 feet are mined from a total depth of 16 feet of diatomite. It is also overlain by basalt. During 1926, 439 long tons were produced by two operators in this district.

A good description of the New South Wales diatomite deposits will be found in E. J. Kenny's[1] report.

The following shows the total diatomite produced from each division up to the end of 1923.

Division	Long tons	Value
		£
Barraba	460	994
Cooma	1,252	3,750
Lismore	105	344
Coonabarabran	647	1,294

Queensland

Fairly extensive diatomite deposits occur in the southeast corner of the state between Southport, Beaudesert, and the border of New South Wales. The principal occurrences are at Meerschaum mountain and within the southeast Moreton district; at Woodbine, 27 miles north of Gatton station, and at Planet Downs, south of Comet station.[2]

During 1927 a deposit was opened up at Black Duck, 25 miles south of Gatton, by the Sterling Products, Ltd. This deposit of 2 to 8 feet of compact laminated diatomite is said to contain over 40,000 tons of available material and is overlain and underlain by basalt.[3] Almost all the known Queensland diatomites are of Tertiary age and are associated with basalt flows. The typical diatom is the "*Melosira*" type, and the deposits thus appear to be similar in character to those of Quesnel, B.C. Some of the deposits are associated with common opal in the form of bands and irregular nodules. This local change of the diatom silica to the opalescent state has already been noted in the descriptions of some of the Californian and Washington deposits of the United States.

There does not appear to be any recorded output of Queensland diatomite.

[1] Kenny, E. J.: "Diatomite", N.S.W. Geol. Surv., Bull. 15, 12 pp. (1924).
[2] Dunstan, B.: Queensland Govt. Min. Jour., pp. 585–88, Dec. 15, 1916.
[3] Ball, L. C.: Queensland Govt. Min. Jour., pp. 308–310, Aug. 15, 1927.

Victoria

The principal diatomite deposits in Victoria, occur in Loddon River valley, mainly at Lillicur on Bet Bet creek, 8 miles west of Talbot and 100 miles northwest of Melbourne. The deposits occur in basin-shaped hollows and in beds, about 4 feet thick, above and below basalt flows. In former years a considerable tonnage was extracted by means of small shafts and tunnels by the Australian Kieselguhr Company.

About a dozen deposits have been recorded between Lillicur and Melbourne, some of which are a few miles north of the latter city and were discovered 70 years ago.[1] Almost all the Victoria diatomites are associated with basalt and usually occur as thin beds from a few feet to 150 feet below the surface; they are of freshwater origin and are Tertiary in age.

Up to 1920 the total recorded production from Victoria amounted to approximately 7,500 long tons, since when little or none has been produced, but during 1927 a large deposit, 10 feet thick, was opened up at Newham, 50 miles north of Melbourne.

Western Australia

Diatomite of Recent age is of common occurrence in the lakes and swamps of the southwestern coastal plain. A deposit estimated to contain about 175,000 tons of dark peaty material, occurs in a 3-foot bed at lake Gnangara, 10 miles north of Perth. A residue of pure white fluffy diatomite is obtained on calcining at a low temperature. Other occurrences, all in this district, are at Minginew, Gingin, Wanneroo, Jandakot, and Albany.

There has been no production except for experimental purposes.

New Zealand

Diatomite occurs in numerous localities in New Zealand. In the North Auckland district the largest known deposits are those at Pakaraka where it is reported to be 10 feet thick, of which 7 feet is of good quality; also at Kingsland where a small amount of work has been done. A deposit of high-grade white diatomite, 6 feet thick, occurs in the Ngongotaha valley, Rotorua district, North island, and was mined during 1926. Between Rotorua and Taupo a bed of diatomite, 18 feet thick, has been traced almost continuously for 15 miles along the Waikato River valley.

With the exception of a series of deposits northwest of Oamaru in the South island, all the reported occurrences are near the surface and are of Recent origin. The Oamaru diatomite which is said to be of Oligocene age occurs in a series of beds having a maximum thickness of 12 feet and outcrops at many points over an area of several square miles. Much of the material is, however, impure and valueless. Other deposits in this island occur near Middlemarch, Akaroa, and in Green island.

No data as to the amount extracted are available, but the total is very small.[2]

[1] Mahony, D. J.: "Diatomaceous Earth and its Occurrence in Victoria", Geol. Surv., Victoria, Bull. 26, 16 pp. (1912).

[2] Private information Geol. Surv., N.Z., Dec. 1927.

EUROPE

Austria

A deposit of diatomite, which is said to be one of the largest in Europe,[1] occurs near Limber in lower Austria. The Limberger Industrial and Mining Company started extensive operations here in 1923.

British Isles

Ireland. The total diatomite production from the British Isles, which amounts to between 2,000 or 3,000 tons annually, is obtained from both banks of the Lower Bann river, between Toomebridge and Coleraine near Lough Neagh, Antrim and Londonderry counties, north Ireland. The deposit is operated by the Diatomite Co., Ltd., Manchester, and occurs in beds of 3 to 5 feet in thickness overlain by peat. It is locally known as Bann clay and is somewhat high in alumina and was formerly used locally for making crude bricks[2], but is now mainly used for insulation purposes.

Scotland. Diatomite occurs in numerous localities in Scotland and is usually found beneath a layer of peat, but none has been mined for several years. It was first recorded as being discovered northeast of Loch Kinnord, near Bullater in Aberdeenshire in 1880 and was mined intermittently for 30 years. It was also mined at Ordie in the same locality.

At one time the island of Skye was an important source of production where the diatomite, said to be 40 feet thick, occurs at Loch Quire. It occurs in several other lakes in the island, some of which were once worked on a small scale. Other localities include the island of Mull, at Loch Osabhat, and at Tolsta in Lewis where about 7 feet of diatomite occur under 4 feet of peat.[3]

Denmark

A mixture of diatomite and clay occurs on the islands of Mors and Fur in the north centre of Denmark. This material, which is known as "moler," is exposed as cliffs from 50 to 150 feet high and extends inland for an undetermined distance. The deposit was opened up near the shore by means of a large open-cut about an acre in area and 85 feet deep, as well as several shafts of the same depth farther inland, all of which are in the moler. Up to 1914 about 65,000 tons had been mined and shipped, and in 1926 and 1927 the production was 14,707 and 16,210 long tons respectively, nearly all being used for insulating bricks and slabs, known as "moler bricks." The deposits are now being operated by the Moler Products, Limited, who ship the raw material to their modern brick plant at Hythe, near Colchester on the east coast of England.

France

The French diatomite is obtained mainly from the Departments at Ardiche and Cantal. The annual exports amount to about 5,000 tons but part of this may be material obtained from Algeria and other sources.

[1] Eng. and Min. Jour. Press, p. 459, Sept. 15, 1923.
[2] Insulating bricks of the material, known as "Dome" bricks, are made by the Derbyshire Silica Firebrick Co., Ltd.
[3] Brief descriptions and analyses of numerous deposits are given in Bull. Imp. Inst., vol. III, pp. 94–96 (1905).

Germany

Diatomite was mined in Hanover in 1860 when the name kieselguhr was first applied. There are numerous deposits throughout the north and centre of the country, the principal of which occur in the Lüneburger Heide where the diatomite is now mined extensively in the vicinity of Münster, Unterlüss, Hützel, and Oberohe about 50 miles south of Hamburg. About 25 years ago the main supply for the world was obtained from these deposits which occur in beds of 20 to 50 feet thick, with a total depth of about 150 feet. The top beds which are white are covered by diluvial sand and are underlain by grey diatomite, the lowest stratum of 50 to 100 feet being a greenish colour, high in organic matter. Diatomite has also been mined near Klieken and Coswig in Anhalt, 60 miles southwest of Berlin, where the material occurs in comparatively shallow beds containing sand and ochre seams. Other deposits occur in Oberhessen near Altenschlirf and Steinfurt, 80 and 40 miles north and northeast of Frankfurt. These deposits of about 30 feet thickness are overlain by basalt and underlain by basalt tuffs.[1]

The organic matter from the Lüneburger Heide is calcined in kilns, 15 feet high by 6 feet diameter. After the first ignition, no addional fuel is required, the calcined material being removed from the bottom and the fresh added continually at the top.

For many years the annual production was between 3,000 and 4,000 tons, but since 1920 this has increased to about 5,000 tons. The main selling organization is the Vereinigte Deutsche Kieselguhrwerke of Hanover.

Immediately prior to the outbreak of the world war large supplies of diatomite were said to have been stored in Germany and the control of deposits undertaken.

Italy

Diatomite occurs in beds from 3 to 10 feet thick near the base of the trachyte formation of the Monte Amiata region (Tuscany), about 60 miles south of Florence, and is mined from Santa Fiora, Arcidosso, Castel del Piano, Bagnore, and Bagnolo, all of which are a few miles west and south of the moutain. Fabbroni, in 1794, utilized the greyish white, fluffy earth from Santa Fiora for making bricks, which he found would float on water, but the material was not identified as diatomite until 1872 by Verri,[2] when it was mainly used as a filler in the manufacture of dynamite. For a number of years there has been a fairly regular production which is now increasing, principally from the Caselle quarry east of Castel del Piano, and is known as "farina fossile".

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[1] Dammer, B., and Tietze, O.: "Die Nutzbaren Mineralien", pp. 202–212 (1913).
[2] Verri, A: La Montagnola Senese ad Il Monte Amiata, Soc. Geol., Italy, p. 39 (1903).

Scandinavia

Beds of diatomite occur in the former lake of Jallasjo near Vanas Sag, in the province of Kristianstad, Sweden.

The deposit, which is about 15 feet in thickness, differs from the ordinary diatomite in that it is intermixed with about 20 per cent bituminous matter. It was exploited in 1923 and the material was used for building purposes, the bitumen making an excellent binder. Patents have been taken out by the Swedish Kieselguhr Company for the making of building slabs, etc., which are said to be impervious to moisture. The only producer in 1925 was the Hasslaröds Kieselguhr, Osby, with an output of 819 metric tons, about half of which was exported.

A large number of diatomite deposits occur in shallow Norwegian lakes especially between Flekkefjord and Stavanger in the southwest, also at the Markvatn, in Nordland county. During the last six years there have been four producers by whom a small tonnage has been produced annually.

Other Countries

Diatomite occurs in many other countries some of which are:—Barbados, Chili, China, Czecho-slovakia, Egypt, Finland, Georgia, Hungary, Jugoslavia, Madagascar, Mexico, Nicobar Islands, Nigeria, Peru, Portugal, Russia, and Spain. Of these, the only recorded producing countries are Hungary, Portugal, Russia (including Georgia), and Spain. Details of the diatomite in these and in several others will be found by consulting the references mentioned in the Bibliography.

CHAPTER V

MINING, PREPARATION, AND MANUFACTURE

MINING

There are two types of diatomite deposits: those that are above the present water levels and are comparatively compact and dry, such as occur in the west; and those of more recent origin which are wet and occur on lake bottoms or in marshes, and which are typical of the eastern deposits.

Dry Compact Deposits

The method of mining these deposits necessarily depends on the thickness of the overburden, the thickness and slope of the commercial beds, and whether they are on hill-sides or flat country. The usual practice, however, is the open-cut or quarry method using the bench system. In quarrying out the blocks, advantage is taken of the bedding-planes or laminations and transverse joints, but if they are not present, the blocks are either sawn or loosened by a light charge of powder. The mining methods and the machinery used for cutting out the diatomite at some of the United States deposits follow.

Celite Company, Lompoc, California

The overburden which varies from 1 to 10 feet is removed by scrapers or drags; cuts are then made in the diatomite, 4 feet deep and 4 feet apart, by means of a chain-saw channeling machine (Plate VII B). The blocks are then wedged away and broken up into convenient size and stacked. As the quarry develops a vertical wall is left on one side and the material is removed from the floor parallel to the bedding which averages 30 degrees. In the natural brick quarry, the bricks are cut out in place to almost their exact size by means of special machines having a number of parallel circular saws. These machines travel on rails laid down across the quarry and cut out rows, 7 bricks long by 2 deep, the machine making the horizontal cuts being followed by one making the vertical and back cuts (Plate VI B). The bricks are then placed by hand into open boxes, which are hauled by aerial tram to the brick trimming sheds. The broken and chipped brick discards are utilized as material for the manufactured bricks.

The material from the various quarries, which has to be ground, is usually broken into suitable sized blocks and built up into walls for air-drying (Plate VI A). The diatomite contains 25 to 40 per cent moisture and has to be dried from 40 to 50 days to reduce the moisture to 5 per cent. It is then hauled by motor trucks or aerial tram (depending upon location of the quarry) to a large storage bin above the mill.

The Tri-O-Lite Company, Nevada

The method of mining the diatomite is somewhat unusual. An inclined shaft parallel to the dip (35 degrees) of the beds has been sunk on the hill-side and in the centre of the deposit. At about 100 feet in depth a tunnel has been driven from the shaft along the strike of the bed. The diatomite is mined by stoping up the incline for 20 feet at regular intervals of 10 feet, the material between being left as temporary pillars. One of these stopes continues to the surface and acts as an air shaft. The floor of these stopes comprises the central calcareous seam and it is proposed later to remove the floor of the bed which covers the best material and use a caving system. The diatomite, which contains 15 to 20 per cent moisture, after a preliminary air-drying is trucked to the mill where it is pulverized and graded by cyclones.

Lake or Swamp Deposits

The material in the eastern deposits is obtained either by straight dredging or through preliminary draining. It is generally better to drain the deposit if this can be done economically, but some lakes are too large and the location of others does not allow this operation. Some deposits are covered with a thick overburden of mud or silt, are interbedded with seams of sand and other impurities, and the thickness of the diatomite varies. In these deposits, preliminary draining would reveal the nature of the deposit and would enable open quarrying operations and a proper selection of the diatomite and rejection of the impurities. The material can be removed by shovelling into trucks running on previously laid rails on the top of the deposit. On the other hand, with underwater dredging all the material is liable to be mixed together and it is, moreover, difficult to determine the limits of the deposit. In a drained deposit the material is very soft and wet and it is usual to excavate it by means of a bucket dredge, the bottom of the pit being kept free from water by pumps or adequate drainage where possible.

In a deposit in Florida a suction dredge having a boom end equipped with a rotating, knife-bearing head is used. The material is pumped into a box having a grid or coarse screen for eliminating roots, etc., and then flows into a sluice box which after a short distance widens out to 4 feet. The stream flows slowly over about 500 feet of riffled sluice which catches the heavy particles and gritty material, so that by the time the material reaches the settling-tanks very little grit is left.

PREPARATION

In wet deposits the excavated diatomite or material from the settling-tanks is piled up to drain and is then spread out to air-dry, after which it is usually completely dried in a rotary furnace or kiln. The compact deposits may have from 15 to 40 per cent absorbed moisture and in most cases the mined blocks are broken up into lumps small enough to allow thorough drying and are built up as walls. It takes from one to two months to dry the material to 5 or 6 per cent absorbed moisture.

The preparation of the dry diatomite for the market varies according to its intended use. In some cases it is shipped out in crude lumps, but is usually pulverized in a hammer or impact type of mill and mechanically dried if necessary.

