Title: Asbestos, Its production and use

Author: Robert H. Jones

Release Date: January 30, 2011 [EBook #35121]

Language: English

Credits: Produced by Barbara Kosker and the Online Distributed Proofreading Team at https://www.pgdp.net (This file was produced from images generously made available by The Internet Archive)

ASBESTOS

ITS PRODUCTION AND USE

WITH

SOME ACCOUNT OF THE ASBESTOS MINES OF CANADA

By ROBERT H. JONES

LONDON:

CROSBY LOCKWOOD AND SON
7, STATIONERS' HALL COURT, LUDGATE HILL
1888

PREFACE.

The substance of the following pages was originally comprised in a series of Letters from Canada to a friend in London, who was desirous of obtaining all the authentic information possible on a subject on which so little appears to be generally known.

The use of Asbestos in the arts and manufactures is now rapidly assuming such large proportions that, it is believed, it will presently be found more difficult to say to what purposes it cannot be applied than to what it can and is.

Under these circumstances, although much of the information here given is not new, but has been gathered from every available source, it is hoped that the compilation in its present shape may be found acceptable.

R. H. J.

HOTEL VICTORIA,
NORTHUMBERLAND AVENUE,
LONDON.
April 20, 1888.

CONTENTS.

	PAGE
INTRODUCTORY	5-8
ASBESTOS AT THE AMERICAN EXHIBITION	9, 10
WHERE FOUND	12-15
ITALIAN AND CANADIAN ASBESTOS COMPARED	16-18
WHERE USED	18
THE ASBESTOS OF ITALY	19-24
MINING FOR ASBESTOS	24-29
ASBESTOS MINES OF CANADA—	
THE THETFORD GROUP	29-36
THE COLERAINE GROUP	36-42
BROUGHTON	42-46
DANVILLE	46
SOUTH HAM	47-50
WOLFESTOWN	50
USES TO WHICH ASBESTOS IS APPLIED	55-72
INDEX	75, 76

[Pg 5]

ASBESTOS.

One of Nature's most marvellous productions, asbestos is a physical paradox. It has been called a mineralogical vegetable; it is both fibrous and crystalline, elastic yet brittle; a floating stone,

which can be as readily carded, spun, and woven into tissue as cotton or the finest silk.

Called by geologists "asbestus" (the termination in os being the adjective form of the word), the name of the mineral in its Greek form as commonly used (ἄσβεστος), signifies "indestructible." The French adopt the same derivation, calling it "asbeste" (minèral filamenteux et incombustible). In Germany it is called "steinflachs" (stone-flax); and by the Italians "amianto" (from ἀμίαντος, pure, incorruptible); so-called because cloth made from it was cleansed by passing it through fire. Charlemagne, we are told, having a cloth made of this material in his possession, one day after dinner astonished his rude warrior guests by throwing it in the fire, and then withdrawing it cleansed and unconsumed.

As a modern pendent to this well-known legend, the following is current in Quebec. A labouring man, who had left the old country to seek a better fortune in the Dominion, found employment at once on arrival in one of the many lumber yards on the St. Lawrence, where his energy and activity, supplemented by great bodily strength, soon secured for him a good position. It so [Pg 6] happened, however, that one evening, on returning from their daily toil to their common apartment, some of his fellow-workmen saw him deliberately throw himself into a seat, kick off his boots, and then pull off his socks, and having opened the door of the stove, coolly fling them in on to the mass of burning wood. Possibly no particular notice would have been taken of this, judged as a mere act of folly and waste on the part of the new-comer; but when, almost immediately afterwards, they saw him open the stove door again, take out the apparently blazing socks, and, after giving them a shake, proceed just as deliberately to draw them on to his feet again, that was a trifle too much! Human nature could not stand that. Consequently the horrified spectators, having for a moment looked on aghast, fled precipitately from the room. To them the facts were clear enough. This, they said, was no human being like themselves; such hellish practices could have but one origin. If not the devil himself, this man certainly could be no other than one of his emissaries. So off they went in a body to the manager and demanded his instant dismissal, loudly asseverating that they would no longer eat, drink, or work in company with such a monster. Enquiry being at once set on foot, it turned out that some time before leaving England the man had worked at an asbestos factory, where he had learned to appreciate the valuable properties of this mineral; and being of an ingenious turn of mind, he had managed to procure some of the fiberized material and therewith knit himself a pair of socks, which he was accustomed to cleanse in the manner described. He was, as has been said, an unusually good workman, consequently his employers had no wish to part with him. Explanation and expostulation, however, were all in vain; nothing could remove the horrible impression that his [Pg 7] conduct had made upon the minds of his superstitious fellow-workmen; go he must and did, nor could the tumult be in any way allayed until he had been dismissed from his work and had left the yard.

Leaving this digression, however, it may be said that the peculiar properties of the mineral were known long before Charlemagne's time. The ancients, who believed it to be a plant, made a cere-cloth of it, in which they were accustomed to enwrap the bodies which were to be burned on the funeral pyre, so that the ashes might be retained, separate and intact, for preservation in the family urn, an aperture being left in the cloth to allow a free passage for the flames. How they succeeded in weaving this cloth is now unknown. It has been suggested that its accomplishment was effected by weaving the fibres along with those of flax, and then passing the whole through a furnace to burn out the flax.

The lamps used by the vestal virgins are also said to have been furnished with asbestos wicks, so that the modern adaptation of it to this purpose is only another exemplification of the truth of Solomon's saying that "there is nothing new under the sun."

The mineral has been variously described. In general terms it may be said to be a fibrous variety of serpentine, closely allied to the hornblende family of minerals, the Canadian variety of which is called by mineralogists "chrysotile." In the local vernacular of the mining districts this is "pierre-à-coton" (cotton-stone), perhaps as expressive a term as can be found.

The ore takes a variety of forms; much of it (especially that found in the States) is of a coarse woody character, of but little value for mercantile purposes.

Sir William Logan, in his "Geology of Canada," says that foliated and fibrous varieties of [Pg 8] serpentine are common in veins of the ophiolites of the Silurian series, constituting the varieties which have been described under the various names of baltimorite, marmolite, picrolite, and chrysotile. The true asbestos, however, he says, is a fibrous variety of tremolite or hornblende.

In *Le Génie Civil* for September, 1883, Canadian asbestos is thus described: "La chrysotile du Canada n'est pas comme l'amiante ordinaire formée d'un paquet de fils d'un blanc verdâtre et remplissant des cavités irrégulières: c'est une véritable pierre d'une densité comprise entre 2 et 3, qui se trouve en couches de 3 à 10 centimètres d'épaisseur. Cette pierre possède la propriété de se reduire en fibres perpendiculairement à sa longueur sous un effort très faible. Ses fibres transversales sont plus résistantes et beaucoup plus facile à filer, à tisser, et à feutrer que l'amiante ordinaire." This is as good a description of chrysotile as can be found anywhere.

Until the discovery of the Canadian mines, the variety here spoken of as amiante (amianthus), was esteemed the most rare and delicate kind, on account of its beautifully white, flexible, long, and delicately laid fibres. This variety is generally found buried in the centre of the older crystalline rocks in the Pyrenees, the Alps of Dauphiny, on Mount St. Gothard, in North America, in the serpentines of Sweden, the Ural Mountains, Silesia, and New South Wales. The most beautiful specimens, such as are preserved in museums and mineralogical collections, have mostly been brought from Tarantaise in Savoy, or from Corsica.[1] In this latter place it is said to

be so abundant that, its mercantile value being unknown, it has often been used, instead of tow, as a material for packing.

In a handbook published by the Dominion Government in 1882 (before the discovery of the mines of chrysotile) on the mineral resources of Canada, it is said that— [Pg 9]

"What is commercially known as asbestos is really a term used to denote a peculiar fibrous form assumed by several distinct minerals, rather than to designate any particular species. Tremolite, actinolite, and other forms of hornblende and serpentine, passing into fibrous varieties, assume the name of asbestos, and the 'Geology of Canada' does not give the mineral as a distinct one, but recognizes it under these different headings. As yet comparatively little asbestos has been found in Canada."

This is sufficient to show how small was the interest, even so recently as that, attaching to this substance in the very country which was so soon to find it taking important rank amongst her natural productions.

That singularly beautiful mineral termed "crocidolite," which displays such sheens and radiances of gold and bronze and green as give it the appearance of satin changed into stone, is nothing more than compressed asbestos. The derivation of its name is not happy. It is said to be from κροκος λιθος, simply crocus-coloured or yellow stone. This is doubtless its general colour, but the finest crocidolite is anything but yellow.

Having heard that there were some fine specimens of asbestos on view at the recent exhibition of the United States products at Earl's Court, I made a journey there specially to see them. In this, however, I was disappointed. There was but one small tray of so-called asbestos (amphibole) on view; and this was of a coarse woody character, very similar in appearance to a sample I had had sent to me recently from California. It was, moreover, of a very poor colour and certainly not of the kind that would readily find a market. I found there, however, a piece of unmistakable [Pg 10] chrysotile, grouped amongst a miscellaneous lot of American minerals. The exhibitor at once told me, in reply to my questions, that this was not an American product at all, but that it was a "vegetable matter" found in Canada. He evidently did not know much about it, and said it was not asbestos at all. It was not by any means a fine specimen: it had somewhat the appearance of ordinary Thetford No. 1, though differing slightly in colour. I could get no further information about it, except that it had come from near Ottawa.

At this exhibition I found a splendid display of crocidolite, the sight of which well repaid the visit. I secured a good specimen, but found, on enquiry, that like all the superior qualities of this mineral, it had been brought from Griqualand (South Africa). The sample I secured was of the kind that in the States is called "Tiger-eye," as I presume, from its general tawny-coloured streaky brilliancy. The exhibitor said it was a silicate of iron occurring in asbestos-like fibres. It is of an exceedingly hard, densely compact nature; from its hardness difficult to work, but susceptible of a very high polish. A few years ago it was thought to be a precious stone and accordingly commanded a high price, but recent discoveries of large deposits considerably reduced its value. It is used for a variety of ornamental purposes, for which, from its extreme natural beauty, it is peculiarly adapted. The grain is very fine and in its rough state the fibres are singularly distinct.

There is another very singular substance worth alluding to here, which is often put forward as a substitute for asbestos, and which is said by the manufacturers to be fireproof, frost-proof, vermin-proof, sound-proof, indestructible, and odourless. This is a good deal to say, but is in a great measure true. It is largely used in the United Slates, especially for insulating and other [Pg 11] purposes of a like kind. I mean the artificially manufactured material called "Mineral or Slag Wool," which is made from the refuse of the furnaces at ironworks, by, it is said, passing jets of steam through molten slag. This material is manufactured on a somewhat extensive scale by the Western Mineral Wool Company, of Cleveland, Ohio. There is no doubt it is a very useful substance for many of the purposes for which it is recommended, but it can scarcely be expected to compete to any material extent with asbestos from its total want of elasticity and lubricity. Even the finest quality on being crushed between the fingers has a harsh, gritty, metallic feeling, very different from the silky, springy, and greasy feel of the natural fibre.