Calcination

Diatomite, when pure, contains approximately 4 per cent of combined water. It also contains volatiles and organic matter which in the dry compact deposits varies from a trace to 1·5 per cent, but in the lake deposits the organic matter may be anything up to 50 per cent. Calcination removes the water and these impurities. It is important that the temperature be sufficient for this purpose, but not high enough to fuse any of the stable impurities or destroy the delicate skeleton structure of the diatoms. The temperatures at which the combined water and carbonaceous matter are driven off were determined in a series of experiments conducted at the Mines Branch, Ottawa. The analyses of the diatomites tested will be found in Table XI, Nos. 6a, 8, 63a, 63c, and in Table XII, No. 4, from which it will be seen that the samples had a wide variation in chemical composition and purity. It was found that the percentages of water remaining at different temperatures were not affected by the purity and were as follows: 2·0 to 2·5 per cent at 500° C.; 1·5 to 1·7 per cent at 600° C.; 1·0 per cent at 700° C.; 0·55 to 0·75 per cent at 800° C.; and 0·25 per cent at 900° C.

The carbonaceous matter was entirely removed at a dark red heat between 500° C. and 600° C. Since all diatomites appear to act alike, a full red heat of about 800° C. would be the most practical temperature for calcination.

For the majority of uses the combined water is, however, not injurious, so that the materials from many of the western United States deposits, which contain under half of one per cent carbon dioxide and organic matter, are not calcined before being placed on the market.

Removal of Iron

Other impurities, the commonest of which are iron, alumina, lime, magnesia, and alkalis, cannot be removed by calcination. When quantities of 1·5 per cent or more of iron oxide are present the calcined material becomes pink or even brick-red if iron is high. The state of the iron can be changed by adding a small amount of soda, magnesia, or common salt to the crude material, resulting in a pure white product after calcining. The amount added should be just sufficient to take care of the iron present, as an excess will cause the diatoms to fuse together and so injure their filtering and insulating properties. The calcining temperature should be kept as low as possible. Lime also prevents the red colour but larger proportions must be added which tends to mar the purity of the finished product. In all diatomite high in iron, either with or without the addition of a reducer, the lower the calcining temperature, the whiter will be the product.

As a result of a series of experiments on a number of different diatomites high in iron, it was found that in most cases the material calcines white with the addition of salt. In some instances, particularly with the peaty material from the Maritime Provinces of Canada, the salt imparts a purple tinge, which was found to be caused by a trace of manganese. When calcined alone, the pink colour due to the iron masks that due to the manganese, but the addition of the salt only removes the iron discoloration. Experiments are now being conducted to find an economic method whereby a white calcined product can be obtained from a diatomite containing manganese. A sample of each foot of the Digby Neck, N.S., material was calcined and found to turn pink, the colour darkening as the depth increased. When calcined with 3 to 5 per cent salt, the first 4 feet consisting of peaty matter turned snow white, but the top portion of the underlying grey material took 15 to 20 per cent. Below 8 feet the colour was darker than when calcined alone. In the case of the Quesnel diatomite the best results were obtained by adding salt, the improvement with soda being almost negligible. In British Patent No. 229021 the inventor mixes the diatomite with 5 per cent sodium chloride, calcines, and pulverizes the burnt material. It is claimed that the apparent density is lowered and the volume increased 50 per cent making a more porous product, which is especially suitable for sugar filtration.

The calcination period can be conveniently regulated by the rate of feed through the rotary calciner, keeping the temperature constant; increased rate of feed having the same result as lowering the temperature.

Final Preparation

The dry diatomite, either before or after calcining, is usually cleaned and graded by means of air separators of the cyclone type. A separation of the large from the small or finely broken diatoms can be partly obtained by passing the material through a series of cyclones having varying positions of the outlets. Grading can also be obtained by sucking the diatomite powder through a long, fan-shaped, air chamber divided along its length into a number of bins. The grit and coarsest materials naturally settle in the first bins and a fair separation is made. Suitable arrangements can be made to bag the products at points along the circuit.

Separation of Sand and Grit

Sand and grit should, as far as possible, be removed by sand traps during mining operations. They can be further removed in the first cyclone, the air suction being regulated so that the heavier particles drop to the bottom and at the same time allow the diatoms to be carried over to the next cyclone.

EXPERIMENTS AT THE MINES BRANCH, OTTAWA

Experiments were made in a Gayco air separator (Figure 25) at the Mines Branch Ore Testing Laboratory, Ottawa, on a crude diatomite from lake Michel, Chertsey township, Quebec, containing about 10 per cent grit. The original sample of 25 pounds was passed through a Raymond pulverizer (Figure 26) and thence four times through a Gayco. Each product was separately weighed and examined and the following results were obtained:—

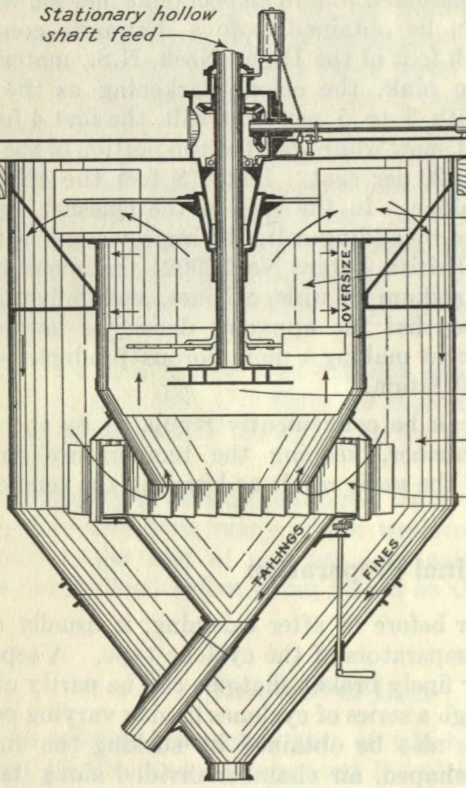

Figure 25. Section through a Gayco air separator

Passes	Recovery	Distribution of grit as per cent of original sample
	per cent	
1	50	0·20
2	17	0·15
3	6	0·15
4	4	0·10
Over-size and clean-up	20	7·00

It will be seen from the above, that most of the coarser grit was removed after the first pass and that no advantage resulted from the third and fourth passes. The grit for analysis was obtained by taking a weighed sample of each and washing in a beaker with several changes of water and decanting after settling for half a minute. Each sample, including the original, was washed eight times and stirred to free all diatoms before settling and

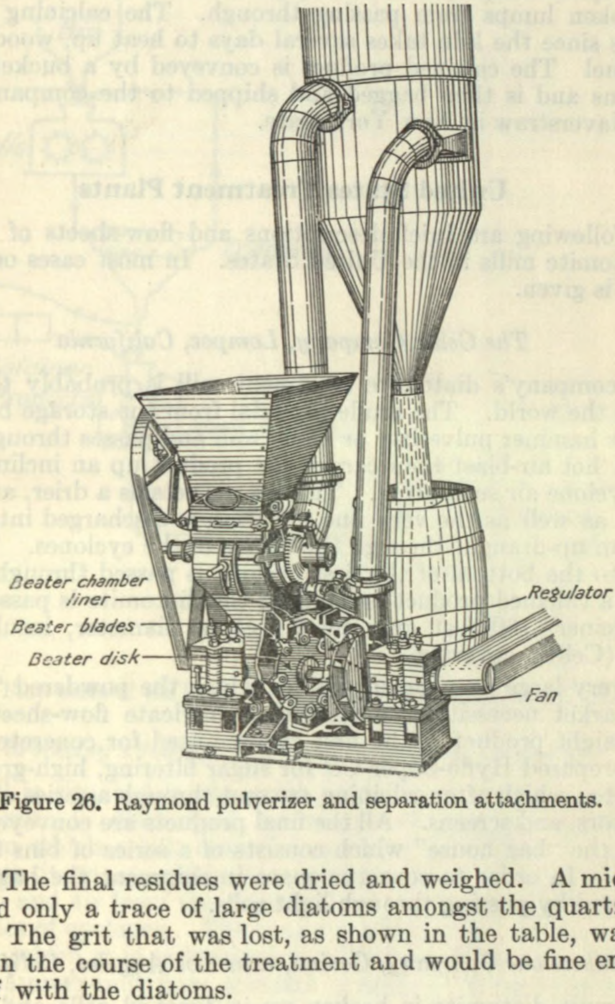

Figure 26. Raymond pulverizer and separation attachments.

decanting. The final residues were dried and weighed. A micro examination showed only a trace of large diatoms amongst the quartz and other impurities. The grit that was lost, as shown in the table, was probably ground up in the course of the treatment and would be fine enough to be decanted off with the diatoms.

Canadian Treatment Plants

At present (1927) the Oxford Tripoli Company is the only diatomite producer in Canada and it now has a preliminary treatment plant 10 miles south of Tatamagouche on the main road to Truro, Nova Scotia.

The calciner and drier consist of a large rotary firebrick-lined kiln, 72 feet long by 5 feet diameter, with a 5-foot drop, and enclosed in a concrete chamber. The material in a semi-dry condition is fed into the kiln by means of a screw conveyer. The first 50 feet of the kiln acts as a drier and in the remaining 22 feet, which have direct access to the fire, the diatomite is calcined. Baffle plates placed at intervals inside the kiln lift and break up the lumps while a fireclay grid, 7 feet from the fire-box, prevents any unbroken lumps from passing through. The calcining operation is continuous since the kiln takes several days to heat up, wood slabs being used for fuel The calcined product is conveyed by a bucket elevator to storage bins and is then bagged and shipped to the company's finishing plant at Haverstraw in New York state.

United States Treatment Plants

The following are brief descriptions and flow-sheets of some of the larger diatomite mills in the United States. In most cases only a general procedure is given.

The Celite Company, Lompoc, California

This company's diatomite treatment mill is probably the largest of its kind in the world. The crude material from the storage bins is broken up in a bar hammer pulverizer or Dolly mill and passes through a trommel screen. A hot air-blast then carries the product up an inclined tube to a series of cyclone air separators. The hot air acts as a drier, and the steam produced, as well as the very fine particles, is discharged into the air by means of an up-draught through the centre of the cyclones. The material that falls to the bottom of the first cyclone is passed through a second or third. If a calcined product is required the diatomite is passed through a rotary calciner, 160 feet long by 9 feet in diameter, insulated with a diatomite (Celite) covering.

The very large number of uses for which the powdered "Celite" now finds a market necessitates a somewhat intricate flow-sheet and varies from a straight product of the first cyclone used for concrete, etc., to the specially prepared Hyflo-Super-Cel for sugar filtering, high-grade polishing powders, etc., which after calcining are sent through a series of pulverizers, air separators, and screens. All the final products are conveyed or dropped down into the "bag house" which consists of a series of bins for each type of product. In order to conserve space in shipment the bagged material is compressed by passing through light rolls.

Featherstone Company, Covina, near Los Angeles, California

The crude diatomite is broken up in toothed rolls and then passed through a series of trommel screens. Some of the trommel fines are used for brick and tile making, but part is further prepared by passing over vibrating screens and pulverized in a Gruendler hammer mill. The very finest product then goes to the air separation plant consisting of two cyclones. The cyclone product is mainly used for polishing powders. A large rotary calciner, insulated with diatomite, is also used for preparing certain products such as powder for sugar filtering, etc. (Figure 27).

The Buttle Properties Inc., Bradley, California

This company has a small mill at their mine near Bradley. It consists of a crusher, trommel screen, hammer mill, and a cyclone air separator. Preparations are, however, being made to increase the capacity and efficiency of the plant.

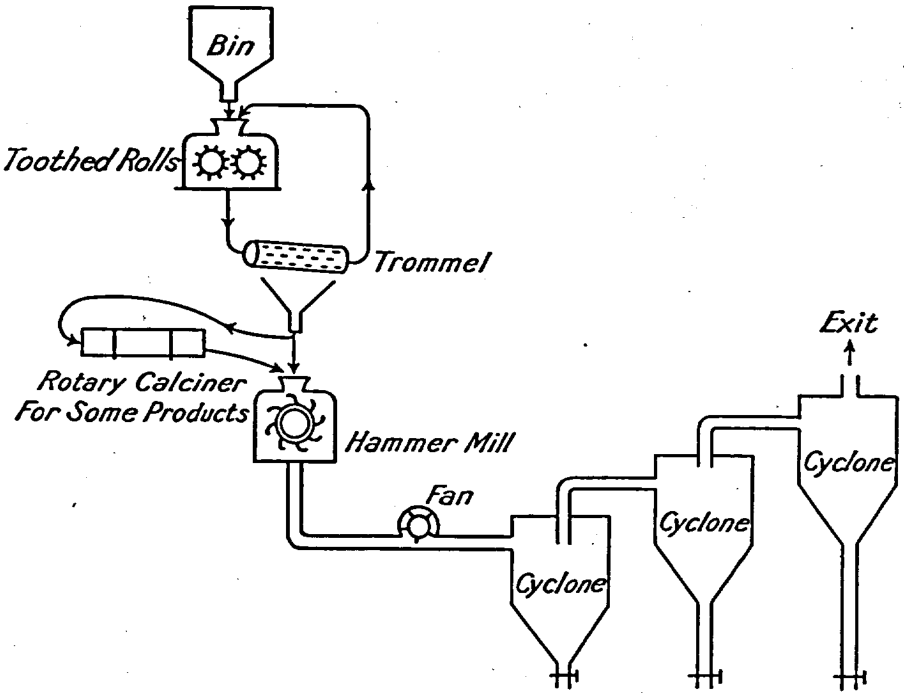

Figure 27. Flow-sheet of the Featherstone Company's diatomite mill, Covina, Cal.

Monterey Products Company, Monterey, California

The mill is situated in the gulch at the foot of the deposit and the mined diatomite is discharged by means of wooden chutes into the mill bin, from which a belt conveyer carries it to toothed rolls. A bucket elevator takes it to an oil-fired revolving drier. A suction fan draws off the steam and air from the drier and the discharge is sucked through a pipe to a series of cyclones. The coarse material from the drier is elevated to bins from which it is pulverized in a K-B hammer mill. An air blast carries the hammer-mill fines through a pipe to a long settling-chamber divided into bins, the finest being at the discharge end. The excess air containing the unsettled fines passes through a cyclone where the very finest material is collected. The material from the various cyclones or at different points along the air chamber can be sacked as desired. The plant has a capacity of 120 tons per 24 hours, and the storage-shed will hold 20 carloads of finished product.

The company has recently been reorganized and the flow-sheet is being changed. The process will now consist of passing the material over a fine grizzly after the toothed rolls, to a Raymond pulverizer having an air suction outlet to 3 cyclones, the heavy product in the first cyclone going back to the pulverizer. About 90 per cent of the finished product will come from the second cyclone.

The California Kieselguhr Company, San Miguel, California

The crude diatomite from the mine is dumped from the motor trucks to the bins from which a belt conveyer takes it to a Williams hammer mill of 5 tons per hour capacity. A 45-inch Sturtevant fan draws off the discharge, through a pipe with traps for the heavier material, to the first cyclone. There are three of these cyclones, the discharge from one passing to the next, the product from each being bagged separately. (Figure 28.)

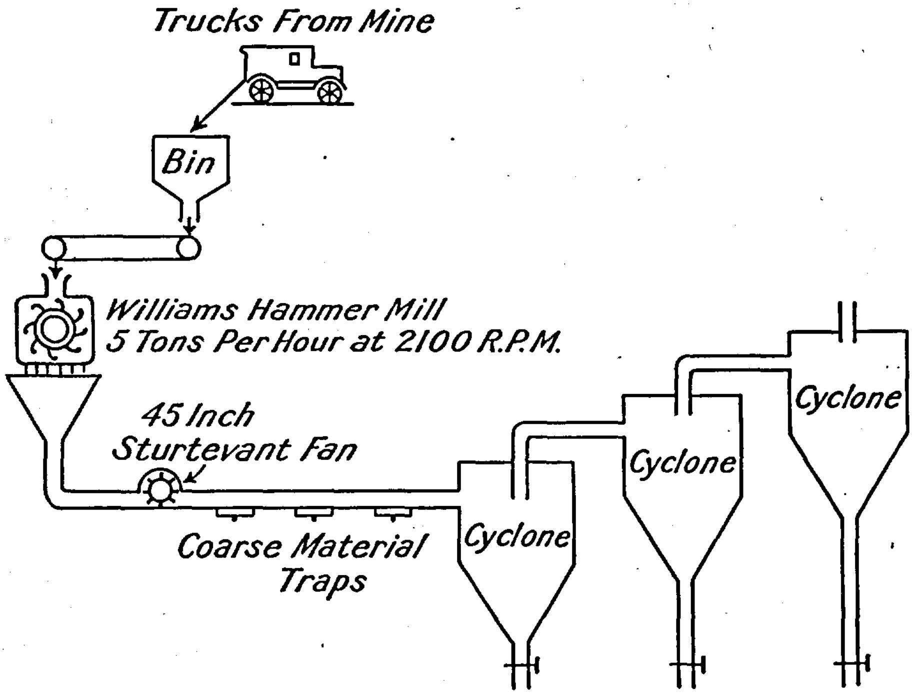

Figure 28. Flow-sheet of the California Kieselguhr Company's diatomite mill, San Miguel, Cal.

Great Western Silica Company,[1] *Ellensburg, Washington*

The following is a brief outline of the company's treatment plant which was recently destroyed by fire. The diatomite was hauled to bins on the east bank of the Yakima river where the lumps were broken up in a crusher. A Riblets tram conveyed the material across the river to the mill bin at Roza where it was pulverized in two Schutz-O'Neil D.-mills. It was then blown through an air chamber of the usual type, from the bins of which several products were bagged by means of screw packers. A new plant is being erected (1927) at Kittitas, 17 miles to the northeast of the deposits.

[1] Recently reorganized as Kittitas Diatomite Co.

Atomite Company, Terrebonne, Oregon

The air-dried material from the mine is dumped into storage bins and thence to a pair of toothed rolls. The broken product is stored in another bin from which it is then conveyed to an impact hammer mill with a screen at the bottom.

The fines are drawn by means of a fan to a cyclone, the discharge from which passes to another cyclone, and thence through an air chamber with baffles (Figure 29). The products of the two cyclones and air chamber are bagged. The mill has a capacity of about 25 tons per day. The plant is equipped with a drier, 60 feet long and 7½ feet in diameter, but at present it is not being used.

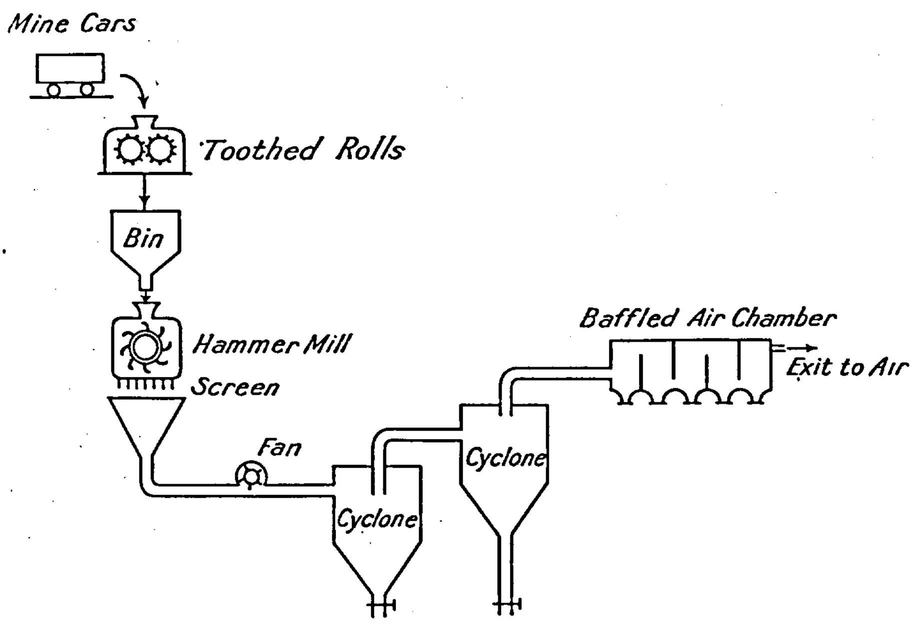

Figure 29. Flow-sheet of an Oregon diatomite mill.

Tri-O-Lite Company, Carlin, Nevada

The diatomite from the mine is conveyed by motor truck about 2 miles to the plant, and dumped into a storage bin, and thence onto a one-inch grizzly. The lumps are broken up and pushed through the bars by means of a stamp mill with long prongs. As this product, which drops into another bin, still contains considerable moisture it is elevated to 2 steam-jacketed, slow-moving screw-conveyer troughs kept at a temperature of 200° F. The dry material drops into another bin from which it is fed to a Raymond pulverizer fitted with a suction pipe that draws the fines to a series of 5 cyclones. The coarse material from the Raymond pulverizer passes over a trommel having screens of three sizes. The through material drops into a box with an air-suction attachment and the fines are drawn to join the Raymond fines to the first cyclone. The heavier or coarser product of each trommel screen is caught in bins and

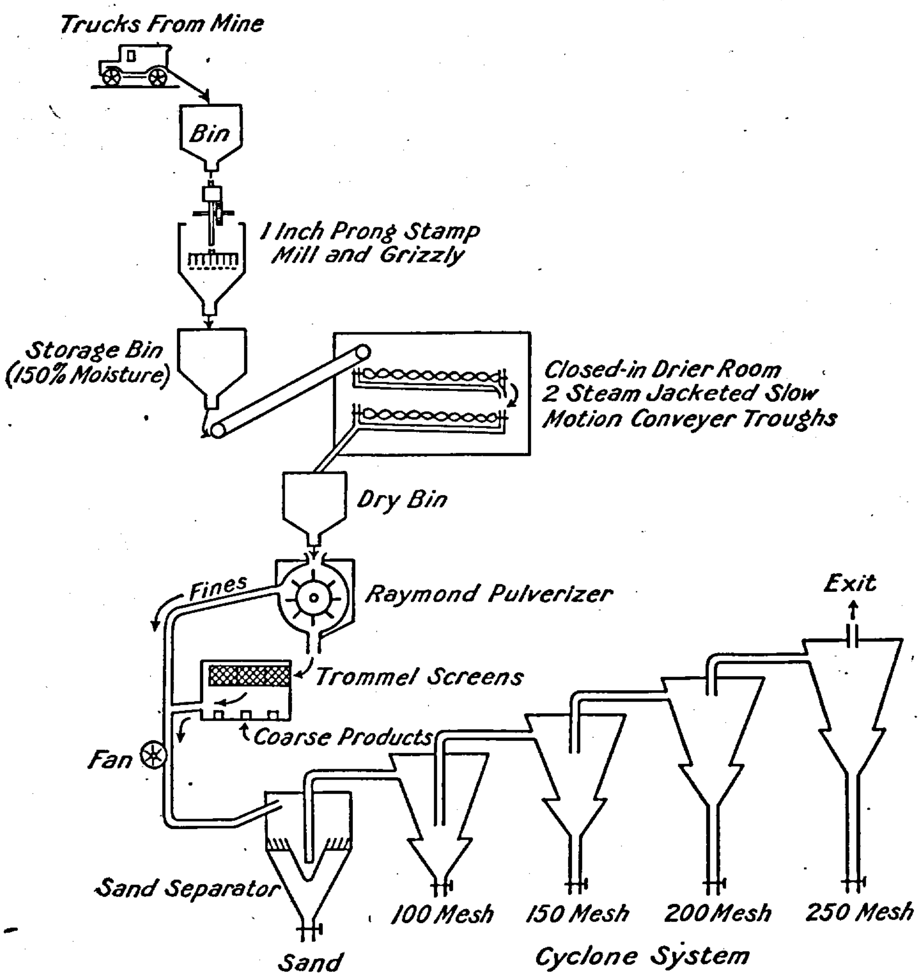

Figure 30. Flow-sheet of a Nevada diatomite mill.

sacked. The first cyclone acts as a sand, or grit, extractor and has a baffle arrangement on the top which catches the grit which is drawn out at the bottom. The discharge passes in turn to 4 cyclones having varying heights of intake and discharge pipes and from which 4 products from 100 to 300 mesh are sacked. (Figure 30.)

MANUFACTURE OF DIATOMITE PRODUCTS

Bricks

NATURAL DIATOMITE BRICKS

At the quarry of the Celite Company at Lompoc, California, the bricks are cut from the quarry face by special saws. The bricks, which are oversized, are conveyed by aerial trams to a drying-kiln of the tunnel type, fired from underneath. After drying, the rough bricks are placed on a belt conveyer and pass under and alongside a series of thin, short-toothed carborundum wheels which cut or trim them to the required dimensions. A special contrivance turns each brick over while the belt is moving, so that all the sides and ends are cut. They then pass along another belt where the broken or faulty bricks are discarded, the perfect ones being sent either to the packing house or to the kilns. The latter are calcined at a temperature of about 1800° F.; they have a pink colour due to the presence of iron, and show the banded structure of the original bedding.

Diatomite starts to shrink at about 1600° F., which is about the temperature at which tridymite begins to form. This is accompanied by internal temperature alterations and if the shrinkage is too rapid the bricks tend to split along the bedding-planes, so that careful mechanical control and regulation of the kiln temperature are essential throughout the operation.

BONDED AND BURNED BRICKS

The method of making these bricks and the equipment used is somewhat the same as in the case of firebricks. The Celite Company's method is briefly as follows: The diatomite is pulverized in a bar hammer mill, screened to ½ inch, wetted with water (with a small amount of bonds and other ingredients) and thoroughly mixed in a mixer to the proper consistency. It is then sent to brick presses of the Fernholtz type which moulds four bricks at a time at a pressure of 100 pounds per square inch. The bricks as they come out of the press contain about 130 per cent moisture (3 pounds of water each) and are very brittle. They are then sent to driers of the oil-fired, tunnel type, built in sets of three, each 160 feet long. Approximately 63 cars of 400 bricks each pass through the driers in 24 hours, the hot air and moisture being taken away by a draught fan. The dried bricks are then considerably firmer and can stand more handling. These are then piled and stacked in one of the down-draught brick kilns, the largest having a capacity of 60,000 bricks. After the burning is completed the furnace is allowed to cool and the bricks are taken out and placed on a gravity, roller run-way down to the packing room. They are sorted on the run-way and the faulty bricks are rejected.

The whole cycle takes about 8 days, of which 2 days are at the burning temperature. This temperature depends on the type of brick, one of which ("C—22") is burnt at about 2,000° F., and the other ("Super brick") at 2,500° F. The latter is very strong, will withstand a very high temperature and has a high shrinkage point.

As mentioned above, tridymite theoretically starts to form at 1,600° F. and shrinkage takes place until its formation is complete, which, however, would necessitate a very prolonged burning. It appears that in the low-temperature brick only a small proportion of tridymite is formed, but in the high-temperature brick the proportion is much greater thereby causing a higher shrinkage. A microscopic examination of both bricks shows that in the high-temperature brick the diatom structure is partly destroyed, so that a further increase in temperature would cause further destruction with a consequent lowering of the insulating properties.

Details of the maximum temperatures, crushing strength and thermal conductivity of these bricks will be found in trade literature. Plate V shows a general view of the Celite brick plant.

Bonded and burnt diatomite bricks made by other Californian producers are turned out in a somewhat similar manner to the above, but with considerably smaller output and equipment.

SPECIAL BRICKS

An especially light and porous brick is made by mixing together diatomite, ground cork or sawdust, a little clay, and the requisite amount of water. These are then moulded, pressed, dried, and finally burnt at a uniform temperature. In the calcining process the cork is first carbonized and then gradually burns out completely, leaving a highly porous brick. The brick weighs about 1½ pounds or 29 pounds per cubic foot and has ten times less heat conductivity than ordinary building brick but it starts to shrink at 1,600° F. This cork bond brick is made by the Armstrong Cork Company and is known as Nonpareil brick.[1] Other insulation articles such as slabs, tiles, pipe coverings, etc., are made in a similar manner to the bricks. Mortars of the same composition are also made for use with these special insulators.

A similar type of bricks to the above could be produced by using crude diatomite containing about 10 per cent carbonaceous matter. They could be either cut out direct or pulverized, moulded and pressed, and then burned. The natural carbonaceous matter would burn away in the same manner as the cork or sawdust. Some Canadian diatomites are suitable for this type of brick, particularly the lower beds of the Digby Neck, Nova Scotia, deposit.

OTHER TYPES OF BRICKS

In some diatomite deposits the natural impurities are utilized in the manufacture of bricks. Amongst these may be mentioned the "moler" deposits of Denmark in which the clay or other materials present enables the operators to produce a good grade of natural and burnt bricks direct from the quarries.

In the plant of the Moler Products, Ltd., near Colchester, England, the crude moler is delivered from the ships by belt conveyer to storage bins and thence through Erfurth rollers in order to separate out stones and rubble. The earth then passes through Erfurth three-shaft mixers in which water is added and from thence to fine-grinding rolls. The ground material is fed to an Erfurth triple-shaft pugmill of a new design, fitted

[1] Met. and Chem. Eng., vol. 13, p. 129 (1915); *also* vol. 14, p. 551 (May 1, 1916).

with cutting-knives, which thoroughly prepares the mixture. The extruded column of clay is cut off by means of Fey automatic cutting tables and the cut blocks are conveyed to drier pallets. The piled up blocks are carried by means of a finger car to a drier chamber, and when completely dry the car takes them to the unloading rack. They are then automatically transferred to the kiln cars which run on rails into the kiln chambers and burned at about 880° C.[1]

Another type of waterproof diatomite brick is produced direct from the bituminous deposits of Sweden.