In connection with this manufactured article, a very curious natural production is called to mind, the origin of which is somewhat similar though brought about by natural causes. I refer to the product of the lava-beds of Hawaii, called by the natives "Pélé's hair." Miss C. F. Gordon Cumming, in her "Fire Fountains of Hawaii," speaks of this as "filaments of stringy brown lava, like spun glass, which lie scattered here and there, having been caught by the wind (when thrown up) in mid-air in a state of perfect fusion, forming fine lava drops, a rain of liquid rock, and so drawn out in silky threads like fine silky hair."

"In fact, this filmy, finely spun glass is known as Pélé's hair—Rauoho o Pélé. It is of a rich olive green or yellowish brown colour—a hint for æsthetic fashions—and is glossy, like the byssus of certain shells, but very brittle to handle. Sometimes when the great fire-fountains toss their spray so high that it flies above the level of the cliffs, the breeze catches it sportively and carries it far away over the island; and the birds line their nests with this silky volcanic hair. Sometimes you can collect handfuls clinging to the rocks to which it has drifted, generally with a pear-shaped [Pg 12] drop attached to it." This, it is evident, would crumble and break off short in the fingers, and the mineral wool when handled has just the same gritty brittle feeling one can imagine Pélé's hair to have.

Returning to asbestos, however, its formation or actual origin is at present unknown. In its

pure state it is as heavy as the rock in which it is found, so closely are its fine elastic crystalline fibres compressed together. These have a beautiful silky lustre, varying in colour from pure white to a dusky grey or green, sometimes of a yellowish green; the direction of the fibres being transverse to the walls of the vein. The essential point in which it differs from any other known mineral consists in its being at once fibrous and textile. Its quality is determined by the greater or less proportion of silicious or gritty matter with which its fibres are associated. When crushed out from the rock, these fibres, which vie in delicacy with the finest flax or the most beautiful silk, can be corded, spun, and woven into cloth in precisely the same way as any other textile fibre.

Of good quality it is only found in serpentine. One instance of its having been found in quartz is mentioned; but, even in that case we are told, when six feet of the superficial quartz rock had been blasted away, the inevitable serpentine was found cropping through.

According to Mr. Ells,[2] the serpentines in which it is found are intimately associated with masses of dioritic or doloritic rocks, of which rocks certain varieties, rich in olivine or some allied mineral, the serpentine is, in many cases, an alteration product. They are frequently associated with masses and dykes of whitish rocks, which are often composed entirely of quartz and felspar, but occasionally with a mixture of black mica, forming a granitoid rock. They occur generally not [Pg 13] far from the axes of certain anticlinals which exist in the group of rocks called by Sir William Logan the "altered Quebec group."

For centuries asbestos was regarded merely as a mineral curiosity. Indeed, it is only within the last few years that it has developed into a valuable article of commerce, the first modern experiments in the use of it practically extending no farther back than 1850.

Its uses in the arts and manufactures are of a very important character, and now that it is clearly demonstrated that a fairly abundant supply can be obtained at a moderate cost, there seems no reasonable limit to be put to the demand, new uses for it being continually found. These will, of course, rapidly increase as its value becomes more clearly and widely known.

It is found in most parts of the world, but in only a few places of a sufficiently valuable kind or in quantities large enough to give it any commercial value. The main sources of supply at present are Canada and Italy.

A good deal has, at times, been found in Russia; and I remember an incident which occurred a few years ago at some extensive ironworks in that country, with which I was at the time connected, which amusingly illustrates how little was then known there of the nature and properties of the mineral. The iron ore, in the district referred to, is found in bunches or nodules, near the surface of the ground; and in order to get it, the peasants dig out pits about seven or eight feet in depth, and then burrow, rabbit-like, into the surrounding earth in all directions below. When all the ore is got out from one spot, they dig another pit further afield, and so they go on until the particular patch of ground they are working on is exhausted. On the occasion referred to, some of our men, in their burrowing, threw out a considerable quantity of asbestos. [Pg 14] They had not the slightest idea what it was. In fact, they knew nothing at all about it, except that it was not what they were in search of; and, consequently, as it obstructed their work, they threw it all out in a heap near the piles of ore. Presently, one of the foremen or overlookers saw it, and wanted to know what all that rubbish had been put there for. "Here," said he, to some of the men, "just clear up all that mess at once, and fling it into the furnace, and get rid of it." And this was immediately done, with what result you may imagine.

Recently, however, it is said that enormous quantities of asbestos have been found in Russia, although I cannot learn that any use is made of it there at present. Its mercantile value must of course depend on its quality and distance from market. I have had a great number of specimens sent me, but they mostly turn out to be a coarse kind of so-called bastard asbestos, which would not pay for extracting. Now, however, we are told that from Orenburg to Ekaterinburg the country is thickly dotted with asbestos deposits, while near the Verkin Tagil ironworks there is a hill called Sholkovaya Gora, or Hill of Silk, which it is asserted is entirely composed of asbestos. The ore here is also said to be of the best white quality, well adapted for all the most important purposes to which asbestos is applied. I should much like to see a specimen of this; its value could be easily determined on inspection. In the Gorobtagsdat district of Perm, again, there are said to be large deposits cropping out above the surface, and also that enormous quantities could be had there for nothing, as at this moment it possesses no value in the Ural region. I imagine it would be found of considerable value if a practical man were sent out to see to its fiberization on the spot, when it might be compressed, packed, and exported in the same way as cotton. There [Pg 15] can, however, be little doubt that if its quality is as good as it is represented to be, it will very soon be utilized, and will then form a very important addition to the vast mineral wealth of that region.

As might be expected, asbestos is also found in China, but, as a matter of course, the use to which it is put there is one we should little dream of here. For instance, in the translation of a Chinese medical book by Dr. Hobson, of the London Medical Mission, asbestos is seen to figure (of all places in the world) under the head of *tonics*, in company with such heterogeneous substances as "dried spotted lizard, silkworm moth, human milk, parasite of the mulberry tree, asses' glue, stalactite," and a few more surprising things. Perhaps it may be just as well for us that we are not yet educated up to so fine a point as that, and that consequently the mineral we are speaking of does not yet find a place in the British Pharmacopœia, but is left to exhibit its apparently more natural properties in the arts and manufactures.

A correspondent of *The Financial News*, writing from Barberton in January, 1888, says that at

Komali Fields, fifty miles from that place, asbestos has just been found, but that it was as yet too soon to discuss the merits of the find.

In sending you an account of the Canadian asbestos industry, you will scarcely expect me to give you any very detailed information about its Italian competitor. Any account of the one, however, would necessarily be so incomplete without some mention of the other, that I will do the best I can with the little information I have been enabled to obtain on the subject of the Italian mines.

Experiments with the view of utilizing asbestos in Italy appear to have been first successfully carried on in 1850 by the Chevalier Aldini, of Milan, and others, mainly with the object of turning the mineral to account in the manufacture of asbestos cloth. The Chevalier had a complete suit [Pg 16] made of it—cap, gloves, tunic, and stockings—for the purpose of testing its protective powers for firemen; and of this I shall have something to say presently.[3] But it was not until twenty years after this that any success was attained in the manufacture of asbestos millboard and paper, the commercial value of which is now assuming such large proportions.

About the same time the manufacture of asbestos into packings for piston glands was successfully accomplished in America; and some two years afterwards a company, calling itself "The Patent Asbestos Manufacturing Company, Limited," was formed in Glasgow for the purpose of making piston packings according to this American invention. In 1880 this Glasgow Company united its business with that of Messrs. Furse Brothers and Co., of Rome, asbestos manufacturers, as well as with that of the Italo-English Pure Asbestos Company, and, when the amalgamation was complete, the new Company, taking the name of "The United Asbestos Company, Limited," became possessed of nearly the whole of the known Italian mines, and, consequently, of a practical monopoly of the trade in asbestos from that country.

Italian differs very materially from Canadian asbestos, not only in appearance, but in formation also, as well as in the mode of extraction. The two are, in fact, entirely separate and distinct kinds of the same mineral; notwithstanding which their intrinsic qualities are practically the same, and the uses to which they are put are almost identical.

An extraordinary specimen of Italian asbestos, obtained from one of the mines of the United Asbestos Company, situate in the Valtellina Valley, is in the possession of that company, and is no doubt the finest piece of asbestos ever brought from Italy, whether as regards strength or fineness of fibre. Any one interested in the matter would, I have no doubt, be readily permitted to [Pg 17] inspect this natural curiosity, on application to Mr. Boyd, the courteous manager of the company, in Queen Victoria Street.

Just about this time (1880) Canadian asbestos, also, was being much talked about and sought after; and it is therefore perhaps scarcely to be wondered at that the company which first began to work the mineral in Italy on a large scale, and which, at great expense and trouble, had managed to secure the whole of the Italian mines, and so become possessed, as they supposed, of a monopoly of the trade, should have viewed with jealousy the rapid progress made in public estimation by the Canadian ore when once it was introduced to the market.

It is not my purpose, however, to enter on the vexed question of the relative merits of the two varieties, which would be altogether out of place in a letter of this kind. But I think we may safely conclude that both possess undeniably good qualities, and that there is an ample field for both, inasmuch as the peculiar properties which render one kind unsuitable for some particular purpose are often precisely those which best adapt it for another. Each variety will assuredly make its own way and take its proper place in public estimation as further experiments and greater experience in the use of it shall bring its special value more prominently to light.

Ample proof has been given of the valuable qualities of Italian asbestos; and if any proof were needed of the intrinsic value of its Canadian competitor, nothing more would be required than to point to such houses as that of John Bell & Son, of London; of Wertheim, of Frankfort; or to the Johns Manufacturing Company, or the Chalmers-Spence Company, of New York, whose world- [Pg 18] renowned manufactures are made of Canadian asbestos alone.

The essential characteristics of both sorts are alike in this respect, that they are absolutely indestructible by fire, or even when exposed to the action of any known acid; the Canadian variety possessing in addition, in a very high degree, that strange peculiarity (which is also claimed for one of the Italian sorts), and is common also to plumbago and soapstone, of being a self-lubricator. Good Canadian fibre is known at once by its soft, greasy, soapy feeling; and one of the leading New York firms claims for its products, made entirely of Canadian asbestos, that they will resist even the flame of the blowpipe; and further asserts that this mineral transcends all previously thought-of materials for fireproofing, in that it is not only absolutely indestructible by fire, but that its power of resistance cannot be worn away or diminished by lapse of time or hard usage, as invariably happens in the case of such applications as tungstate of soda.

Regarding its use, Germany is a very large consumer. In France the consumption is not so great, although manufacturers in that country are now beginning to bestir themselves, especially in regard to some very valuable kinds of paper, which they are making entirely out of Canadian fibre; and Paris has now set the world an example by the adoption of the Chevalier Aldini's plan of clothing firemen in a dress of asbestos cloth.