EARLY CANADIAN EXPERIMENTS

It is of interest to mention again the early experiments in the manufacture of diatomite bricks in 1879 by Dr. Hoffmann of the Canadian Geological Survey, referred to under "Early Experiments", p. 40. In these experiments the diatomite was used alone, as well as admixtures of 5 and 10 per cent clay and others with 1 and 2 per cent lime. After being mixed and moulded, the test pieces were dried and then placed in covered crucibles in an air furnace. The temperature was gradually raised to a white heat and maintained for two hours. Although no tests on their conductivity are recorded, it was noted that they "could be held between the fingers without the slightest inconvenience whilst the other end was heated to redness in a blast lamp." Other observations were that in all instances their form remained intact, with sharp edges and showed no indication of having undergone even the most incipient fusion. They were all highly absorbent, particularly the plain and the lime mixture. The clay mixtures were the strongest. The lime bricks were the loosest in texture and had the lowest linear contractions, those of the clay samples being considerably higher. The weight of the plain brick was less than half that of a fire-brick of the same dimensions; the lime bricks being the lightest and the clay bricks the heaviest.

Roofing Tiles

Several designs of roofing tiles are made by producers in Europe and the western United States, particularly in California. The Featherstone Company near Los Angeles, California, amongst others, is putting hollow curved roofing tiles on the market, which, in addition to a pleasing colour, are good roof insulators. They are made by mixing the diatomite with clay found in the lower beds of their deposit at Covina. Until recently they were modelled by hand but machinery is now used. They are placed in a drying chamber and burnt in a down-draught kiln. Hollow building tiles are also made in a similar manner.

ENGLISH EXPERIMENTS

During 1921 a series of experiments was undertaken by the Imperial Institute to ascertain the suitability of East African diatomite for roofing tiles in that country, the results of which were published.[2] Two samples were used, No. 1 containing 52 per cent silica and 30 per cent alumina,

[1] "The British Clayworker", Sept. 1927, pp. 168–172.
[2] Bull. Imp. Inst., vol. XIX, pp. 306–311 (1921).

and No. 2 containing 70 per cent silica and 8 per cent alumina; they also contained 3·5 and 4·5 per cent iron oxide. The series of 6 tests consisted of the diatomites alone; both mixed; and each mixed with clay and also shale. After mixing, moulding, and air-drying, some were fired at 900° C. and others at 990° C. It was found that No. 2 (the analysis of which is very similar to the Quesnel, B.C., Canada, deposits) gave the best results as to strength and lightness at the lower temperatures. It was found that at the higher temperature there was a decrease in strength except in the case of No. 2 bonded with shale. The water absorption of the plain No. 2 was the highest, being four times that of a plain Yorkshire tile. To overcome this, glazing experiments using lead and other glazes were successful when applied to the tiles at 850° C. Salt glazes at 1,200° C. were tried and were not a success as No. 2 and clay mixture were found to be bent, pitted, and contracted, while No. 1 and clay contracted and did not take the glaze.

The use of Portland cement was tried out as a binder for the tiles and it was found that No. 1 required 10 per cent and No. 2, 40 per cent of their own weights of cement to produce tiles of sufficient strength. Mixtures of the diatomites with lime and gypsum were also tried. Although they hardened well under water, on removing and exposing to the air they developed cracks after a few days.

Pipe-Covering Compounds

In order to give the necessary bond about 10 per cent of asbestos is mixed with the diatomite and the mixture is moistened with water and pressed into moulds of the required shape. The coverings are made in two sections longitudinally and when finished are thoroughly dried and then placed together in the form of a tube, or jacket, and wrapped with canvas. For special high-temperature work a special double jacket is made, the inner tube consisting of a diatomite mixture as above, while the outer tube is a prepared magnesium carbonate mixture. The latter is made, by calcining magnesite. The oxide is formed and the carbon dioxide given off is collected and kept under pressure in tanks. The carbon dioxide is then passed back through the magnesia which has been previously crushed to a fine powder. Combination takes place forming a magnesium carbonate which is said to be lighter and more porous than diatomite up to 700° F. At this temperature some CO_2 begins to come off thus lowering its insulation value. This prepared magnesium carbonate is mixed with 10 per cent asbestos and moulded and put together in the same manner as the diatomite. The inner diatomite tube which is used for temperatures between 750° and 2,000° F., sometimes also contains a small percentage of the magnesium carbonate.

Slabs, tiles, and other forms are made from diatomite and bonded in a similar manner to the above.

Polishes and Cleansers

METAL POLISH

It is generally an advantage to mix the diatomite with a detergent such as paraffin or soap solution, also a mild acid, so that the article is cleaned as well as abraded. The following are the percentages by weight of the ingredients of an English metal polish paste: diatomite, 14·5; rouge, 35; palm oil, 43; castile soap, 6; powdered oxalic acid, 1·5.

A simple and very efficient metal polish can be easily and cheaply made by thoroughly mixing the diatomite into a paste with a strong solution made by dissolving soap in hot water. On cooling it sets into a good thick paste which lathers when applied with a damp cloth to the article being cleaned. If a little glycerine is added to the mixture the paste will keep moist almost indefinitely, provided the container is kept closed. The best results will, however, be obtained by grinding all the ingredients together in a burrstone or suitable mill in a manner similar to that used in the manufacture of paints.

A typical liquid metal polish is as follows:[1] soapflakes, 1 ounce; fine silica (diatomite), 4 pounds; wood alcohol, ½ pint; paraffin, 1 gallon.

AUTOMOBILE POLISH

As in the case of metal polishes, all manufacturers have their own ingredients and proportions. A typical example consists of thoroughly mixing together paraffin oil, some mucilage such as corn-starch and a little diatomite. A small amount of acid may be added so as to cut the grease and dirt on the varnished surfaces. For ordinary domestic purposes a pure grit-free diatomite powder can be added to almost any of the liquid furniture polishes now on the market. All these liquid polishes should be thoroughly shaken before applying since the diatomite settles to the bottom of the container.

CLEANSING COMPOUNDS

In the manufacture of polishing soaps a small amount of diatomite is often added to the soap ingredients. An English scouring soap consists of 50 parts of diatomite, 10 parts of flour emery, brought to a suitable consistency in hard soap dissolved in spirits of wine (soap solution).

DIATOMITE AS AN ADMIXTURE IN CONCRETE

The Action and Advantages of the Diatomite Admixture

The addition of a small percentage of diatomite in a concrete not only facilitates the handling of the wet mix, but also improves the concrete, since it increases the flow and workability without the extra addition of water. Workability, with its attendant advantages, is one of the most important factors in a concrete job and is usually obtained by the addition of an excess of water, but this causes honeycombing and decreased strength

[1] Searle, A. B.: "Abrasive Materials", p. 61, 1922 (Pub. by Sir Isaac B. Toman, London, England).

in the concrete. A number of materials are added to produce workability, but recent tests by the U.S. Bureau of Standards[1] have shown that per unit weight diatomite (Californian material) as an agent of workability is twice as effective as kaolin, three times that of hydrated lime, and six times that of Portland cement.

Diatomite, owing to its high absorptive properties, retards the settling of the solids in the wet mix during handling or transportation so that the water is less likely to work up to the surface. This ensures uniformity, tends to prevent segregation, and makes central mixing a more practical operation. The moisture is retained for a sufficient length of time within the mass for the concrete to set and harden gradually and more effectively. The diatoms tend to fill up the minute voids, thus giving a dense, uniform, and smooth material. The appearance of the finished concrete is improved and, after the forms have been removed, the surface can usually be painted or calcimined without patching or any preliminary treatment. The increase in bulk due to the addition of diatomite in some cases will offset the extra cost of its use.

Tests have shown that the addition of diatomite increases the compressive strength of concrete. This may be due to the more complete filling in of the voids, and possibly to a chemical action between the ingredients—particularly the free lime of the Portland cement—and the diatom silica, thus forming a solid bond. It is probably for these reasons that a diatomite concrete, after it is completely set, loses its porosity and is more waterproof than concrete devoid of it.

One of the main dangers of using ordinary concrete for submarine work is due to the fact that the magnesium sulphate of the sea-water combines with the free lime of the Portland cement. The resultant sulphate occupies a larger volume than the lime and causes internal expansion. The magnesium sulphate also attacks other ingredients of the mix, and this, together with the expansion, results in the eventual disintegration of the mass. It is claimed that the addition of silica, in the form of diatomite, which on setting is believed to combine with the lime, renders the compounds more insoluble and inert, thus eliminating to a large extent the expansion and disintegration.

It is also said that in the construction of concrete sidewalks and highways a diatomite admixture not only produces a surface smoother than that obtained by normal concrete, but rapid evaporation of the moisture is avoided (particularly in hot climates), thus avoiding the expense of a damp covering during the setting period.

The proportion of the diatomite to be added depends on its purity, the type of concrete to be made, the amount of water in the mix, as well as the coarseness of the ingredients. It should, however, rarely be more than 5 per cent of the weight of cement, for an increase over this is generally detrimental. The average amount is usually about 3 per cent, but the leaner the mix the greater should be the proportion of diatomite. For waterproofing, the best results are attained by the addition of a slightly larger percentage of diatomite. The material is added in the mixer along with the other ingredients and owing to its workability the mix can be poured more quickly and more cleanly.

[1] Pearson, J. C. and Hitchcock, F. A.: "Economic Value of Admixtures", Proc. Am. Concrete Inst., vol. XX, pp. 312–347 (1924).

Although the length of the setting period does not appear to be materially affected there are cases where the normal 28-day period has been reduced with safety to 24 days with a diatomite mix.

It should be borne in mind that best all round results depend not only on the proportion of diatomite used, but on the suitability of the actual diatomite itself, the degree of coarseness and the type of the aggregates, the kind of cement used, the richness of the mix, and the conditions under which the diatomite is cured or set. Best results can be achieved only by a series of preliminary tests, and the use of diatomite should not be condemned if at first these tests do not indicate advantages.

References to literature on this subject will be found in the Bibliography under "Uses—Concrete."

Tests

UNITED STATES TESTS

A number of tests have been made by the American Society for Testing Materials and by individual firms in the United States. Two of these taken at random show that a mixture of 1 part cement, 2¼ parts sand, and 3½ parts gravel gave a slump of 6½ inches and a compressive strength of 1,370 pounds per square inch, but the same material with the addition of 2 per cent diatomite (Californian) resulted in a 5-inch slump and a compressive strength of 1,680 pounds. Another test with a 1 : 2¼ : 4 mix gave a 6-inch slump and a compressive strength of 2,020 pounds per square inch, but with 1½ per cent diatomite the slump was only 5 inches and the compressive strength 2,700 pounds per square inch. All tests were made after setting for 28 days. It may be noted here that where a concrete having a 2-inch slump is required, a slight increase in the water content above the normal is necessary when diatomite is used; for concrete with higher slumps, which are commonly used, no extra water should be added.

An exhaustive series of tests on admixtures were made by Messrs. Pearson and Hitchcock. Their findings are published by the American Concrete Institute.[1] The tests for strength were made after ageing for 28 days, one complete set being stored in a damp closet, one out of doors in the shade, and one inside the laboratory. It was found that the workability of concrete containing diatomite was improved to the extent already mentioned, and that the strength was slightly decreased in all the richer mixes, and that this was further decreased as the proportion of admixture increased (above 2 per cent). The leanest mixes showed increase in strength except with 5 per cent diatomite (California). The decrease in strength was also more marked after curing in a dry atmosphere than in a damp one. The increase in bulk due to the diatomite was in every case greater than when twice the amount of kaolin and three times the amount of lime admixture were used in comparative tests and would probably be sufficient to entirely offset the cost of the admixture. The density was only affected slightly but there was a general decrease over the plain. The authors in their final summary state that:—

[1] Loc cit.

It has been shown that small proportions of powdered admixture do not detract appreciably from the strength of the concrete except in the rich mixtures, where the need for and the values of such admixtures disappear. On the other hand, the improvement in workability that can be brought about by the judicious use of admixtures is considerable, and this must tend to reduce costs and improve the uniformity of the finished product, under given labour conditions.

It should be noted that the tests were made after 28 days and showed decrease in strength for the richer mixes. In a discussion on these tests Dr. D. A. Abrams did not appear to be in complete agreement with these findings, the pros and cons of which are beyond the scope of this report but may be found in detail on pages 340-347 of the Proceedings.[1]

CANADIAN TESTS

Strength Tests

A series of tests using different proportions of different diatomites was made during 1927 by the Department of Public Works, Ottawa, in co-operation with the Mines Branch. The diatomites used were a calcined material from Digby Neck, N.S.; crude material from Quesnel, B.C., and the standard concrete admixtures from the Celite Company, Lompoc, Cal., U.S. (*See* microphotographs, Plate IX.) All were pulverized to pass 150 mesh. The proportions added were 2 and 4 per cent by weight of the cement. Three different mixtures of concrete were made in the proportions of 1:5, 1:6, and 1:7 by weight. Three complete series of tests were also made after curing under water for 28, 90, and 200 days.

The best quality cement was used, but was somewhat finer than the standard (78 per cent through 200 mesh). The aggregates were high-quality, crushed and graded limestone and clean pit sand.

The coarse limestone aggregate consisted of 1¼ parts of 1½ to 1 inch, 1 part of 1 to ½ inch, and ½ part of ⅝ to ¼ inch; while the fines were 25 per cent limestone screenings passing through ¼ inch and 75 per cent washed pit sand. These were all mixed together in the proportion of 3½ coarse to 2½ fines by weight, a sufficient quantity being made up for all the tests. The mixed aggregates weighed 123 pounds per cubic foot and contained 27·2 per cent voids. Varying proportions of cement were added to produce different mixes according to the table below and the proportions for each test cylinder were weighed and mixed separately. The water required for a slump of 1 inch was first obtained by trial, using standard methods, and the water constant calculated by formula. This constant was 6·14.

The water-cement ratio was varied for the kind and for the quantity of the diatomite, so that the same slump (1 inch) was obtained for each mixture. This water-cement ratio ($\frac{w}{c}$) is on the basis of Imperial gallons (10 pounds) to a 94-pound bag of cement.

The moisture content of all three diatomites was almost the same and varied from 9·31 to 9·64 per cent.

Table XIII gives the proportions of water added for each mix to bring to normal consistency, and Tables XIV and XV show the compressive strengths and the increase in strength from 28 to 90 days.

[1] Loc cit.

TABLE XIII

Concrete Tests

(Mixes and controlled water)

—	1:5 Mix		1:6 Mix		1:7 Mix	
	Per cent water	$\frac{w}{c}$[1]	Per cent water	$\frac{w}{c}$[1]	Per cent water	$\frac{w}{c}$[1]
Plain concrete	8·559	4·83	8·210	5·39	7·995	6·00
Diatomite:						
Nova Scotia.........2 per cent.	8·889	5·00	8·497	5·59	8·202	6·17
4 "	9·219	5·20	8·780	5·78	8·450	6·35
British Columbia.....2 per cent.	8·780	4·95	8·402	5·53	8·120	6·11
4 "	8·999	5·04	8·591	5·65	8·285	6·23
California.............2 per cent.	8·889	5·00	8·497	5·59	8·202	6·17
4 "	9·219	5·20	8·780	5·78	8·450	6·35

[1] $\frac{w}{c}$ (water-cement ratio)=Imperial gallons (10 pounds) to 94 pounds cement.

The above were made in 6 x 12 inch cylinders, three of each tested for compression at 28, 90, and 200 days.

Workability

Although no actual tests for workability were made in the above experiments, the better workability of the diatomite mixes was quite manifest during the handling of the mixes. The mix using British Columbia material appeared to be slightly better than the others in this respect.