America, however, is the country where the most rapid strides are being made in the development of every branch of this new industry, and there also the Canadian fibre alone is used.

A considerable quantity of it is made use of in England, in the manufacture of some valuable

kinds of packing for engineering work, millboards, felts, lubricants, paint, and the like; but in England we lack in some degree the readiness which is found on the other side of the ocean, in the adaptation of new materials and new methods of work. [Pg 19]

Whether it be that Englishmen are influenced by climatic or other causes, certain it is that they are slow to adopt new systems, to cultivate novel ideas, or to move out of old grooves. Consequently, when new materials, or even novel applications of those long used, are suggested, they ponder over them, hesitate, and weigh the chances, and in so doing not infrequently let slip valuable opportunities; whilst the keener and more enterprising American, once he sees the drift of the new matter, will, to use his own expression, "catch hold" at once. It by no means follows, however, that this is the fault of the manufacturers alone; they have naturally to gauge the requirements of their customers, and prefer to limit their make to what they know they can sell.

The finer kinds of asbestos, the strong fibres of which are of a pure white colour and of a fine silky texture, being at the same time free from silicic acid or metallic oxide, are comparatively rare; and, on account of their lubricating qualities, are especially valuable. This particular kind, I am told, is at the present time only to be found in Canada and some parts of the States. Whether this statement is correct or not, I am not in a position to say; but that it is found in Canada I know, for I have there personally witnessed the blasting out of many hundreds of tons. In the Dominion it is invariably obtained from hard rock somewhat difficult to work.

In an interesting paper on Italian asbestos, to be found in the "Journal of the Society of Arts" for April, 1886, to which I have been indebted for a good deal of information respecting the Italian mines, I find a very singular statement given as the result of long observation by the *employés* of the United Company in Italy. It is there said that "if asbestos be found on the surface of a rock exposed either to the south or south-west, the product is generally fairly abundant and of good quality. If exposed to the east there is fine quality, but very small quantity; whilst if exposed to the north the quantity is plentiful but dry and hard, and on entering the rock all traces of it are lost." [Pg 20]

Whether this be at all consistent with Canadian experience I cannot say. The lie of the ground and the course of the veins being so different, it is quite possible the theory may have no applicability at all to Canadian mining. But it is certainly suggestive and interesting, and I will cause inquiry in this direction to be set on foot at once.

In the same paper I find the following given as analyses of the two varieties. The first is stated to be by Professor Barff, but by whom the latter was made does not appear. According to these there would be little doubt which was the most valuable for general manufacturing purposes, but as there is nothing to show what kind of Canadian ore was submitted for analysis, or by whom the analysis was made, you must take it as an analysis only, *quantum valeat*.

	ITALIAN.	CANADIAN.
Lime and magnesia	37·84	33·20
Silica	41·69	40·90
Oxide of iron	3·01	5·75
Potash	·85	traces
Soda	1·41	·68
Alumina	2·57	6·60
Moisture evaporated at 100° C.	3·04	—
Loss on heating to white heat, water of hydration, and organic matter	9·56	12·50
Chlorine	—	·25
Loss	·03	·12
	100	100

[Pg 21]

Three distinct kinds of asbestos are said to be found in Italy, viz., Grey, Flossy, and Powdery. The grey is a long, fibrous variety, possessing, in addition to strength, the much-prized saponaceous quality; and this is mostly found in the two Alpine valleys of Valtellina and d'Aosta. The flossy, which has a smooth, silky appearance, but a dry feeling when touched, is found and worked in part of the chain of mountains which bound the valley leading from Susa to Turin, and at an elevation of about 8,000 feet above the sea level. This is the kind which is mostly used in the manufacture of gas stoves. It is commonly found in thicker seams than the grey, lying mostly in a horizontal direction, but dipping rapidly as the rock is entered. The third is a powdery kind, which, while possessing all the heat-resisting properties of the two others, crumbles in the hand when touched. This variety is found in the same range of mountains as that last mentioned, but at a much lower level; it appears to have been first brought to light by a landslip exposing to view a seam of it three feet wide. When first seen it is said to have had a pasty consistency, but on exposure to the air it dried and crumbled into powder.

Italian ore, generally speaking, is won by running driftways, or tunnelling into the face of the rock. In Canada the mineral is got out by open quarrywork, no tunnelling there being possible. The serpentine rock in which the asbestos or chrysotile is there found is so split and seamed in every conceivable direction by the veins and stringers that if tunnelling were attempted the first blast would inevitably bring the whole superincumbent mass down about your ears. You might as well attempt to tunnel through loose sand or gravel. In other words, the relative difference in the two modes of winning the ore appears to be that the Italian asbestos may be said to be won by tunnelling into the face of the rock; whilst the Canadian chrysotile is found in veins, running, it is [Pg 22]

true, with the greatest irregularity, but yet with a distinctly perpendicular declension. The Italian variety, again, seems frequently to be found, or the seams to end, in pockets, some of which have been known to contain a ton or a ton and a half of asbestos, after exhaustion of which all appearance of its presence ceased. The Canadian ore, on the other hand, generally runs in veins and seams, which almost invariably improve both in quantity and quality the lower you go down, but where or how it ends has never yet been discovered.

It may possibly be, however, that the more correct way to put this would be the very opposite of what I have just stated; because if you stand and face the rock when laid bare in any of the Canadian mines and trace the downward course and increasing strength of the veins, it would really seem as if this strange mineral substance, at some former time, when in a state of violent ebullition, had striven energetically to force an outlet into the upper air, splitting the overlying rock in all directions in its passage upward from below; and that, as it gradually cooled off and expended its force, the rifts in the rock, which now form the veins, became narrower and narrower, until, when the surface of the ground was at last reached it had only just sufficient energy left to bubble over through the cracks, where it then cooled off and hardened into thin lava-like ridges. These ridges are to be seen in all directions in the asbestos districts of Canada, [Pg 23] wherever the peculiar yellowish-looking stone forming the upper crust of the asbestos-bearing rocks is found. And notwithstanding the plainly visible evidence that these rocks, from centuries of exposure to the elements, have been worn away on the upper surface until they have assumed a rounded, water-washed, boulder-like shape, the narrow ridges spoken of have apparently always remained in the same state, alike indestructible and undisturbed.

If you will imagine to yourself the mountain masses of almost perpendicular rock, which contain the horizontally-lying seams frequently found in Italy, to be thrown backward and downward so as to lie face uppermost, and so that you could walk on the face, you will get a rough idea of the lie of the veins in the Canadian serpentine. And possibly on further exploration the analogy would be still further borne out by these veins being found to terminate in reservoirs or pockets, just as it has been said is usually found to be the case in Italy. No one has yet gone far enough down to test the depth of the veins in any Canadian mine. It will no doubt presently be done. All that would be required would be to bore until the next series was reached. The experiment, if expensive, would be both valuable and instructive, especially bearing in mind the well-known fact in Canadian mining that the deeper you follow the veins into the ground the better the quality of the cotton becomes.

There is one more point of distinction between the two kinds, and that is in the surface indications, which may possibly be due to atmospheric influences. In Italian exploration the prospector is not guided by any hard lines or ridges on the rock surface of the ground, as in Canada. On the contrary, he finds cracks in the perpendicular face of the rock filled with a white powdery substance which, when the surface is broken away, is said to assume a leathery [Pg 24] appearance, after which, when further entry is made, the true asbestos is found.

Thus, it will be seen that there is not only a considerable difference between the two sorts of asbestos which supply the demands of the market, but that the mode of winning it is also different; as are, moreover, the natural indications which guide the explorer in his search after the mineral.

FOOTNOTES:

[1] "Encyl. Brit." Art. "Asbestos."

[2] A member of the Geological Survey Department, Ottawa.

[3] See *post*, p. 66.

CANADIAN MINING FOR ASBESTOS.

And now I will leave the subject of the Italian mines altogether, and proceed to give some account of the asbestos mining industry as carried on in Canada; mainly the result of my notes and observations during a residence at the mines.

The main sources from which the supply of asbestos in the Dominion is derived lie in the province of Quebec, in the counties of Megantic and Beauce. The serpentine rock in which it is found crops up at intervals all along the belt of what has been previously alluded to as the "altered Quebec group"[4] (pre-Cambrian), throughout a range of over 120 miles in length, occasionally attaining a width of more than 2,500 feet, mostly bearing from north-east to south-west, and crossing the Coleraine District nearly east and west. It extends almost uninterruptedly [Pg 25] from the boundary of Vermont, in the State of Maine, running north-eastward, to some distance

from the Chaudière River, a little beyond the latitude of Quebec.

Large tracts of serpentine, probably containing the mineral in paying quantities, occur at Belmina in Wolfe County, and in the vicinity of Brompton Lake; but although the work of exploration has been carried on in several places with fair prospects of success, the profitable working of the mineral up to the present time has been mostly confined to Broughton, Thetford, Coleraine, and Danville.

In the Shickshock mountain region of New Brunswick, said to be a detached area of the pre-Cambrian formation, which constitutes the chief mineral belt of the Eastern Townships (within which the last-mentioned districts are comprised), serpentine and chromic iron are the only two minerals which have as yet been recognised. Looking, however, to the fact that these two minerals everywhere accompany the deposits of chrysotile, as well as the ores of copper, lead, and antimony, with occasionally richer deposits of gold and silver, in the region to the south-west, it would scarcely seem unreasonable to anticipate discoveries of asbestos in the as yet unexplored region of the Gaspé peninsula. The range here extends through the northern portion of the peninsula in rear of Saint-Anne des Monts, and further east on the lower part of the Dartmouth River.[5]

Indications of asbestos are found at most points throughout the whole serpentine formation. The developments, so far as is yet known, are principally, as we have said, in the districts around Thetford and Coleraine. There can, however, be no valid reason why chrysotile of the richer sorts and in paying quantities should not be found at other points, it being only reasonable to suppose [Pg 26] that future exploration will materially extend the area over which profitable mining operations can be carried on.

In the Blue Book on the "Geological Survey of Canada, 1882" (Mr. Willimott's report), published by the Dominion Government, it is stated that "there appears to be unlimited quantities of asbestos distributed throughout the entire serpentine belt which attains its greatest prominence in the townships of Thetford and Coleraine. Its existence is generally made apparent by a whitish shining substance found coating the serpentine, arising from the decay of the outcropping veins. But this," he says, "must not be taken as always indicating the presence of workable veins."

The character of the rock varies considerably, and in some places it is even now apparently in the transition stage between the original rock from which it is derived and a true serpentine, having still almost the hardness of felspar, while it yet retains the general aspect and colour of the serpentine in which it is found. Large masses of dioritic rock, having the aspect of dykes, are found in most of the quarries, possibly representing portions of the original rock not yet altered to serpentine.[6]

It may be taken as a general rule that wherever the true serpentine occurs asbestos will be found, though it is difficult to say how the veins have been formed, or how the fact of their existence is to be known with any degree of certainty, except by the light superficial indication already mentioned, which seems at present to be the only, but by no means infallible, guide. The asbestos traverses the serpentine in irregular veins ranging from mere threads or stringers to a thickness of three or four, and in some cases it is asserted of as much as six inches; the fibre always, unless affected by the dislocation of the containing rock, lying at right angles to the sides [Pg 27] of the fissure.