Strength

The tests show that diatomite acts slowly at first. There is a decrease in strength over the plain in the early stages of curing particularly in the richest mixes, but as ageing proceeds the strength of the diatomite mixture increases and becomes greater than that of the plain.

At 90 days every diatomite mix showed an increase over the plain which varied from 7 to 43 per cent. Also all the diatomite samples showed a greater rate of increase than the plain in each mix between 28 and 90 days and at the latter the 4 per cent diatomite in each case was stronger than the 1:5 plain (Table XVI). In the richest mix the British Columbia diatomite proved the strongest, but its value dropped as the mixes became leaner and the proportional increase of the 4 per cent mix on curing was almost as low as that of the plain; the 2 per cent mix, on the other hand, showed the steadiest rate of increase. The Nova Scotia diatomite, although weaker than the other mixtures at 28 days, showed the most uniform rate of increase on further curing, and with the 4 per cent mix this rate was greater than all the others. The 4 per cent mix using California diatomite was in every case stronger than the 2 per cent mix both at 28 and 90 days. Although it is claimed that the leaner the mix the greater the benefit of the diatomite, these experiments show that the maximum was reached in the neighbourhood of a 1:6 mix.

After 200 days' curing, considerable variation was found in the breaking points of the different series of test cylinders and the strongest was in most cases well above the average of the three. In all instances, however, the 2 per cent diatomites were stronger than the 4 per cent in the richest mixes, but the reverse took place in the leanest mix. Although this average for the 200-day test is included in Table XIV and in the chart, Figure 31, it is felt that owing to this wide variation in the test pieces, some experimental errors have crept in and results should be regarded with an open mind. It is claimed that tests made on California admixtures, by various engineers in the United States, have shown that the increased strength has been maintained after ageing for periods up to one year.[1]

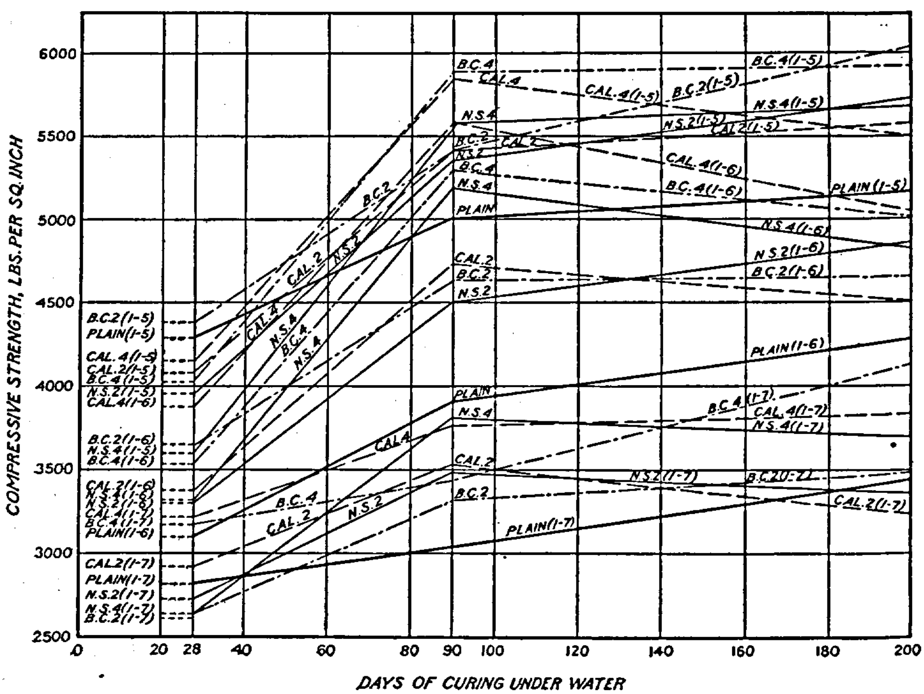

Figure 31. Concrete tests: showing comparative strengths of all mixes.

Since these cylinders were made on a 1-inch slump, different results may be obtained with a 5- or 6-inch slump typical of field concrete. On the other hand, in a very wet mix little or no advantages are claimed for diatomite admixtures. Further tests will however be carried out after prolonged curing on similar mixes to the above but having commercial slumps of 5 or 6 inches.

[1] Connor, C. N.: "Concrete Improved by Use of Diatomaceous Earth" (Test by North Carolina State Highways), Eng. News Rec., Dec. 17, 1925.

Slump Tests

A batch of test cylinders was made from a mix 1:7 and compared with one of the diatomite samples (California 4 per cent) having slumps of 1, 4, and 6 inches, and a plain concrete having a 1-inch slump. In this test all the diatomite admixtures, including the one having a 6-inch slump and containing one gallon more water per bag of cement, are stronger than the plain having 1-inch slump (Table XVII).

TABLE XIV

Concrete Tests

(Compressive strength in pounds per square inch)

Average of three, 6 x 12 inch cylinders	28 days	Per cent	90 days	Per cent	200 days	Per cent
1:5 Mix						
Plain	4,330*	100·0	5,007	100·0	5,160	100·0
Diatomite:						
Nova Scotia .... 2 per cent.	3,952	91·2	5,353	107·0	5,727	111·0
4 "	3,608	83·3	5,584	110·0	5,695	110·3
British Columbia .... 2 per cent.	4,385	101·2	5,427	108·3	6,031	116·8
4 "	4,037	93·2	5,886	117·5	5,910	114·5
California (Celite) .... 2 per cent.	4,083	94·2	5,428	108·4	5,580	108·0
4 "	4,150	95·8	5,841	116·6	5,510	106·7
1:6 Mix						
Plain	3,107	100·0	3,908	100·0	4,293	100·0
Diatomite:						
Nova Scotia .... 2 per cent.	3,320	106·8	4,510	115·4	4,878	113·6
4 "	3,327	107·0	5,187	132·7	4,845	112·8
British Columbia .... 2 per cent.	3,625	116·6	4,637	118·6	4,650	107·3
4 "	3,535	113·7	5,281	135·0	5,012	116·7
California (Celite) .... 2 per cent.	3,365	108·3	4,733	121·0	4,510	105·0
4 "	3,886	125·0	5,589	143·0	5,065	118·0
1:7 Mix						
Plain	2,821	100·0	3,036	100·0	3,434	100·0
Diatomite:						
Nova Scotia .... 2 per cent.	2,732	96·8	3,487	114·8	3,359	97·8
4 "	2,641	93·6	3,801	125·1	3,719	108·3
British Columbia .... 2 per cent.	2,633	93·3	3,301	108·7	3,494	101·7
4 "	3,175	112·5	3,437	113·2	4,131	120·3
California (Celite) .... 2 per cent.	2,928	103·7	3,535	116·4	3,249	94·6
4 "	3,217	114·0	3,761	123·8	3,849	112·0

* One cylinder broke at 3,336 and was omitted as faulty.

TABLE XV

Concrete Tests

(Per cent increase in strength from 28 days to 90 days)

Mixes		1:5	1:6	1:7
Plain concrete		15·6	25·8	7·6
Diatomite:				
Nova Scotia	2 per cent.	35·5	35·8	27·6
	4 "	54·7	56·0	44·0
British Columbia	2 per cent.	23·8	28·0	25·4
	4 "	45·8	49·3	8·2
California (Celite)	2 per cent.	33·0	40·6	20·7
	4	40·7	43·8	17·0

TABLE XVI

Concrete Tests

(Strength of 1:6 in per cent of 1:5 Plain (100 per cent) at 90 days)

1:6		Per cent of 1:5 plain
Plain		78·0
Diatomite:		
Nova Scotia	2 per cent.	90·0
	4 "	103·6
British Columbia	2 per cent.	92·6
	4 "	105·5
California (Celite)	2 per cent.	94·5
	4 "	111·6

TABLE XVII

Concrete Tests

(Comparative strengths for different slumps Mix 1:7 at 90 days)

—	Plain	Diatomite, California 4 per cent		
Slump, inches	1	1	4	6
Water, per cent	7·995	8·45	8·87	9·30
Imp. gals to 94 pounds cement	6·00	6·35	6·67	7·00
Pounds per square inch average of 3 tests	3,036	3,761	3,441	3,290
Strength increase of diatomite admixture in per cent of plain 1 inch	100	123·8	113·4	108·4

At the present (1927) local cost of cement at 0·6 cent per pound and the high cost of imported diatomite at almost 3 cents, there is little to choose between the actual costs of the two mixes under discussion, but it is confidently expected that Canadian diatomite suitable for concrete will be obtained for at least half the present price of the imported.

It is often argued that if more cement were added instead of diatomite equally good results would be obtained. If an equal weight (3 per cent) of cement were added it would have but little effect on the comparative strength of the concrete, but if added to the leaner mixes by volume (approximately 25 per cent by weight) the cement would behave as in the case of the richest mixes. It would seem, however, that the tests should be made on the basis of substitution by weight rather than by addition, and comparisons drawn showing what proportions of cement to diatomite would give equal benefits. Comparisons would be of interest during the construction period (workability, increased yield, etc.), also on the strength after periods of 3 and 6 months.

The simplest and best way of using diatomite is to incorporate it in the original cement during manufacture, this ensures a thorough mixing of definite proportions and saves the extra time and handling of the separate bags of diatomite during construction. It is understood that several cement companies in California are now marketing a diatomite cement, at least one of these adds 2½ per cent to standard cement.[1]

Waterproofing Tests

Tests on the waterproofing value of diatomite were carried out at the same time as those of the compressive strength, using the same diatomites and aggregates. Mixtures of plain cement and of 5 and 7 per cent diatomite were made in proportions of 1:6, 1:7, and 1:8, and moulded into slabs of 10 x 10 x 3½ inches. These were cured under water for 14 days and dried for 3 days at 110° F. Some of these were then subjected to a water pressure of 10 pounds for 7 days and others at 40 pounds for 2 days. At the end of these periods the slabs were removed, broken across the middle, the two halves placed together centre to centre and immediately photographed. In Plate IX the water penetration appears as a darker zone around the centres of the half slabs.

In the 1: 6 mix the California (Celite) material showed the least penetration, the 7 per cent being almost dry. The British Columbia 7 was about the same as the Celite 5, but both were drier than the plain. The Nova Scotia showed no appreciable difference from the plain. The photographs of this mix, unfortunately, do not clearly indicate the above differences and are not shown.

In the 1:7 mix the water penetrated almost entirely through the plain, but in all the diatomite mixtures the penetration was considerably less, the British Columbia 7 being slightly drier than the Celite 7. (Plate IX).

In the 1:8 mix the water penetrated to such an extent that no accurate comparison could be made, although it was observed that the penetration of Celite 7 was very slightly less than the others.

[1] "Operations of the Old Mission Portland Cement Company" ("Old Mission Plastic Watertite Cement"). Cement, Mill and Quarry. p. 18, June 20, 1927.

Experiments of the Public Works Department, Ottawa

Tests on the action of diatomite in concrete were first made by the Public Works Department during 1912. In 1920 a series of experiments was conducted on the compressive strengths of mortar bricks composed of 7½ per cent diatomite in a mix of one part cement to four parts sand. Although no figures have been published, it was nevertheless ascertained that the diatomite bricks broken at 90 days and after 6 years were appreciably stronger than the plain mix for the same periods, including the specimens in which the diatomite was substituted for the cement.

In the spring of 1922 a number of concrete cylinders, 6 x 12 inches, were placed in the sea waters of the east and west coasts as well as in the alkali waters of the mid-west. These cylinders were made up in a series of proportions of 1:6, 1:8, and 1:10, both plain and with 7½ per cent diatomite. The diatomite used was a crude gritty material containing 10 per cent silt, from lake Michel, Chertsey township, Quebec. The latest reports on these, in 1927, showed that nearly all the eastern samples have disintegrated and all those in the west were about equally attacked, but some of the diatomite samples are weathering very slightly better than the plain. In the alkali waters the diatomite cylinders although also attacked are, on the average, slightly better than the plain mixtures. Observations are, however, still in progress so that no definite conclusions can as yet be drawn.

Canadian Patent

Canadian Patent No. 226350 covering the use of diatomite in concrete for strengthening and for waterproofing was taken out by Messrs. C. W. Ball and F. L. Pilgrim of Ottawa on November 21, 1922.

MORTARS

In a series of experiments with lime-cement mortars Weymouth[1] has shown that, when 25 to 50 per cent of the lime is replaced by one-half its weight of diatomite, the increase both in the relative compressive and tensile strengths over the plain mix is considerable, although the plasticity and cost are the same in all cases. The *addition* of diatomite to a mortar greatly increases the plasticity, but the increase in strength is not so marked as with a mix in which there has been a *proportional replacement* of the lime with diatomite, although it has some effect in strengthening the weaker mixes.

[1] Weymouth, L. E.: "Improved Brick Mortars"; Proc. Am. Soc. Test. Mat., vol. 27, pt. II (1927).

DIATOMS AS AN ORIGIN OF OIL

The close proximity of some of the large beds of diatomaceous shales to oil-bearing strata in various parts of the world has lead many oil geologists to believe that the origin of the oil was, in part at least, due to living diatoms which were so prolific in the Tertiary period. In California, where there are immense oil and diatomite beds, this is the generally accepted theory. Statements regarding this are recorded in numerous United States Geological Survey reports between 1910 and 1917, a quotation from one of which is as follows:[1]

> The Los Angeles and Ventura counties petroleum occurs in quantity in the foraminiferal and diatomite shales of Miocene age...along the western border of the San Joaquin valley the oil is everywhere closely associated with and appears to be derived from a great succession of diatomaceous and foraminiferal shales many thousands of feet thick, that occupy about the same position in the stratigraphic column as the main oil-bearing beds of the coast.

In a more recent publication[2] W. A. English gives several arguments both for and against the diatomaceous shale theory for the origin of the Californian oil. He believes, however, that these shales were in some localities partially responsible for the oil, but in the case of some of the Los Angeles fields he states that there is some doubt as to the truth of this theory.

This problem is also discussed in detail by F. M. Anderson[3].

Credit for the original discovery that petroleum deposits originated from diatoms is given to J. O. Whitney in 1865. The author (Anderson) concurs fully with this theory as regards about 80 per cent of the production of the state, namely, the asphaltic oils from Miocene strata. He believes, however, that the paraffin oils such as are produced in Ventura county may have had an animal origin (probably *Foraminifera*).[4]

Another author believes that the diatoms play a very minor part in the origin of the oil, the principal accumulations being due to impounded muds deposited in places partly cut off from the sea by barriers.[5]

It is a proven fact that living diatoms do contain oil and in some species the quantity is appreciably high. Experiments are being conducted on some living diatoms (*Aulacodiscus*) from the south Washington coast and preliminary tests have indicated that they contain 2 per cent oils,[6] mainly asphalt base, but also contain 4 per cent chlorophyll. This is extracted by means of acetone, since alcohol breaks up the chlorophyll. On fractional distillation other oils and paraffins including possibly some petroleum have been obtained. The experiments are, however, not yet completed.[7]

On considering the above-mentioned opinions and experiments it would seem reasonable to believe that the massive beds of Tertiary (Miocene) diatoms were one source of most of the Californian oil.