The rock is often impure, the impurity arising mostly from the admixture of particles, occasionally of small irregular thread-like veins, of magnetite or of chromic iron, which break the continuity of the fibre and cause very careful cobbing of the ore to be necessary in order to get rid of these impurities. This is particularly the case at Thetford, as we shall see when speaking of Messrs. King's mine there.[7]

In other districts the fibre is discoloured (and the value of it consequently much reduced) by the infiltration of water impregnated with the oxide of iron. This is especially the case in the Black Lake district, more particularly on the property of the Anglo-Canadian Company, where the serpentine is a good deal shattered by the action of the weather, or possibly from other causes. This discoloration ceases as a general rule, or at any rate becomes considerably diminished in intensity, in proportion as the containing rock becomes more solid. It is, however, a most serious matter as affecting the character and pecuniary value of these mines.

In the case of nearly all the mines there are large quantities of so-called bastard asbestos found in and about them. This is a woody, brittle variety of apparently as yet unformed mineral, for which at present no use seems to have been found; but, judging from the course new applications of the mineral are now taking, there can be little doubt that this inferior article will presently command its price in the market, a use being found for it in some of the many purposes for which coarse pulverized asbestos is found to be applicable.

Many other very singular types are also to be seen. Some of the pieces as they lie on the ground, after blasting, have so much the appearance of a wood-cutter's choppings (being, in fact, [Pg 28] in the coarse and peculiar grain of the fibre, so like chips of wood), that, if placed side by side with actual chippings from rough timber exposed to the weather in the woods, the one could in no way be distinguished from the other, except of course by handling, when the weight and stony feeling of the asbestos would make the difference at once perceptible.

Chrome iron is frequently found, sometimes as at Thetford and South Ham, in very large quantities in close proximity to the asbestos-bearing rock. In the iron, where this is the case, although the stringers of asbestos may be very minute, they will almost certainly be found intersecting the ore, just as we have already seen that the grains and threads of the chrome iron

often cut and spoil the fibre of the asbestos.

The marketable value of asbestos is determined in the first instance by the colour, coupled with the thickness or width of the fibre in the vein. The colour, it may be said, largely depends upon the locality of the mine, and will be distinguished at once on inspection of the rocky gangue. At Thetford it is of a greenish hue, being there found in the darker coloured serpentine; whilst at Broughton the ore is of a pearly yellowish green, the surrounding rock being mostly of a grey or pale green colour. This difference of colour in the ore, however, in no way affects the value of the mineral, as when crushed out the fibre is mostly of a uniform whiteness.

There are other distinguishing characteristics in the ore even of closely adjacent mines, of so marked a nature that an expert has no difficulty in determining the locality of the mine, or even of the mine itself, from the appearance of the ore.

Although scarcely within the scope of the present remarks, it is worthy of note that serpentines [Pg 29] of an ornamental character are very abundant in Canada; some very beautiful specimens of which were recently shown in London, at the late Colonial and Indian Exhibition at South Kensington. Many of these contain small quantities of chromium and nickel, and are associated with soapstone, potstone, dolomite, and magnetite. A band of limestone also occurs at Templeton containing masses of a light-coloured translucent serpentine. These, however, beautiful as they are, do not at this moment specially concern us, as none of them contain asbestos in workable quantities, the stone being entirely of an ornamental character. They are exploited with some success by the Canadian Granite Company of Ottawa, and are used by them for monuments, mantelpieces, vases, and such like. One would certainly think that their importation into England would meet with success, seeing that there is always a demand here for fine marbles and stones for architectural and other purposes.

Sir William Logan says: "Les serpentines, dans toute l'étendue de leur gisement, fournissent de très-beaux marbres vert-de-mer souvent ressemblant au vert antique."

THE THETFORD GROUP OF MINES.

Although the existence of asbestos in Canada, in one at least of the above-mentioned localities, was known to geologists for many years prior to 1877, it was not until the autumn of that year that a mine was discovered which proved to be of any commercial importance. This was first [Pg 30] found by a farmer, named Fecteau, in the township of Thetford; and, true to its reputation, Thetford has continued to be the head-quarters and main source of the supply ever since.

This, the first regular Canadian mine, was opened up in 1878 by Messrs. Johnson and Ward. The demand at first for the produce of this mine was exceedingly limited; indeed, great difficulty was experienced in finding a market at all. The output the first year was only about fifty tons; but the great value of the mineral being soon ascertained, exploration on the serpentine belt in this neighbourhood was prosecuted on an extensive scale, which resulted in asbestos being found in workable quantities over a very considerable area.

The mine spoken of is now the property of the Johnson Company, of which the Hon. George Irvine, Q.C., is president, and Mr. Andrew Johnson, who now represents Megantic in the Provincial Legislative Assembly at Quebec, is the resident manager. The features of this and the neighbouring mines are very similar. They consist of a massive serpentine, varying in colour from a dark green to almost white, intersected by numerous veins of asbestos of varying thickness, remarkably free (except in one instance) from any admixture of foreign substances. A large extent of this mine is now opened. It is being worked with energy and success, its produce being second to none that has yet been put on the market. According to a statement given in the Canadian *Mining Review* for October last, its output for 1886 was approximately 375 tons, the total output of the mine up to the end of that year being given as 2,500 tons. I was recently informed by the president of the company that they had now made a contract for the sale of the whole of their output for the next five years. The produce of the mine is nearly all No. 1, and is [Pg 31] worth from $80 to $100 a ton.

Adjoining the Johnson Company's mine is one belonging to the "Boston Asbestos Packing Company," of which Mr. Hyde Rust, of Boston, is treasurer, and Mr. T. Sheridan, local resident manager. This mine is being steadily and efficiently worked, and being practically on the same level with that of the Johnson Company, the produce is of a very similar character. It is remarkably good, and some exceptionally fine asbestos has been got out here. In a pamphlet published a short time ago by the Canadian Government on the mineral resources of Canada, it is stated that the yield from this mine (including of course that last mentioned), is pronounced by European manufacturers to be the finest and strongest fibre of the kind known; and it is further stated *that there is no question at all as to the profitable nature of asbestos mining in this belt of country*.

The output of the Boston Company's mine, according to the authority just cited, is about 400 tons per annum. Mr. Ells, of the Geological Survey Department, Ottawa, says that in 1886 the quantity extracted was about 700 tons, and the total produce of the mine to the end of that year about 3,000 tons. There must, I imagine, be some misapprehension of the figures here, and I feel sure that those given above are nearer the mark.

The value of the output of this mine is certainly as high, it is possible taking it all round, that it may be higher than that of the last mentioned. Steps are now being taken to introduce machinery and prosecute the work on a more extensive scale.

The next mine here is one of a more recent date, worked by the Brothers Ward, and owned by them conjointly with the Hon. James Ross of Quebec. It is turning out fairly good material, and [Pg 32] judging by the indications, coupled with what has been already done, there is no reason to suppose that this mine will not presently be as remunerative as those already mentioned.

The output of this, on the same authority, is 150 tons, which is, I believe, the extreme limit of what has yet been done. This mine has been opened now about four years, and in that time has produced, as near as I could learn when last there, about 400 tons. It is said to be worth from $70 to $80, but I did not hear of any of it fetching more than $70, which is doubtless its present value.

The same gentlemen own some very promising-looking land on the other side of the railway, which, in fact, bisects their property; but as this is on a lower level it looks very much as if they will be troubled with water when they begin to open.

The only other mine now opened at Thetford is that owned and worked by Messrs. King Brothers. It is in the same vicinity and bears much the same character as those already mentioned. The output is given at 175 tons per annum.

These four mines form the Thetford group, and are at present by far the most important in the province. They are on a lower level and are consequently worked at a greater depth than those next to be described. The output for this reason moreover is of a more uniform character, and does not require such close classification as some of the other mines farther on. Practically, No. 1 and No. 3 are the only divisions here, the produce being mostly available for No. 1. No. 3 is a very inferior kind, merely the refuse in fact, which is sold and shipped in bulk at $10 a ton, without being bagged up at all, and is mostly used for cement, boiler covering, &c.

The Thetford river marks the western limit of the serpentine on these properties, the rocks on [Pg 33] the other side of the water being mostly altered slates and sandstones. To the east of the railway, which cuts directly across the area, the serpentine forms a knoll with an elevation of about 90 or 100 feet above the line of rails; all the workings at present being confined to this portion of the area. They consist of open cuttings on the face of the hill, apparently very little having as yet been done to ascertain the value of the ground between the railway and the river. There are certainly good indications there, and when I was last at Thetford I found Mr. Ward prospecting in this part with some success. Here, however, is the place where the water trouble will first arise, which will have to be provided for at the outset.

The essential peculiarity of the veins at Thetford is that they are occasionally associated, as already mentioned, with grains and threads of chromic iron and also of magnetite. The magnetite forms rather conspicuous masses between the veins of asbestos in Messrs. King's mine, where it sometimes entirely replaces the latter.[8]

As a general rule, however, the surface veins at Thetford are nearly as pure as those lying deeper in the rock, the reason being that the surface is mostly naked rock only scantily clothed with vegetable mould, moss, or other foreign element, contact with which deteriorates, by discolouring, the fibre, as is found to be the case in a very marked degree in the mines next to be described.

It is a peculiarity of the veins of asbestos that they are never continuous. They vary very much in size, and, in precisely the same way as other mineral veins, they are affected by faults or slides, which not infrequently cut off completely a valuable working face. Where this occurs the [Pg 34] slicken-sided character is very marked.

Sheets, also, of imperfect or immature asbestos, having a long coarse woody fibre, are frequently to be seen lying all along the sides of the fault; but, although there is a good deal of this, the general quality of the produce of all the Thetford mines is excellent. The fibre is fine and of a smooth silky texture, very easily worked. The veins are mostly, especially in the lower cuttings, more free from impurities than those of Coleraine.

No steam power is at present used in this district, the whole of the proprietors at present continuing to rely upon hand labour; the Boston Company are, however, as just mentioned, now seriously turning their attention that way, with a view of increasing their output.

The Thetford mine-owners are one and all kind and hospitable men, always ready to give every information and to facilitate an inspection of their works by anyone who will take the trouble to visit them; a trouble which I always found very amply repaid by the courtesy with which I was received, and the candour and obliging readiness with which all my inquiries were immediately answered.

The workers in the mines here are mostly resident on the spot, sufficient accommodation having been provided for them in the immediate neighbourhood of the mines; the proprietors, who appear to act with a liberal consideration towards their men, deeming it incumbent on themselves to look after their welfare; and they find their account in so doing, in not running short of hands at critical times.

The practice at Thetford is to close down entirely for the winter months, it not having yet been found advantageous, in view of the limited market, coupled with the difficulty of outdoor quarrywork, to encounter the extra expense of working at this season. Some of the owners, [Pg 35] Messrs. King in especial, being largely interested in the lumber trade, to which they devote themselves in the winter, are able to find plenty of employment at that season for their men and others, who then go off into the woods.

At Thetford, as elsewhere, great mistakes, arising mainly from inexperience and want of the knowledge now possessed, were made when the mines were first opened up, which will inevitably

entail serious loss in the future; as an instance, much valuable ground is now seen to be covered up by the dumps, which will unquestionably have to be moved presently when the land is wanted for working.

The same want of foresight, for which there was less excuse with the Thetford experience to guide them, will inevitably cause trouble in the near future at Black Lake, on the property of the Anglo-Canadian Company, even to a more serious extent. The parties who first opened up the ground here evidently knew what they were about, but their immediate successors, being destitute of all practical mining knowledge, have, by their neglect of professional assistance, committed such errors of judgment as will presently occasion very serious expense to the company. At their main pit many thousands of tons of waste rock have been dumped on to some of the richest part of the ground, and this must be again moved before that ground can be worked. From the peculiarity of the work, there probably exists no class of mining which so absolutely necessitates the services of a practical mining engineer, in marking out the land in the first instance for mining and dumping, as that for asbestos does.

The cost of extraction varies in different localities, depending mainly on the mass of barren rock to be encountered and removed. At Thetford the cost may be put at from $20 to $25 per ton, the latter probably being nearer the average. On the Anglo-Canadian Company's property at [Pg 36] Black Lake it is a more serious matter. There the quantity of barren overlying rock and earth is enormous, and detracts immensely from the value of the mines. The minimum cost here is $28.

In addition to asbestos, it is worthy of note that the whole of the Thetford district is rich in minerals. Among others some large and valuable deposits of chromic iron are found in the immediate neighbourhood, within but a short distance of the asbestos mines.

THE COLERAINE GROUP.

Four miles farther down the line of railway from Thetford we come to the Coleraine group of asbestos mines, situate at Black Lake.

The pioneer of these mines was a Mr. Noel, now resident at Richmond, near Sherbrooke, in the same province, who, in 1881, discovered and opened up a mine of a promising character here, which in 1882 he sold to Mr. Charles Lionais, who was until recently the resident manager of the mines owned by the Scottish Asbestos Company, at Black Lake and Broughton.

The mine first opened here was called by Mr. Lionais the "Eureka," and some time afterwards he opened another on the same estate which he named the "Emelie." The property on which these two mines are located subsequently came into the possession of the late Mr. Sénécal, and was by him transferred to the "Anglo-Canadian Asbestos Company, Limited," on the formation of that company in London, in the autumn of 1885.

The estate owned by the Anglo-Canadian Company comprises 325 acres, and has a frontage of [Pg 37] 1,350 feet extending backwards over the hills as far as Lake Cariboo. Until recently this was the only place in the district where machinery was employed to get out the ore.

The peculiar characteristic of this property, as distinguished from the mines forming the Thetford group, is that much exceedingly heavy work, necessitating of course great expense and showing very poor results, must of necessity be done before the good veins, if any such exist, as it is believed they do, are reached. Much of this has already so far been done at the Emelie, that at length this portion of the property bids fair, in capable hands, of proving to be a moderately paying mine. Great results were prophesied from it at first, but so far it has by no means realised expectations.

The surface veins, not only at the "Emelie" but all over the property so far as yet proved, are not only thin, but are much discoloured by the infiltration of water which is so strongly impregnated with the oxide of iron as almost to destroy its value. It was thought, and as it would appear with some show of reason, that the output would greatly improve in value as a lower depth was reached; but although there has undoubtedly been a sensible improvement in quality, the general result is disappointing. Started as a No. 3 mine, as such in all probability it will continue. The output from this Company's mines for 1886 was 330 tons.

The No. 3 quality of asbestos, which has hitherto been the main produce of this mine, fetches so low a price in the market that alone it would not pay for working. This, as already explained, is mainly on account of its bad colour and general coarse quality. This latter having somewhat improved, a considerable proportion of the produce would cease to be classed as No. 3 if it were not for the bad colour. It therefore occurred to me that it might be possible to remove this defect [Pg 38] without injuring the fibre, and in consequence I had some experiments made with this object in view, and ultimately succeeded beyond my expectations, in replacing the discoloured fibre by one sufficiently bright to enable it to take rank as No. 1. These experiments, it is true, were only conducted on a limited scale, but, so far as I am aware, there is no reason why it should not be done on a large scale, which would very materially increase the value of the article.

There is ample room for opening up in a more judicious way on other parts of this property on what seems likely to be good paying ground; and a mode of doing this without incurring any further expense might easily be devised, and, if this were done, other seams of better quality might be hit upon.

Another point in the company's favour is that, if judiciously selected, there is abundant room for dumping without encroaching on the ore-bearing grounds—a most important matter when consideration is taken of the enormous quantity of waste rock to be here encountered and

removed.

The buildings on the estate are well constructed, and are in an efficient state of repair, but at present there is an insufficiency of dwelling-houses on the property. These are a necessity in the district, for securing and retaining a better class of labour. No great expense would have to be incurred in supplying this deficiency. Lumber and labour are both comparatively cheap, and the buildings in themselves, moreover, would always return a fair interest on the outlay.

The property on which the "Martin" Mine is located closely adjoins the last mentioned. This has recently been acquired by "The Scottish Asbestos Company," of Glasgow, with the intention of [Pg 39] working it in conjunction with their mines at East Broughton. Judging by the elaborate preparations for work which are being made, and the expenditure which is being incurred in buildings and machinery, it is evidently the company's intention to carry on work vigorously in both places.

Their property at Black Lake covers 102 acres, and is described as being a mile long by 520 feet wide. The output is given as 300 tons, but I should doubt very much if it has yet reached this figure.

The ground here and in front of the Anglo-Canadian Company's land rises very rapidly, from the level of the Quebec Central Railway, until it attains a height of nearly 600 feet, being then about on a level with the Thetford mines. The great serpentine belt crosses both properties, and is bounded along its northern margin by quartzose granulite, separated from the serpentine by a narrow belt of soapstone. It is claimed for property of the Scottish Asbestos Company, that not less than three-quarters of it consists of the rock formation that seems to be the asbestos matrix.

This property is well laid out, and has a considerable number of dwellings already erected on it for the workpeople. It is also traversed by a good road leading down to the line of railway.

On a narrow strip of land, dividing the properties of the last two mentioned companies, is a small mine called the Frechette-Douville Mine, which (working the same seams of ore), was doing very well when I was there. The output of this is not large, but the quality was very good, and this in consequence is no doubt a very paying mine.

These are the only mines at present being worked at Black Lake, but from indications on other properties lying on the same line, there can be little doubt that other mines will presently be [Pg 40] opened up in this locality. Capital is all that is wanting at present, but, as the demand for the mineral increases, the necessary capital for producing it in larger quantities will no doubt be forthcoming.

The companies working at Black Lake when I was last there were working at a great disadvantage as compared with those at Thetford, in the want of a station on the line. The Post Office arrangements were also of a very primitive character, nor was there any wire nearer than Thetford. All this, however, has been remedied, and there is now at Black Lake not only a station but also a post and telegraph office, in addition to many new houses for the accommodation of the workpeople.

The cost of mining, for the reasons already given, is, and must of necessity be, greater at Black Lake than at Thetford, and cannot be put at less than $28 a ton. After removal of the surface earth and rock, the proportion of refuse rock is about twenty-five tons to one of asbestos.

In regard to communication, Black Lake is 80 miles from Quebec, and about 60 from Sherbrooke; the latter being a rising place, where all stores, &c., needed for the mines are obtainable and from whence lines radiate to all parts of the States.

There are several other places in the vicinity of Black Lake where, although all that has yet been done may be called simple exploratory work, the indications are such as to warrant the expectation that valuable results may be looked for. This is especially the case in what are known as the Reed and Haydon properties which extend over about 200 acres.

On Dr. Reed's land, or rather on that part of it known as the "Coleraine Mines," which is about 100 acres in extent, the ground has already been opened up in ten different places, each of which [Pg 41] shows good No. 1 asbestos in quantities sufficient for profitable working.

The outcroppings here, moreover, are far superior to anything that can be seen on the ground lower down where work is now being carried on. A practical mining engineer who was recently sent to examine and report on this property says that it is 100 per cent. better than that at Black Lake; that 75 per cent. of the whole is veritable asbestos-bearing land, and that he knows of no other asbestos mine so well situate for practical work, or showing such advantages in timber, water, and, dumping ground. The timber is sufficient for all practical purposes for at least twenty-five years.

And Mr. Ells, in his Annual Report to the Minister of the Interior, for 1886, speaking of his visit to the asbestos district and of his inspection of these properties, makes special mention of them as follows: "In the vicinity of Black Lake several other areas occur, in which the exploratory work done, though not very extensive, shows indications that *fully warrant* the statement that a valuable and profitable output may be expected. These properties are known as the Reed and Hayden properties, and are situated on lots 27 and 28, Range B of Coleraine. In various open cuts in the side of the hills numerous veins are disclosed, ranging upwards to a width of two and a half inches, with surface indications apparently in no way inferior to those of the adjoining properties now being worked at this place, *or even of those of Thetford mines*, not only as to the *number* and *size* of the veins, but also as to the *quality* of the fibre. These indications appear at many points on both the Hayden and Reed properties, which embrace a total of 200 acres."

Between these properties and Cariboo Lake the serpentines extend in an apparently continuous ridge, and show, at intervals, very good indications of asbestos. This area, however, has not yet [Pg 42] been sufficiently explored for much to be said, from actual observation, of its value as asbestos land, though it seems reasonable enough to suppose that this portion of the serpentine belt will be presently found equally valuable with that of the adjoining section.

In the vicinity of the Coleraine Station of the Quebec Central Railway (the next station to Black Lake), serpentine also occurs; but the main ridge, extending south-west, keeps to the north-west for about a mile and a half, where it forms a conspicuous hill feature. An opening recently made on this south-west extremity by Mr. Kennedy disclosed the presence of a number of asbestos veins, one of which, occurring near the surface had a width, it is said, of nearly four inches. Sufficient work has not yet been done to determine the persistence and value of these veins, though when I was last leaving the district I was given to understand that energetic operations would commence immediately on the opening of the working season.

A peculiarity here is the occurrence of a considerable quantity of mica in direct contact with the asbestos, a circumstance which has not hitherto been found to be the case anywhere else.

BROUGHTON.

The finest vein of asbestos ever yet worked in Canada was discovered at Broughton, when the Fraser Mine was first opened and worked by Dr. Reed; although doubtless the largest, most continuous, and consequently best paying veins have been found at Thetford, some of which, it has been stated, were over six inches in thickness. I confess I have not been fortunate enough to [Pg 43] see anything like this, but I have seen many veins there, the produce of which was of surprising beauty, and specimens of which I have before me as I write, which are broad enough and good enough for any purpose to which the fibre can possibly be put.