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1 Anderson and Pack: U.S. Geol. Surv., Bull. 603, p. 196 (1915).
2 English, W. A.: "Geology and Oil Resources of the Puente Hills Region, South California", U.S. Geol. Surv., Bull. 768, pp. 69–73 (1926).
3 Anderson, F. M.: "Origin of California Petroleum", Bull. Geol. Soc. Amer., 37, pp. 585–614 (Dec. 30, 1926).
4 Private information from Dallas Hanna, San Francisco, Cal.
5 Takahasha, Jun-Ichi, R.: "Preliminary Report on the Origin of California Petroleum". Econ. Geol., March-April, No. 2, pp. 133–157 (1927).
6 Private information from L. B. Becking, Stanford University, Palo Alto, Cal.
7 Becking, L.B., and others: "Preliminary Statement Regarding the Diatom 'Epidemics' at Copalis Beach, Washington, and an analysis of Diatom Oil"; Econ. Geol., June-July, 1927, pp. 356–368.

On the other hand, there does not appear to be any reliable evidence to show that oil-bearing beds are derived from the freshwater swamp or lake diatomite deposits, which are typical of the eastern American continent. This may be due to the fact that the deposits are more recent and very much smaller. The formation of oil from diatoms is believed to depend largely on the rate or completeness of the decay of the diatoms combined with heat and pressure. This decay appears to take place more readily in sea water, while in the freshwater type it is not complete and this is one reason why oil is not common in the vicinity of freshwater deposits. Although nature has not separated out the oil from these more recent diatomite deposits, nevertheless, oil can be artificially obtained from them, particularly those having a high percentage of organic or bituminous matter. The amount so obtained would, however, be too small to be of commercial value.

CLEANING AND PREPARATION OF DIATOMS FOR MOUNTING

It is sometimes necessary to examine for identification, or of interest to collect, the clean diatoms. The diatoms in the strewn slide made for micro-analysis (described in Chapter II) are almost invariably contaminated by foreign material.

The methods used by Dr. Boyer[1] when identifying the Canadian diatoms are as follows.

Some samples require no cleaning whatever and are so pure and in such a friable condition that it is necessary only to place a minute quantity, about as much as would be held on the end of the blade of a penknife, in a homœopathic vial and add sufficient water. By diluting with pure water until the liquid shows a pearly appearance when held up to the light the diatoms are ready for mounting. A typical example of this is the material from lake Simon, Colbert township, Quebec. In most cases, however, the material must be boiled in a solution of carbonate of soda and if the lumps are broken down the liquid is decanted into a glass beaker with pure water, allowed to settle a few hours, then decanted again, repeating the addition of water until the soda is eliminated. In some cases this is all that will be needed. If in any case the lumps are not disintegrated, they should be boiled in nitric acid and then washed. In order to remove the fine silt it is advisable to boil in water to which a very small quantity of soap has been added and then to allow the solution to settle. The continued washing, shaking of the test tube, and in some cases repetition of the process, are successful in many instances. It is essential that all vessels and apparatus be perfectly clean and that the material be kept free from any possibility of contamination by dust from the air or other matter. In boiling in nitric acid place about one-third of a thimbleful of material in a 4-ounce casserole, add acid until it reaches about an inch in depth, and, when the acid boils, add a small piece of bichromate of potash, about the size of half a pea, which disintegrates everything. It is necessary to wait several hours to allow the deposit to settle and the bichromate and acid must be carefully washed out by repeated decanting and adding of water until all traces are removed.

A drop of the prepared diatom solution can then be placed in a cover glass and mounted on the slide by means of storax as previously described. Plate XVF shows a strewn slide of cleaned diatoms.

[1] Boyer, C. S.: Geol. Surv., Canada, Mus. Bull. No. 45, Biological Series No. 12 (Nov. 9 1916).

SOME CANADIAN PATENTS FOR DIATOMITE

Celite Company's Patents taken out in Canada

228860 Feb. 20, 1923—A plaster or cement made by grinding together diatomite and calcined gypsum—4 claims allowed.

228861 Feb. 20, 1923—A filtering and decolorizing agent composed of a mixture of fuller's earth and diatomite—7 claims allowed.

245938 Jan. 6, 1925—Refractory products made by mixing diatomite with a material adapted to lower the sintering point of the clay present and then calcining the mixture at a temperature that will sinter the siliceous dust, but not the entire mass—that is to a state of incipient fusion, but leaving the calcined product in a state of fine division. Also mixing diatomite with a halide of an alkali-forming metal, and calcining the mixture—26 claims allowed.

245939 Jan. 6, 1925—A filter-aid made by finely dividing diatomite and then calcining it at about 1800° F. to produce an increase in the filtration capacity and then finally reducing the calcined product to a state of fine division—17 claims allowed.

262402 July 6, 1926—A refractory heat insulating material consisting of silica in the form of tridymite produced by calcining fabricated bodies made by a mixture of diatomite and water with either a catalytic inversion agent, or a clay-like binder, or lime—19 claims allowed.

262985 July 27, 1926—A filter medium made by heating a mixture of finely divided diatomite and water with either lime or an hydroxide of an alkaline earth—24 claims allowed.

262986 July 27, 1926—Heating a mixture of diatomite, water, and lime until reaction occurs; removing excess of water and subjecting the product to the action of carbon dioxide either in this state or after calcining at 1000 to 1600° F.—19 claims allowed.

266520 Dec. 7, 1926—A cement composition composed of finely divided diatomite in which size of the particles are within certain stated proportions—7 claims allowed.

272847 Aug. 2, 1927—A filtering material consisting of diatomite from which certain stated proportions of coarse and fine particles have been removed. These sizes are specified by rate of water settling and by measurement in microns—11 claims allowed.

Various Canadian Diatomite Patents

178152 July 31, 1917—O. J. I. Martin, Victoria, B.C.: Lining for furnaces consisting of diatomite mixed with brick clay in suitable proportions. Other claims also add salt water or soapstone, or asbestos, each together or separately and rendered plastic by water, the salt being in proportion of ½ ounce to the gallon—7 claims allowed (6 years).

189135 Mar. 18, 1919—H. M. Olsen, Burbank, Cal., U.S.: A refractory material consisting of diatomite sodium sulphate, aluminium sulphate, and lime. The diatomite to be 75-95 per cent of the mass and the binder 5-25 per cent—2 claims allowed (6 years).

226350 Nov. 21, 1922—C. W. Ball, and F. L. Pilgrim, Ottawa: Strengthening and waterproofing cement by adding approximately 7·5 per cent diatomite. Other claims also add limestone, clay, gypsum, and acid—9 claims allowed.

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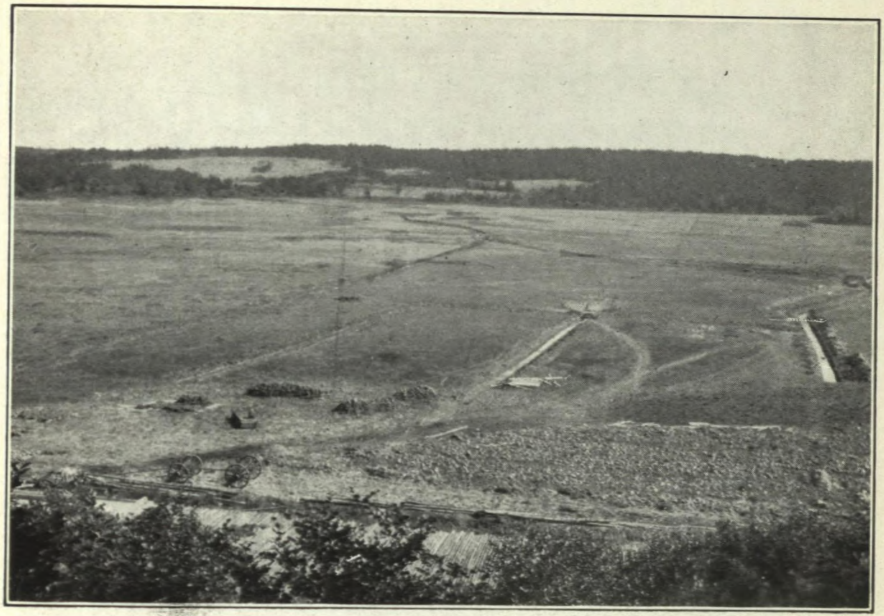
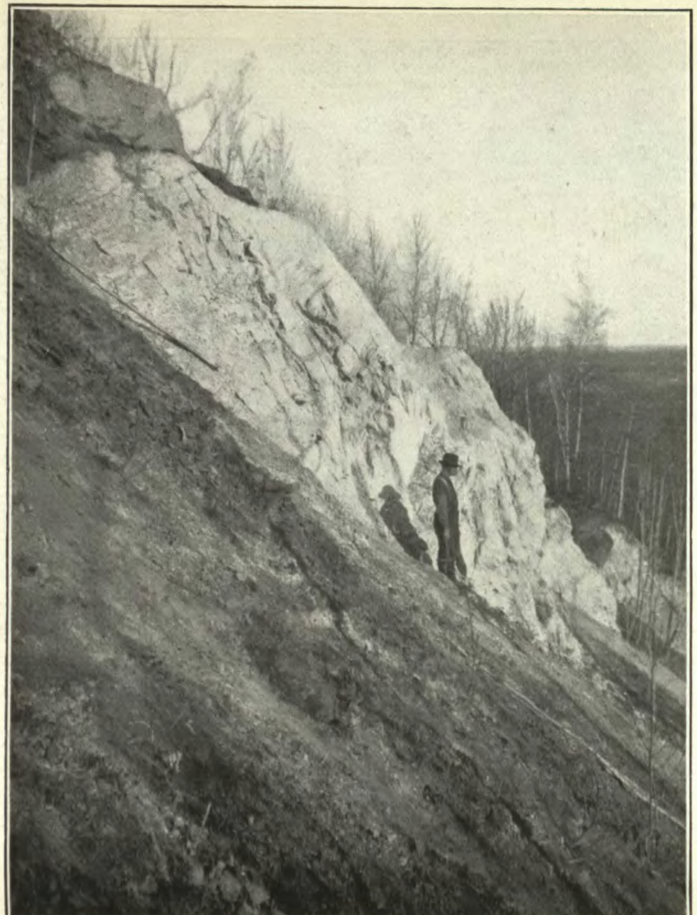


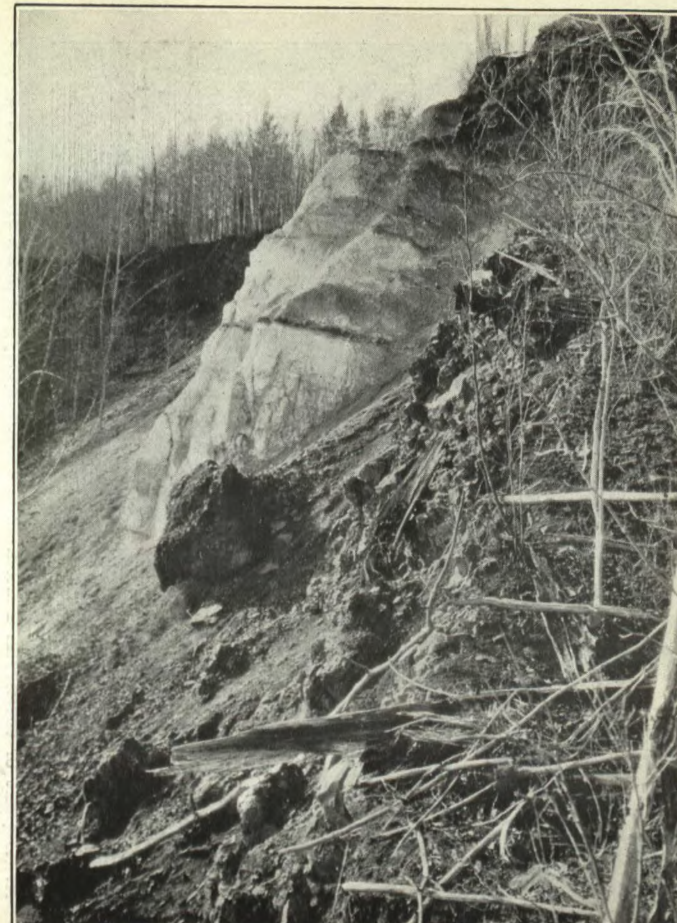
A. Deposit of the Scotia Diatom Products Company, near Little River, Digby neck, N.S.