It must, however, be borne in mind that the same rule obtains with many other things as is noted in the vegetable world—namely, that the largest specimens are not necessarily the best. The broader veins of asbestos do not, as I have already remarked, yield as a rule fibre of so fine a quality as those of a medium, or even of a small size. The length of the fibre, moreover, cannot be determined with any absolute certainty from the thickness of the vein. On the contrary, the broader veins are not seldom found to be separated at right angles to the length of fibre by minute bands of serpentine, chrome, or magnetite, sometimes even by a separation without any perceptible layer of rock, the only indication of this being an irregular, scarcely visible line, readily detected by the expert.[9]

Under the hammer the big veins, in which the separation exists, are at once divided into two, or it may be into three lengths of fibre; but if the cotton be pure and clear, this is no very great detriment. Veins of an inch or an inch and a half extracted from compact rock seldom have these intersections. The veins, moreover, are extremely irregular in character, a small vein at the surface frequently developing into one of considerable size lower down, or breaking off altogether. This is the special characteristic of the veins in the Coleraine district—notably at Black Lake—at the mines of the Anglo-Canadian Company, and at Danville. At Thetford, on the other hand, where the ground is of a more uniform character, and at a lower level than at Black Lake, fine veins are frequently met with just below the surface, which continue for a considerable [Pg 44] distance with very little change.

It will clearly be seen, therefore, that it is not possible properly to appreciate the value of such a mine as this without inspection and thorough examination by an expert. Fine specimens can at any time be obtained, and have before now been exhibited at a distance as being the produce of some particular mine for which a purchaser was wanted, when anyone visiting the spot would at once see the utter impossibility of such having been the case; and even if it were proved to be true that the specimens exhibited came from the place indicated, it would be important to know at what depth they were got, with the nature and general disposition of the mine, as well as the proportion of superincumbent rock requiring to be removed before the valuable veins could be worked. Without a knowledge of this it is self-evident that no practical estimate of expense to be incurred could possibly be made.

The discovery at Broughton made a great stir at the time; but the big vein there was to all appearance soon worked out, the supply thought to be exhausted, and work in consequence discontinued.

That, at any rate, was the view taken by the gentleman who then worked the mine. About 130 tons, I was told, were got out, which fetched from $100 to $120 a ton. It would now be worth a much better price.

The Scottish Asbestos Company have since then purchased this property, and from the extensive preparations they are making for work, and the great outlay they are incurring for machinery, buildings, and plant, it is clear that they do not by any means coincide in the view above expressed. The stratification at Broughton is peculiar, and different from anything that is found either in Thetford or Coleraine. It is quite possible, therefore, that the Company's advisers [Pg 45] may be right, and that the surface deposits will be found to continue in richness and volume lower down. The developments at present consist of an open cut 15 to 20 feet deep by 8 feet wide following the vein and the serpentine reef is laid open for a length of about 900 feet.

When I last visited Broughton, in the autumn of 1886, I went over the ground in company with the late Mr. Fraser, who was then resident on the property, but was unable, from the quantity of water in the cut, to trace any of the big veins which had previously been worked. It was evident,

however, that in consequence of a sudden dip downwards considerable expense would have to be incurred, and much very heavy work done, before the seam could be reached again. The belt of serpentine here is very narrow, and the veins of asbestos are closely pressed together. The strike is east and west, and the dip 30°.

There are prospects here to the north-east, apparently of as valuable a character as those of the mine already opened. A few days after my visit, I was shown some fine samples from the surface work of this place, where the ground had just been stripped, and these bore the precise characteristics of the fine vein already spoken of. The Broughton ore has a pale yellowish hue, as distinguished from the greenish metallic lustre which distinguishes the finer samples from Thetford. This does not, it must be observed, in any way deteriorate or injuriously affect the clear whiteness of the fibre when crushed out, although it at once identifies the locality of its production. There are, in fact, as I have already mentioned, certain peculiarities, even of colour, attaching to the ore of each locality of so marked a character that an expert can at once tell, on inspection, from what locality it was obtained.

There is great abundance of soapstone (steatite) at Broughton; much of it of good quality, and some of it is remarkably pure. I brought away a singular specimen, having all the grain and even the fibrous markings of asbestos, which was nevertheless pure and unmistakable unfibred steatite. [Pg 46]

At present no use is being made of this material at Broughton, but at Wolfestown, in the same province, there is a manufactory for its use, and here slabs of very fine quality can be procured. A workable bed of very superior quality has been found also at Potton, and there is another at South Ham, near the antimony mines on the Lake Nicolet estate. Reduced to powder, the softness and unctuosity of steatite have caused it to be used, in the same manner as plumbago, for lubricating purposes, and when finely ground it is employed for giving a surface to some kinds of paperhangings.

The substance called Venetian or French chalk, used by tailors and others, is nothing more than steatite. It can be readily cut with a knife, and is infusible in any ordinary furnace heat.

Slaty varieties, of which there are many, are comparatively useless.

DANVILLE.

There is a mine at Shipton, about four miles from the village of Danville, contiguous to the line of the Grand Trunk Railway, which has been for some time worked by Mr. Jeffery, whose acquaintance I had the pleasure of making in Montreal, but I much regret that time did not permit of a visit to this mine, so I can give no details of my own personal knowledge.

The outcrop of the serpentine here, I am told, is quite limited, with steep sides till round it. It however contains numerous veins of asbestos which, though mostly of small size, are of good quality. Faults are numerous, and these considerably affect the value of the property, some of the good veins, with a thickness of two inches, for instance, being cut off completely at a distance of fifty feet from the surface. [Pg 47]

In a pamphlet published at Ottawa, by the Department of Agriculture of the Dominion Government, I find it stated that the whole output of this mine has been contracted for the next ten years. This is said to amount to 100 tons per annum, and its value is given as $60 per ton.

SOUTH HAM.

This mine, the property of Dr. Reed of Reedsdale, Megantic, is situate on the Nicolet Estate, in the township of South Ham, 7½ miles from the Garthby Station on the line of the Quebec Central Railway. It was first described as being situate on Big Island, in the centre of Lake Nicolet, where the serpentine rocks rise very abruptly to the height of seventy feet, forming precipitous cliffs on the western side of the island. Recent exploration, however, has shown that the main body of asbestos is on the hill-side, and is of such extent as altogether to eclipse that proved to exist on the island, which was at first thought to be the chief source of supply.

The mine on the island is not being worked, but has been fully proved by numerous openings which have been made at the most promising points, revealing in every case veins of asbestos of remarkably good quality and in great abundance. These, as mentioned, are now known to pass under the lake, and can be seen cropping out in many places on the shore and the hill-side. [Pg 48]

The mineral as seen on the island presents many points of difference from that at Thetford and Coleraine; and in the Geological Survey of Canada, I find it is stated to consist of four varieties, viz.:—

1st. Small veins, rarely exceeding half an inch in width, the fibres not easily separable. This, however, does not detract from its commercial value.

2nd. Apparently occupying a position at right angles to the veins above noticed, is a coarse fibrous mineral, resembling rope, and evidently derived from the associated picrolite. The extreme length which these fibres may attain could not be determined, but judging from exposed portions, it cannot be less than three feet.

3rd. Veins somewhat resembling the latter in aspect, but much finer in texture. The fibre can be separated with great facility, though firmly attached at one end to the parent rock.

4th. A steatitic asbestos rock, resembling "Mountain leather," forming important masses, which

enclose small concretionary pellets of asbestos, the centres of which contain a nucleus of serpentine.

Very little (the report says) has yet been done on the island to develop these asbestos veins, perhaps owing to the difficulty of transport across the lake. This, however, would probably be more than counterbalanced by the magnificent returns which this locality promises to afford.

Dr. Reed at present is altogether neglecting the asbestos and devoting his attention to the development of a very promising antimony mine on the shore of the lake.

Indeed this estate might very justly be termed a typical Canadian mineral estate, and is, in its way, unique, for comprised within its 2,000 acres, there are found to exist not only rich veins of [Pg 49] antimony and asbestos, and, as was stated in the notice of Broughton, enormous quantities of soapstone, but there are also immense deposits of iron, magnetic, chromic, and bog ore, as well as copper and sulphur. Silver to the value of $4 per ton of ore is found with the antimony, and reefs of auriferous quartz run through the entire property, from which a practical miner from Australia, who was examined before the committee appointed in 1887 by the Dominion Government to investigate the gold-fields of Canada, stated that he had taken samples which on assay gave 2½ ozs. gold to the ton. Nickel also is found on the property, and cobalt.

Everything necessary for the working of those valuable deposits already exists on the ground—unlimited water supply, and timber for building and mining purposes, as well as for charcoal for any furnaces that may presently be erected: sufficient, if judiciously managed according to the rules of forestry such as obtain in Germany, Austria, and Russia, to last until a new growth matures. In regard to transport, the roads are good, and a line of rail connecting the Grand Trunk with the Intercolonial will touch the property next summer, and will, it is expected, have a station there just below the antimony mine. In regard to steatite, the quantity here is so enormous that an expert (Captain A. M. Evans, of the firm of Blakemore and Evans, the well-known civil and mining engineers of Cardiff), who was lately sent by me to report on this property, speaking of steatite, says, "All I can say is, there are mountains of it."

This mineral is a more or less pure and compact talc. When pure and of close hard grain it is used as a refractory for lining furnaces, especially those designed for anthracite. It is in demand also for gas burners, not being liable to rust or corrosion, and also for the construction of small [Pg 50] portable furnaces and open stoves. It is used also in the manufacture of paints. When very strongly heated, steatite loses the small portion of combined water contained in it, and then in consequence becomes much harder.

WOLFESTOWN.

The description of the asbestos area of Wolfestown is given by Mr. Ells. It is situate on the north-east extremity of a serpentine ridge which extends south-westerly, with many interruptions, from the road leading from Coleraine Station to Wolfestown, in the vicinity of Lake Nicolet. It belongs to Mr. John Bell (John Bell & Co., asbestos manufacturers, London), and considerable sums have been expended on the property in the way of exploration. The surface indications are said not to be equal to those at Black Lake, but show at several points numbers of veins, some of which are from one and a half to two inches thick.

A very fair showing of workable veins has been exposed on the upper part of a deep cut, which it is proposed to intersect at a considerably lower level. Should the same rule of increase which holds good at Thetford and Coleraine obtain here, there should be good paying ground exposed when the lower level is driven in past the cap of barren rock, provided the veins already disclosed are not cut off by faults, whose presence is noted here as at other points.

The total amount of asbestos taken from the Belmina district Mr. Ells puts at about twenty-five tons.

Considerable quantities of chromic iron are found on the hills in this area, which embraces [Pg 51] about six hundred acres.

The foregoing are all the Canadian mines now in work, as far as I have been able to learn, certainly all of any importance. There can be no doubt, however, that as the demand increases further explorations will be made, and new mines discovered, as well as that increased capital will be put in to further develop those already at work. At the present time the supply scarcely keeps pace with the demand, and capitalists are beginning to wake up to the importance of this industry; *it having been now conclusively proved that mining for asbestos, properly conducted, shows a more steady return for the money invested, with less elements of risk, than mining for any other known mineral*.