B. Operations at the deposit of Oxford Tripoli Company, Rhude pond, East New Annan, Colchester county, N.S.

52474—11½

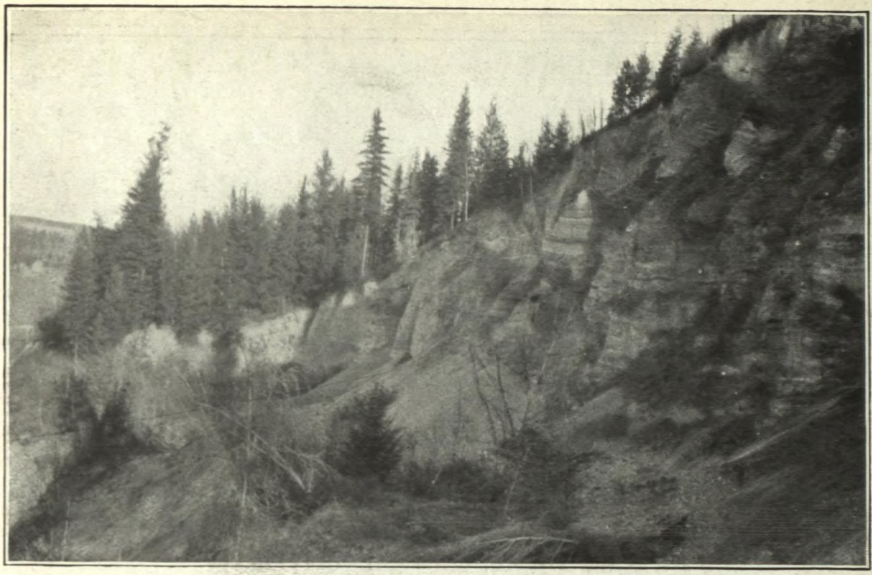


A. Lot 906, Quesnel, B.C., looking north, showing basalt overlying diatomite.



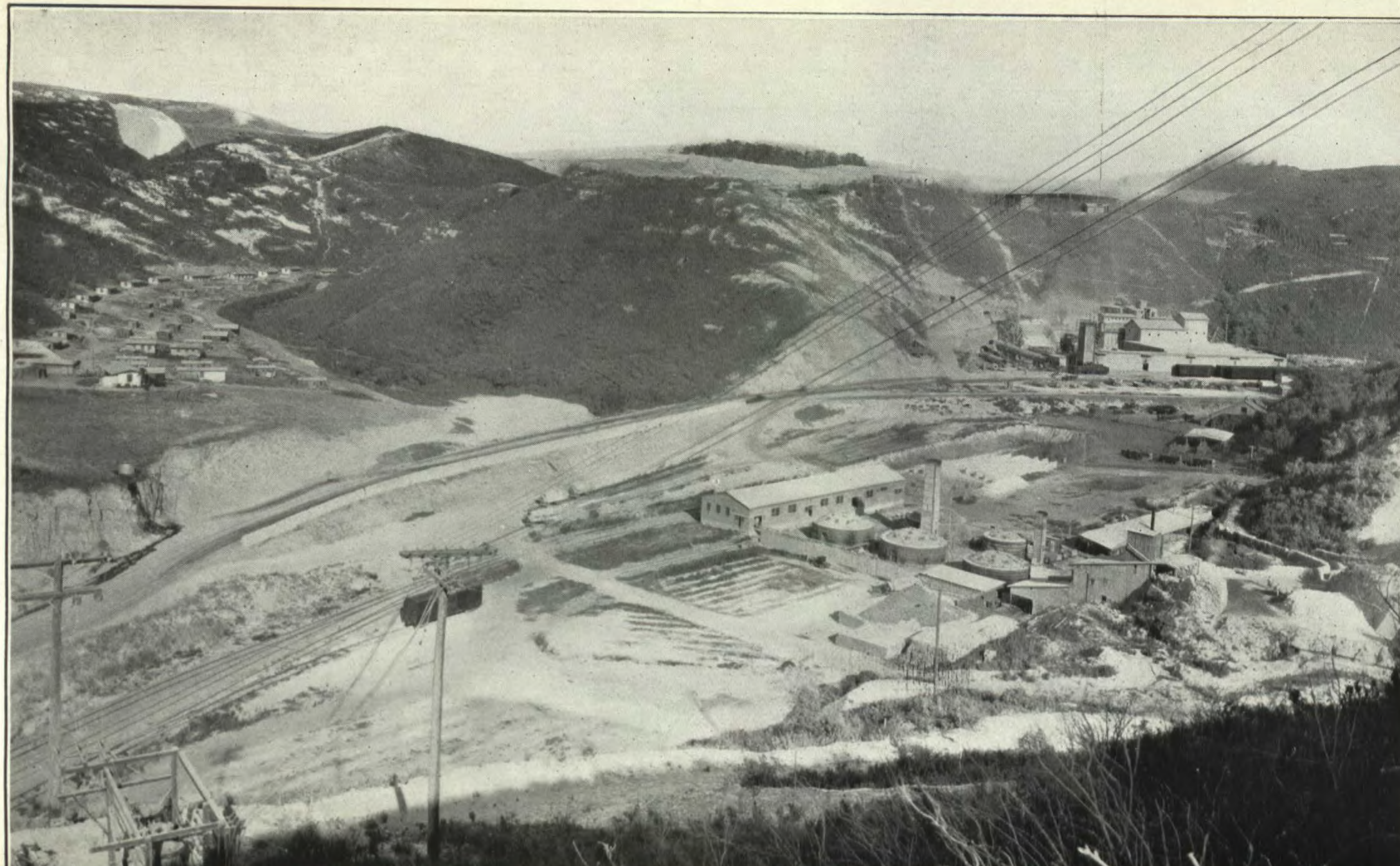
B. Lot 906, Quesnel, B.C., looking south, showing 40 feet of diatomite beds with main iron seam.

PLATE IV

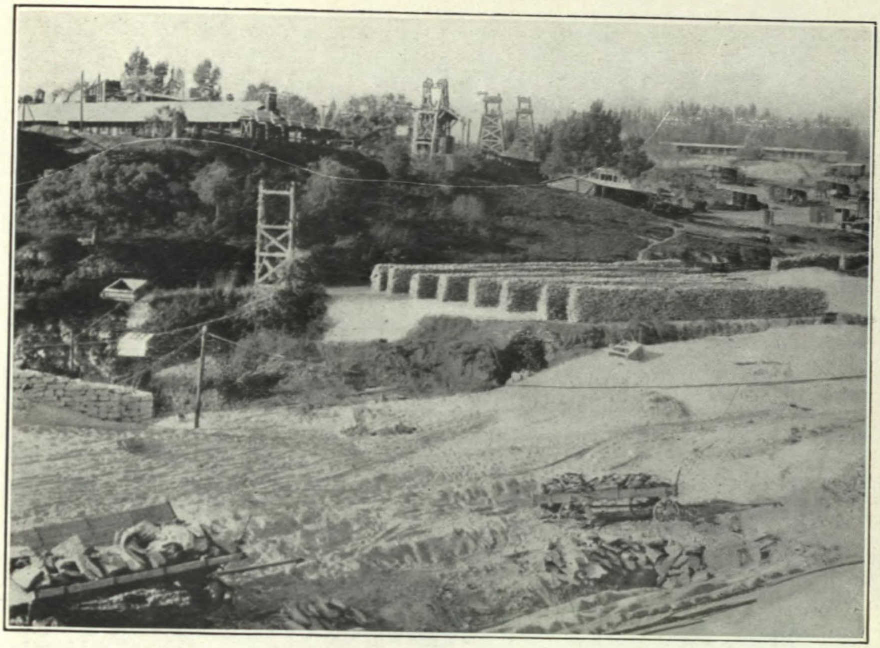


A. Big bend of Fraser River, near Quesnel, B.C., looking southeast, showing slides capped with diatomite.

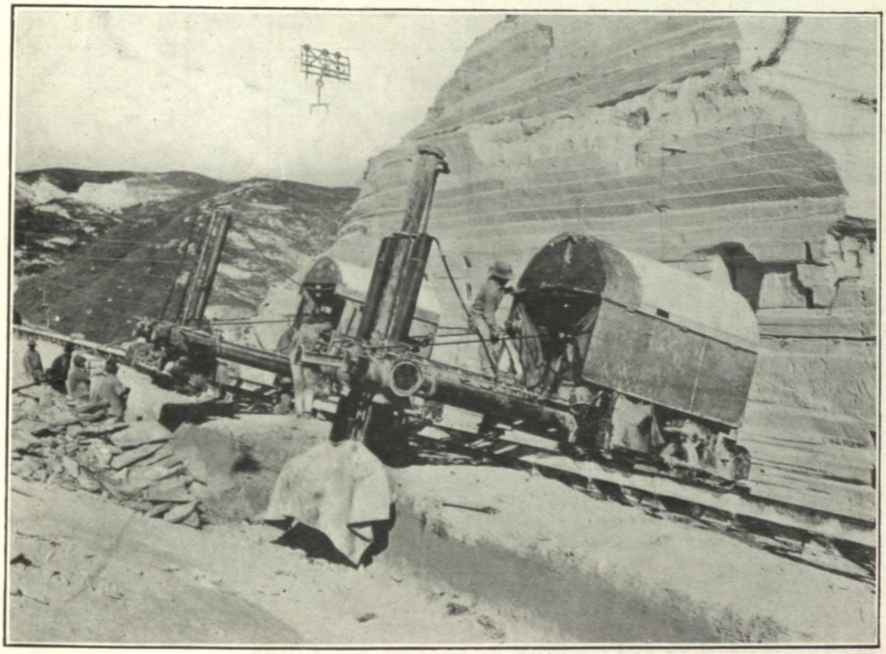
B. Lot 1122, Quesnel, B.C., showing horizontal diatomite beds overlying inclined beds



Celite Company, Lompoc, Cal.: general view of brick plant and mill, looking east.

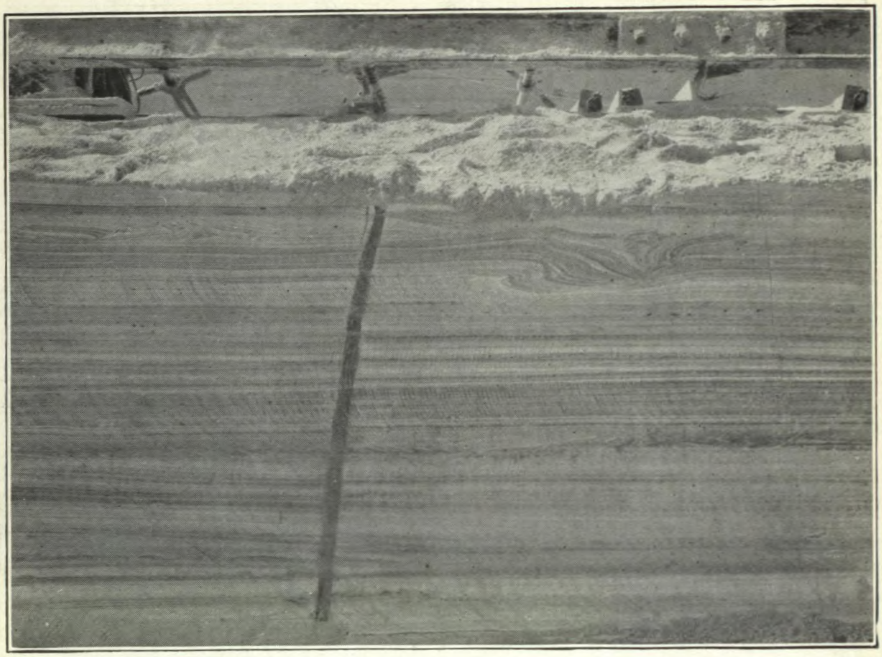


A. Celite Company, Lompoc, Cal.: aerial tram to mill and method of air-drying diatomite

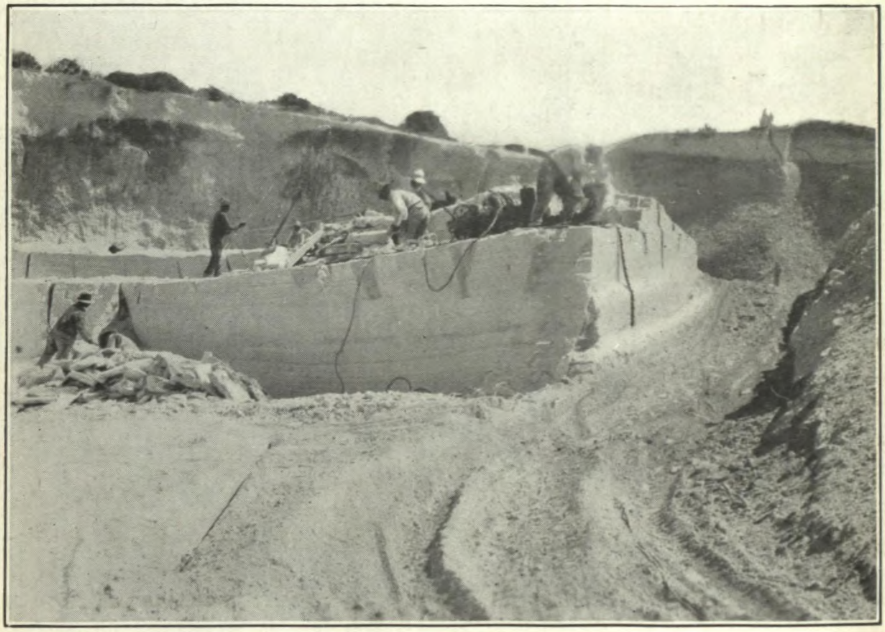


B. Celite Company, Lompoc, Cal.: natural brick cutters operating on a 30-degree slope, aerial brick conveyer, and vertical cut resulting from a series of 4-foot strippings.

PLATE VII

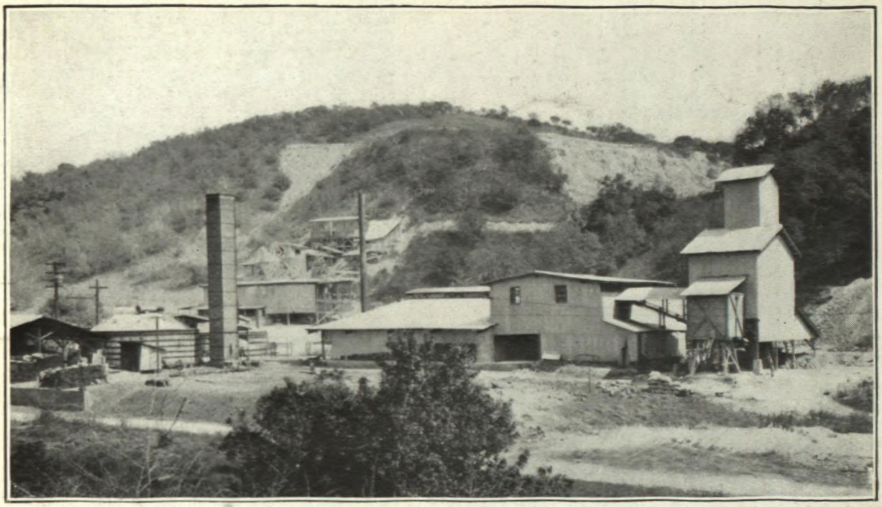


A. Celite Company, Lompoc, Cal.: 4-foot machine cut in main brick quarry, showing local folding of laminated diatomite beds which are cut by a one-inch fracture filled with clay.

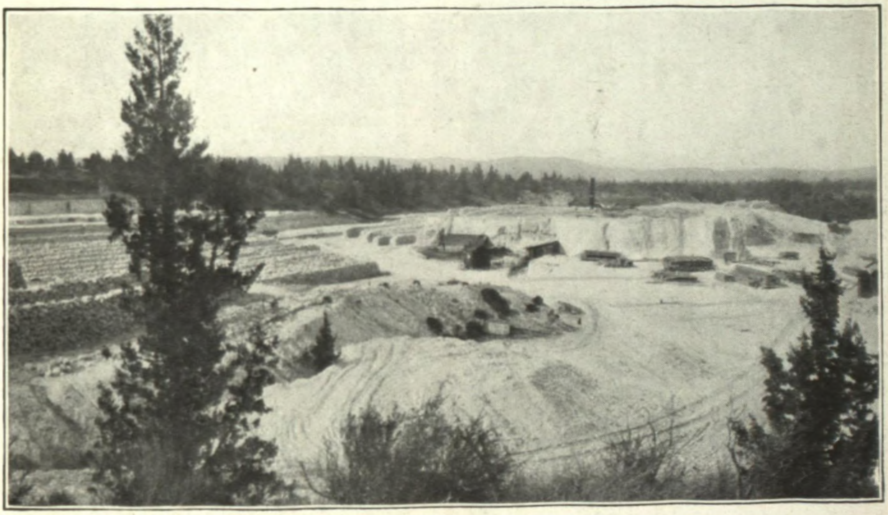


B. Celite Company, Lompoc, Cal.: No. 38 filter-aid quarry showing method of quarrying with a chain-saw channeling machine.

PLATE VIII



A. The Featherstone Company, Covina, Los Angeles, Cal.: general view of brick plant, mill, and quarry.



B. Atomite Company, Terrebonne, Oregon: general view of workings, looking north.

WATERPROOF CONCRETE TESTS

Cured 14 days under water. Dried 3 days at 110°F., under water pressure of 40 pounds for 2 days.