I am unable to say, with any degree of exactness, what is the amount of the aggregate output of the Canadian mines; but I saw it stated in a local paper that, in 1885, it was under 1,500 tons, and that in 1886 it had reached 2,000 tons, giving an increase of over 500 tons for the year. This is quite sufficient to show the rapid strides the business is making, and is probably near about correct, judging by the rate of progression in the imports to the States, for instance. The value of manufactured asbestos imported into the United States from Canada, in 1880, is given in the Government Returns as under 10,000 dollars. In 1884 it had risen to 48,755 dollars, and it has been increasing yearly ever since. That the demand is rapidly increasing is unquestionable, not only for the present articles of manufacture, but for the new purposes to which it is being daily applied. More capital will, doubtless, soon be put in, and then new lines, which almost indicate themselves, will prepare the way for continued success.

As regards the progressive output of crude asbestos at the mines, since its introduction in 1887, the following may no doubt be taken as authentic, being extracted from the "Statistical Report on the Production, Value, Exports, and Imports of Minerals in Canada during the year 1886 and previous years," by Eugène Coste, M.E., published by authority of the Dominion Parliament. In this Report the production and value is given as follows:— [Pg 52]

		Value at the Mines.
	Tons.	Dollars.
1879	300	19,500
1880	380	24,700
1881	540	35,100
1882	810	52,650
1883	955	68,750
1884	1,141	75,079
1885	2,440	142,441
1886	3,458	206,251

The mode of extraction in all Canadian asbestos mines is by open quarry work. Whether the drills are worked by compressed air, or by hand in the old-fashioned way, the effect is the same. When a sufficient number of holes of the proper depth are drilled and duly charged with dynamite or powder, they are linked together, and fired by a battery in such a way that the face of rock shall be thrown outward on to the floor of the pit. The asbestos is then picked out, the adhering rock roughly broken off, and the ore piled into boxes or tubs, which are loaded on to trolleys, and run off on tram-lines to the cobbing-sheds. The refuse rock, of which there is always an enormous quantity (probably as much as twenty tons of rock to one ton of asbestos), is loaded into cars, run off and shot over on to the dumping-ground.

Boys are employed in the cobbing-sheds to chip, or cob, the rock cleanly from the ore, an operation which is much more troublesome with thin veins than with those of the better sort to which, as I have already said, the waste rock is less firmly adherent. This cobbing is a very troublesome and expensive process, costing about 5 dollars a ton. After cobbing, great care is required in sorting the ore into the respective grades of Nos. 1, 2, and 3. It is then put up in bags of about 160 lbs. each, marked, and stacked away in the bins ready for shipment. All this is done in a very rough and ready style, and the waste is simply enormous: there is no doubt, however, that as the ore increases in value more scientific appliances will be adopted with good results. At present thousands of tons of rock containing only thin veins of asbestos are dumped on the refuse heaps as waste which would all be crushed if a proper machine were at hand, and the valuable material saved. [Pg 53]

In the cobbed state ready for market the ore is worth at the mines at the present time from 50 dollars to 55 dollars for No. 2, and from 80 dollars to 100 dollars for No. 1. It is evident, therefore, on a comparison of the cost of extraction with the price realised for the raw material, that there is ample margin for good profit.

Wages run from 1 dollar to 1 dollar 75 cents a day, according to the nature of the work performed, for men, and from 50 cents to 1 dollar for lads and cobbers. The comparison of the cost of production, therefore, with the value of the raw material, shows a very large margin of profit.

There is no scarcity of labour, a sufficient number of hands, mostly French-Canadians, being always forthcoming; but at those mines where there is an insufficiency of houses for married men, accommodation has to be found in the barrack-like building for single men; the married men, who cannot be accommodated, residing frequently at a long distance from their work, which causes them to be of a migratory disposition, and gives considerable additional trouble to the management.

A disadvantage in the employment of French-Canadian labour lies in the great number of festivals incident to their religion, with consequent loss of work at the mines, but apparently there is no remedy for this at present. The greatest curse of the place, however, is gin. Although the district is under the Scott Act, and the sale of liquor consequently prohibited, like every other place where the sale is interdicted there is no difficulty, if you know how to go about it, sometimes even if you don't, in getting as much as you please. At any rate I never yet was in any such place where I did not find it to be so. [Pg 54]

Here is an instance: On one occasion I had been out driving in the pouring rain for several hours, had got drenched to the skin, and was bitterly cold. I pulled up, therefore, at a likely-looking house, went in and called for some brandy, but to my disgust was told no liquors could be supplied, as it was against the law. As I turned to go out again, in no very cheerful mood, the man, seeing the state I was in, evidently took compassion on me, and said, "Better try some bitters;" so calling to mind the old saying that all bitters are warm barring a bitter cold day, which only proves the rule, I assented. He then pushed over a tumbler and a black bottle, when I at once poured out and swallowed a pretty strong dose, feeling when I had done so as if I had swallowed a streak of forked lightning. As soon as I had recovered my breath I muttered my thanks and paid up. "Have another?" says he, with a twinkle in his eye. "No, thanks;" I replied. "Guess you'll remember our bitters," he then laughingly said, prefixing the name of the place, which I afterwards found was in a district where prohibition was very strictly enforced, and which I therefore purposely omit, his breach of the law having no doubt saved me from the dangerous effects of a chill.

The hip pockets in the men's pants form very convenient receptacles for the bottles, and are always pretty well filled after pay days and holidays. The liquor most in favour is a vile compound called gin. It is supplied in the regular square Dutch bottles from the familiar green-painted boxes in which "Hollands" is exported, and which are labelled "De Kuyper;" but the vile stuff is not much credit to that gentleman's manufacture if it be so, which is much to be doubted. [Pg 55]

FOOTNOTES:

[4] *Ante*, p. 13.

[5] "Geol. Hist. Can.," 1880.

[6] See *ante*, p. 12.

[7] See *post*, p 33.

[8] "Geographical Survey of Canada."

[9] *Ante*, p. 27.

USES TO WHICH ASBESTOS IS APPLIED.

In regard to the many varied uses to which this mineral is now put, foremost must be placed the numerous valuable articles manufactured for engineering purposes.

Were I to attempt to enumerate the various kinds of packing, mostly in the shape of millboard, in use for all kinds of engines, for steam joints, cylinder and steam chest covers, pipe flanges, &c., this part of my little book would have the appearance of a manufacturer's catalogue.

The rapidly increasing favour with which high pressure steam is now regarded by engineers, recently necessitated the introduction of a packing capable of resisting the higher temperatures and pressures; as a consequence manufacturers of asbestos goods had to devise improved methods of manufacture in order to meet the new condition of things, and this they succeeded in doing in a way to give universal satisfaction.

For washers asbestos has many advantages over rubber; its weight is less, they can be frequently used, and half the thickness of rubber is mostly sufficient.

The fibre, Sir Frederick Abel says, is as effectual for closing the breeches of big guns so as to prevent the passage of gas, as for ensuring safety, in the same way, for miners' lamps. In these last, it had for a long time been found very difficult to get a good joint between the metallic and the glass parts of the safety lamp, and a great many different materials were tried for filling these joints in such a way that air should not be able to pass through. In many cases, the air was contaminated with a certain amount of gaseous material which would be likely to render the whole explosive, and if this got through the joint between the glass and the metal, there would be very serious risk of explosion. After a great number of substances had been tried and found unsatisfactory, some hundreds of experiments were made by Sir Frederick Abel and Sir Warington Smyth, with asbestos washers, which, in the end, were found to maintain their condition most admirably. [Pg 56]

With regard to closing the breeches of big guns, we are informed also on the authority of Sir Frederick Abel, that the only contrivance which could be called an approach to a perfect arrangement, was one devised by a French artillery officer, M. Dubange, which consisted of a kind of pad of asbestos fibre attached to the breech-closing arrangement. This, from its mineral nature, was nearly indestructible, and, consequently, lasted without material deterioration for a great length of time, notwithstanding that it was subjected to the enormous pressures which are now developed in the bores of very heavy guns.

In connection with the Whitehead torpedoes, we learn from the same authority, that in these and other similar receptacles, within which charges of wet gun cotton are enclosed, the use of asbestos is now found to overcome a great difficulty. The vessels containing the damp cotton have to be soldered, in order to keep them perfectly air-tight, and thus prevent the water from escaping; and in order to do this, with anything approaching safety, the space between the gun cotton and the metal surfaces which have to be soldered, were formerly filled with damp felt wads or discs. This answered the purpose; but Sir Frederick Abel states that it was found after they had been stored for some time, that the effect of the moisture on the felt was to cause it to undergo a kind of decay or fermentation, resulting in the formation of gas to such an extent that the vessels were distended, and threatened to burst, and sometimes actually did burst with considerable violence. Asbestos millboard was then substituted for the felt, and the difficulty and danger were then removed; gas was no longer evolved, whilst the operation of soldering could be performed with safety, the material remaining perfectly unaltered. [Pg 57]

In the manufacture of time-fuzes again, asbestos washers are found most valuable. Washers of

india-rubber and wash-leather were formerly used, but these in time became hard, and acted on the metal surfaces with which they came in contact in such a manner as to cement them together, instead of keeping them mobile, and it was not until the introduction of asbestos washers that difficulties in connection with the proper action of these ingenious contrivances for the explosion of shells in a given time after their discharge, were removed.

One of the latest uses to which asbestos has been proposed to be applied in connection with warfare is as a coating for ironclads. It is alleged by the inventor of the process that if asbestos be packed between the armour-plates it will arrest, or certainly minimise, the inflow of water after the penetration of a ship's side below the water-line. This has already been tried by the Admiralty, and an interesting account of the trial may be found in the *Army and Navy Gazette Supplement*, for August 28, of last year, and in the *Globe* of the previous evening. Should the results of further trials corroborate the success of the first, it is manifest that a great impetus will be given to the asbestos trade, whilst it will, at the same time, raise confidence in our fighting ships, by practically preventing them from becoming waterlogged in action. [Pg 58]

An eminent firm of manufacturers in New York have recently supplied, under contract with the United States Government, a quilting for boiler covers for their model warships, the *Dolphin*, *Chicago*, *Atlantic*, and *Boston*. These quiltings weigh about two pounds to the square foot, and are at all times removable. The same firm make removable pipe coverings a speciality.

Certainly some of the uses to which this mineral is now being put are sufficiently astonishing. Who, for instance, could have imagined that a substance of such comparative specific gravity as crude asbestos could have been manufactured into a cloth available for aeronautical purposes in which absence of weight is of such primary importance? Yet here it appears to be the one thing wanting to give success to that despair of aeronauts, military ballooning. Many years have now passed away since scientific military men first turned their attention to this subject; and it is now long since the War Department of the Government first authorized experiments to be made with the view of utilising balloons in warfare, and notwithstanding all the time and money which has been expended, until now the result in the way of practical success has been *nil*. No use of balloons was made even in the late Egyptian campaign, which shows that up to that date English military men had no great faith in their usefulness or availability.