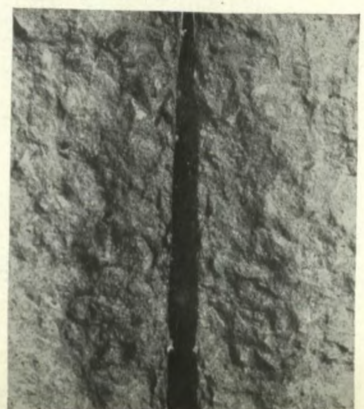
Mix 1-7

Neat

N. S. 5%

N. S. 7%

B. C. 5%



B. C. 7%

Cal. 5%

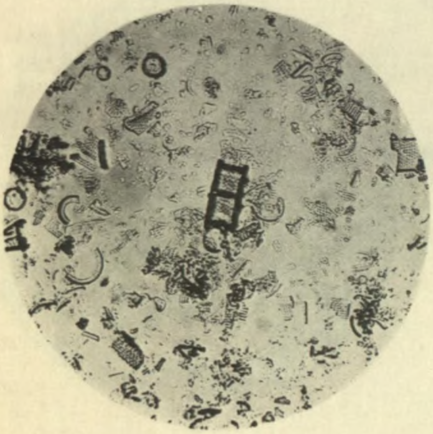
Cal. 7%

PLATE X

A.	Pukaist creek, Highland valley, Ashcroft mining division, B.C.	X 285
B.	Guichon creek, Mamit lake, Kamloops mining division, B.C.	X 285
C.	Chester's farm, Copper creek, Red lake, Kamloops mining division, B.C.	X 285
D.	Oldfield's farm, Prospect lake, Vancouver island, B.C.	X 285
E.	Blackwater river, Cariboo mining division, B.C.	X 285
F.	Quesnel, B.C., lot 906, top beds	X 285

A

B



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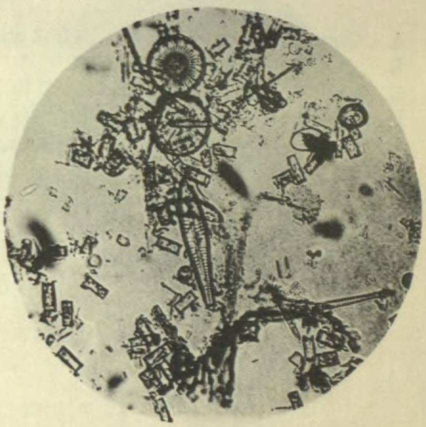

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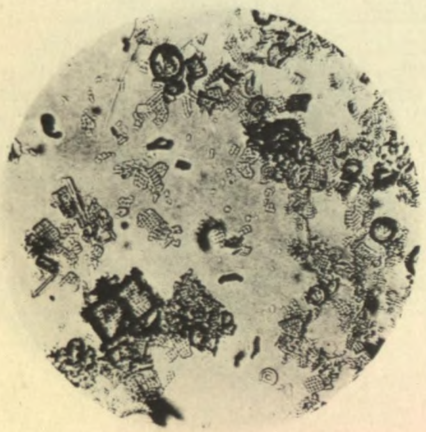

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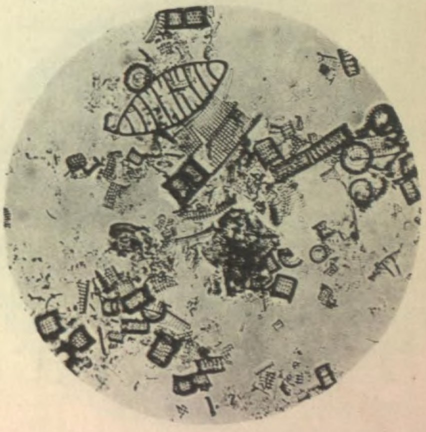

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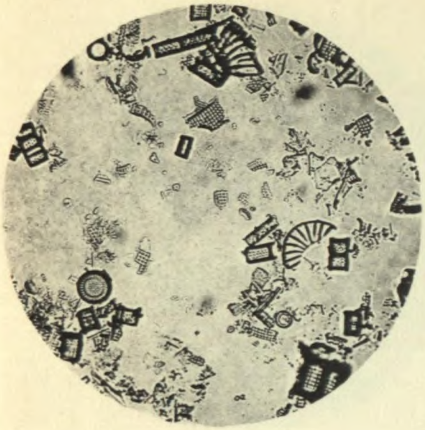
Plate XI

A.	Quesnel, B.C., lot 906, 10–20 feet down	X 285
B.	" " 25–30 "	X 285
C.	" " 30–35 "	X 285
D.	" " 35–40 "	X 285
E.	Oxford Tripoli Company, Rhude pond, Colchester county, N.S.	X 285
F.	Earltown lake, Colchester county, N.S. (calcined mud)	X 285

Plate No. XI



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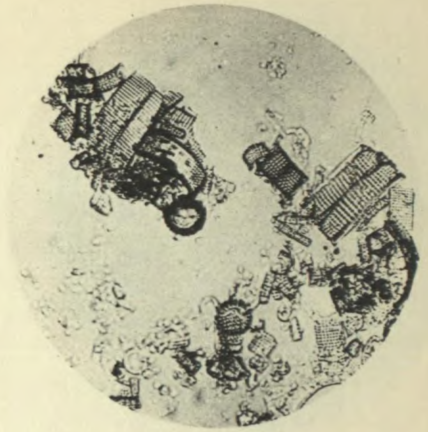

B

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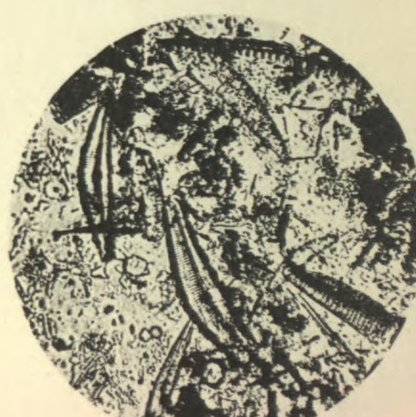

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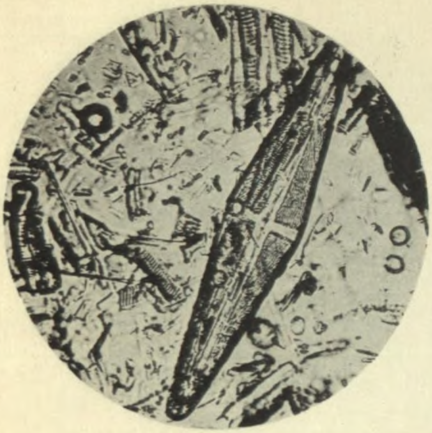
PLATE XII

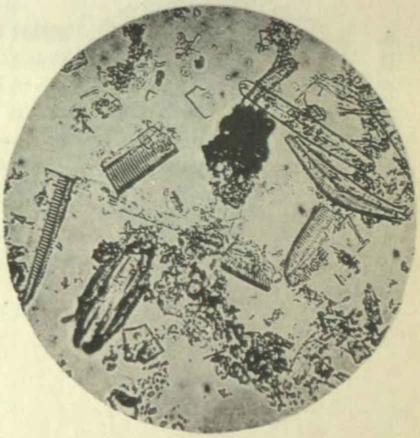
A.	Morden, Kings county, N.S.	X 285
B.	Brora lake, Johnson's marsh, Pictou county, N.S.	X 285
C.	Pollet lake, Kings county, N.B.	X 285
D.	Fitzgerald lake, St. John county, N.B.	X 285
E.	Spence lake, Draper township, Muskoka district, Ont.	X 285
F.	Moon river, Medora township, Muskoka district, Ont.	X 285



A

B

C



D

E

F

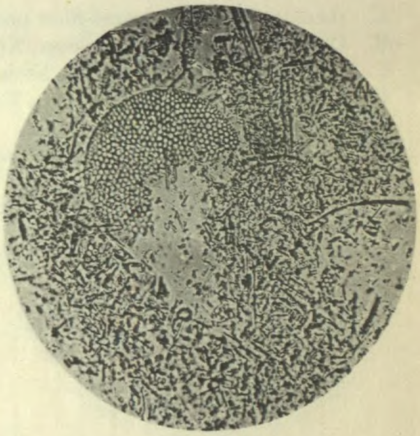
PLATE XIII

A.	Lake Simon, Allen's Mills, Colbert township, Que.	X 285
B.	Jacquot river, Allen's Mills, Bourglouis seigniory, Que.	X 285
C.	Celite Company, No. 38 quarry (filter-aid), Lompoc, Cal., U.S.	X 285
D.	Celite Company, "Hyflo-Super-Cel" filter product, Lompoc, Cal., U.S.	X 285
E.	Bradley, southern Monterey county, Cal., U.S.	X 285
F.	Mt. Shasta Silica Company, No. 13 deposit, Pitt river, Cal., U.S.	X 285

A

B

C



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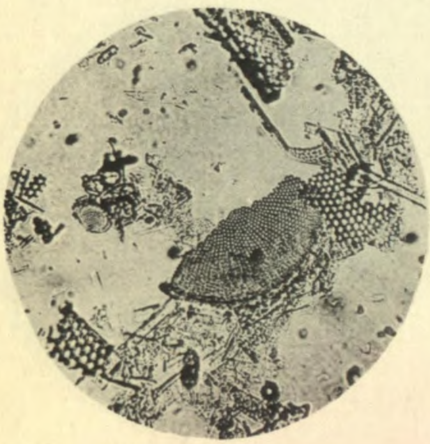

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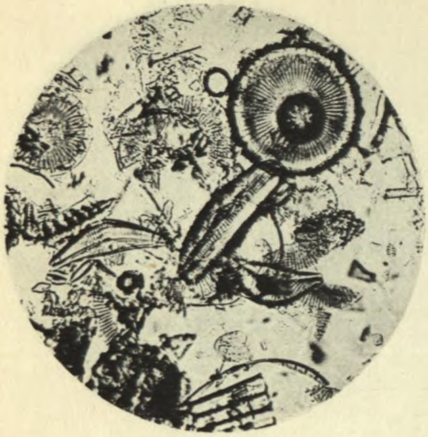
PLATE XIV

A.	Atomite Company, mixed filter product, Terrebonne, Oregon, U.S.	X 285
B.	Great Western Silica Company, Kittitas, Wash., U.S.	X 285
C.	Tri-O-Lite Company, Carlin, Nevada, U.S.	X 285
D.	Clermont, Lake county, Florida, U.S.	X 285
E.	Stepney, Conn., U.S.	X 285
F.	Long pond, St. John's, Newfoundland	X 285

Plate No. XIV



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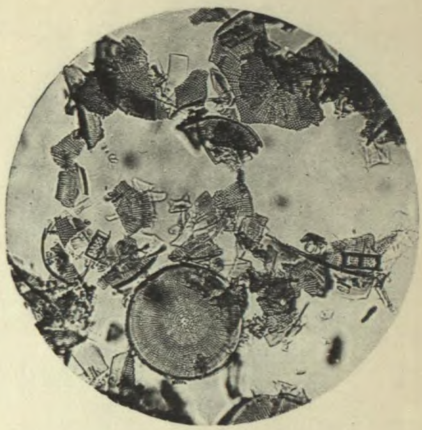

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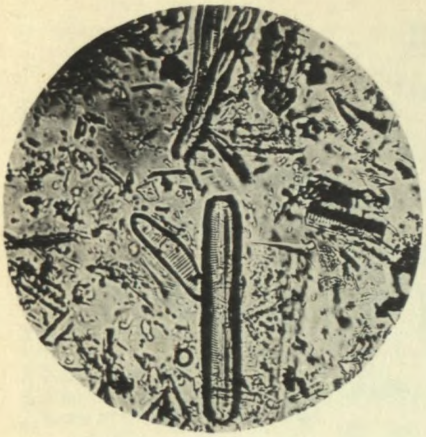
PLATE XV

A.	Digby neck, N.S., product used in concrete test at Ottawa	X 285
B.	Quesnel, B.C.; lot 906, 20–25 feet down, product used in concrete test at Ottawa	X 285
C.	Celite Company, Lompoc, Cal., U.S., standard concrete product used in test at Ottawa	X 285
D.	Diatom girdles, Muskoka, Ont	X 285
E.	Sponge spicules, lake Michel, Chertsey township, Que	X 285
F.	Cleaned diatoms, lake Castor, St. Marguerite, Terrebonne county, Que	X 170



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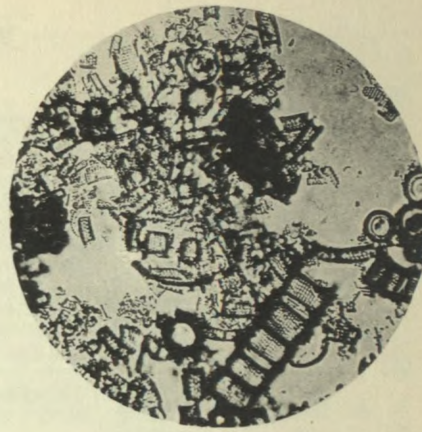

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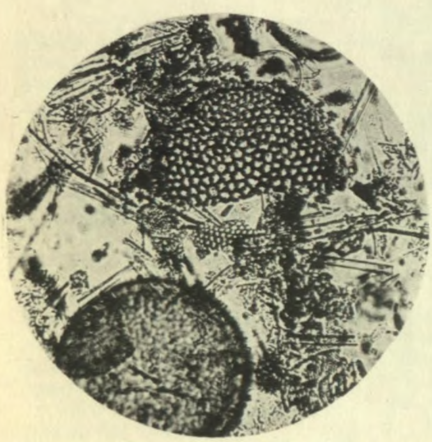

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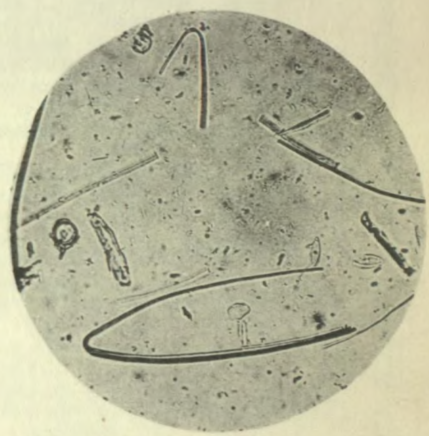

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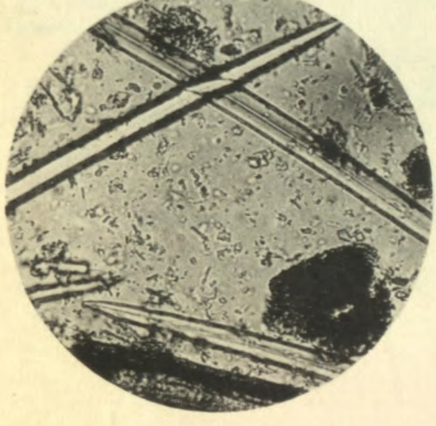

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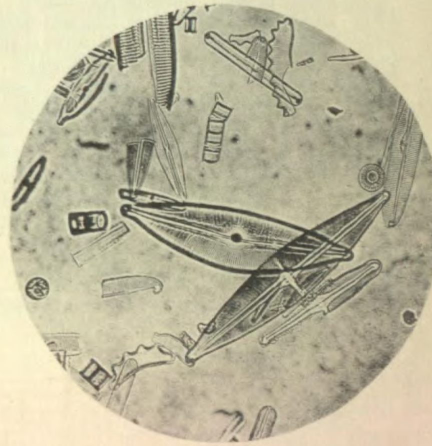

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Canada

DEPARTMENT OF MINES

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

MINES BRANCH

JOHN McLEISH, DIRECTOR

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