The difficulties to be encountered are doubtless sufficiently formidable. Gas, it is clear, could not be carried into a hostile country or into remote and nearly inaccessible districts. Even if procurable at all near the battle-field it could only be obtained by a long and difficult process of generation at the very time when speed and simplicity would be the main factors of success. Gas, therefore, being practically out of the question, it seems to have occurred to Mr. Spencer, the well-known balloon manufacturer, that it would be better after all to revert to the original conception of Montgolfier. The old-fashioned fire-ball, which acquired its power of ascension from rarefied air produced by burning straw or something similar, was, of course, of far too dangerous a character, and had been productive of far too many fatal accidents. It remained, therefore, to construct a balloon of some uninflammable material, in order to obviate this difficulty; and with the assistance of his friend, Mr. Fisher, the Secretary of the United Asbestos Company of London, he ultimately succeeded in so doing. A balloon was accordingly constructed, the whole of the lower part of which was formed of fine asbestos cloth, and the remainder of canvas, covered with a fireproof solution. The first trial took place in the grounds of the Welsh Harp, at Hendon, and this has since been repeated at Chatham, under the inspection of the Royal Engineers' Committee, and on both occasions, I am informed, with success. The balloon, which was a model only, stood about 30 feet high, and was suspended between two uprights, between which it hung down like a limp rag. It was of a cylindrical shape, having a deep zone at the equator, and a containing capacity of about 300 feet. Attached to the neck was a copper spirit-lamp. As soon as a light was put to the spirit the inflation commenced, and the balloon was fully distended in a space of about five minutes. [Pg 59]

The immense advantage gained by this method over the tedious and difficult process of inflation by gas, even under the most favourable circumstances, is sufficiently obvious, whilst it is at the same time apparent that the quantity of spirit requisite for an endless number of ascents could be carried about with the greatest facility. Another advantage remains to be considered, in that whilst the large volume of gas required for an ordinary balloon is in itself deleterious, the rarefied air in the new fireproof balloon is perfectly innocuous, and it can be raised or lowered at will simply by turning the neck of the lamp a little up or down. It is perhaps somewhat superfluous to say that the Russian Government at once adopted these balloons for war purposes. [Pg 60]

In further continuance of this part of the subject, that is the application of asbestos to matters connected with warfare, the particulars of a very interesting experiment, which may have an important bearing on the carriage of explosive material in time of war, was given by Mr. Boyd, the manager of the United Asbestos Company's works at Harefield, of whom I have already spoken, and to whom I have been considerably indebted for much practical information, in a paper read by him before the Society of Arts, on an occasion when, through his kindness, I had an opportunity of being present. He was referring to the value of asbestos millboard as a lining for fireproof cases and deed boxes. The matter, he said, was put to a practical test thus: two iron rails were supported on brickwork at a height of about eighteen inches from the ground, and underneath them a strong fire of wood shavings and chips was made, and when this had well burnt up, a deed box filled with papers was pushed along the rails to the centre of the fire, where it was completely enveloped in the flames, and there it remained for a space of twenty minutes. On the box being withdrawn it unlocked easily, and the papers were found in perfect preservation, being neither charred nor discoloured. [Pg 61]

On seeing this result, one of the gentlemen present asked if the boxes could not be used for transporting gunpowder or other explosive substances. A quarter of a pound of powder was then put in a small bag, and placed inside a fresh box, which was pushed along the rails into the centre of the fire, to which fresh fuel had been added. Those present withdrew to a respectful distance, evidently, said Mr. Boyd, not yet having absolute faith in the heat-resisting properties of asbestos; and after the box had been exposed to the fire for twenty minutes the question naturally arose how it was to be got off again. The manager himself performed that operation by means of a long iron rod and hook, after which the box was again opened and the powder found intact. The question was then asked by some one present who was not yet satisfied, "Why have the powder in a bag? Let it be laid on the bottom of the box loose." This was done, and the fire ordeal repeated, again with the same result. Nothing could well be more interesting or more suggestive to every one connected with the asbestos industry than the foregoing.

As a final instance of its applicability for purposes connected with warfare, it may be interesting to mention that I have lately seen it stated that the fibre would be of great value for use as lint in hospitals and on the battle-field. Of this I am unable to speak, but if it be a fact that it can be so used in favourable comparison with the best lint, as stated, it is certain that its imperishable quality would be of great advantage, seeing that it could be used over and over again, only needing to be purified by passing it through fire after each time of using.

In regard to the use of asbestos in connection with building operations, much attention is now being given to this in a variety of ways, in America especially. The building laws of Boston, New [Pg 62] York, and Philadelphia pay special attention to this, and many material alterations have been required to be made in consequence in the fittings of several important public buildings, whilst the use of the mineral is, I believe, rendered compulsory on those wishing to procure licences for the erection of new theatres, libraries, concert halls, &c. At the American Academy of Music, in Philadelphia, the underwriters went so far as to offer a reduction of one per cent. per annum provided an asbestos curtain was placed in the house. The Fire Apparatus Committee then, it is reported, succeeded in perfecting "the only barrier of complete protection to an audience against fire in the world." This curtain, made of asbestos cloth (97 per cent. pure asbestos and 3 per cent. cotton) is 54 feet wide and 53 feet high. It is hung on wire lines, three-eighths of an inch thick, connecting with a drum located in the apex of the roof, and can be raised with ease by two men and lowered by one.

Again, after the disaster at the Ring Strasse Theatre, at Vienna, when attention was drawn to the great danger arising from the want of some certain and rapidly applicable means of separating the stage from the body of the theatre, the Roman Minister of Public Security issued an order that every theatre should be fitted with a fireproof curtain capable of entirely isolating the stage from the theatre, and he indicated an asbestos cloth curtain as one that would meet the case. All the principal Roman theatres are now supplied with these curtains, the material having been furnished by the United Asbestos Company of London. The same company has also recently fitted a similar curtain for use at the Theatre Royal in Manchester. This is formed of an iron frame holding the asbestos curtain.

Asbestos fireproof curtains are also in use at the New National Theatre, Washington; the [Pg 63] Criterion, Brooklyn; and in the theatre at Cleveland, Ohio. They have also lately been supplied to several English theatres, as well as that at Manchester just mentioned.

The terrible calamity at the Opéra Comique in Paris, coupled with that which so recently occurred at the burning of the theatre at Exeter, again set men's minds running in the direction of greater security from fire in theatres. As a consequence several varieties of curtains, all involving the use of asbestos, have been contrived. For instance, at the building of that pretty little theatre (Terry's) in the Strand it was resolved to replace the usual heavy, cumbrous, slow-lifting iron shield by a single light-grey asbestos curtain, which moves up and down as easily as an ordinary window-blind. And the authorities agree that this is as valuable a protection to the audience as the former ponderous iron portcullis which, winding slowly up and down, was calculated to depress the nerves of the audience in the same way that passers-by in the street are affected by the harsh grating of the iron shop shutters when being wound down for the night.

Again, in the proposals for a new "Safety Theatre," brought to the notice of the public by Mr. Henry Irving, stress is naturally laid on the necessity of sealing the stage, or shutting it off from the auditorium, so that in the event of fire its perils might be confined to itself, and to providing an outlet for the smoke, which is often more disastrous in its effects even than the flames. This he proposed to accomplish by means of an asbestos curtain which, on being dropped, would at once become rigid with the wall on either side. This curtain was proposed to be worked in iron grooves going straight up to the gridiron floor; and the suggestion was made that this should be used as constantly as the ordinary act-drop, there being at the same time nothing to prevent its being [Pg 64] made as ornamental as the usual curtain. It could also be worked as easily, and be just as easily lifted for a recall. The audience, it was said, would thus have the satisfaction of knowing that every time the curtain was dropped they were effectually protected by a fireproof screen, which could be lowered with the same rapidity as the present curtain.

In continuation of this subject it may be worth mentioning, as showing the amount of attention which is now being directed to this important matter, that an experiment was recently made in the neighbourhood of Oxford Street to test the fire-resisting qualities of another new curtain for the stage, said to have been invented by Captain Heath. This experiment took place within a specially built hoarding, within which there was erected a large model of the Drury Lane stage proscenium. Captain Heath explained to the company, invited to witness the experiment, that the curtain was made of asbestos and canvas, and was rolled on a block of wood placed underneath

the front part of the stage, where it occupied an otherwise useless space, and in no way interfered with the business of the theatre. The sides of the model were made of iron plates, and the front entirely of wood. When certain catches were released counterbalancing weights came into action, and the curtain was run rapidly up from below. On reaching the top, it pressed tightly and automatically against the back of the proscenium, turning on at the same time a supply of water from a perforated pipe which ran along the whole length of the top of the curtain so as to keep it constantly wet. The arrangement of the switch used for communicating action to the curtain was such as to turn on the water and close the curtain against the sides at will. He also stated that communication with the lever of the switch could be fitted to any part of the theatre. [Pg 65] A very severe fire test was employed. The model was first filled with inflammable materials such as shavings and large blocks of wood, over which petroleum was poured. At a given signal the curtain was raised and the fire lighted. The flames at once rose, accompanied with volumes of smoke, none of which, however, found their way to the front of the proscenium. The interior looked like a furnace. But so effectually were the flames shut off that it was possible to sit on the fore part of the stage without feeling the heat, the only thing noticeable being the steam arising from the wet canvas. This, Captain Heath explained, might be obviated by painting the canvas in oils. The fire burned fiercely for half an hour, and the universal opinion of those present was that the curtain was perfectly fireproof, and that its construction was as simple as it was useful for the purpose intended.

Whilst these sheets are still in the press, yet another theatre dies the apparently natural death of all such structures, that is, by fire. Portugal is this time the scene of the disaster, the sufferer being the Baquet Theatre in Oporto. The calamity was caused by the wings catching fire from a gas-jet, whereby the whole of the stage scenery was almost, immediately afterwards enveloped in flames, the furious progress of which it was found impossible to arrest. Here, then, was a striking instance of a holocaust being caused by the want of such a curtain as has been described; for, had such a thing been available, the stage would have been at once shut off from the auditorium, and even if it had not been found possible to save the structure, the fire, at any rate, would have been localised for a sufficient length of time, to have enabled the authorities to clear the building, and so have prevented the panic and horror which ensued, and the fearful sacrifice of life which humanity now deplores.

It is worth while perhaps recording the foregoing, because there can be very little doubt that [Pg 66] something of this kind will presently be made compulsory even in England for use in theatres and music halls generally. And it is believed, from the course matters are now taking in the United States, that the use of asbestos in some form or other will be made compulsory there for the shelvings and doors of public libraries and places for the custody of records, for sheathings between wooden floorings and below carpets, for hearthstones, for the linings and doors of elevators or lifts, and for the better preservation of Pullman cars from fire.

The premises of the American Watch Case Company, of Toronto, have their floorings protected by an asbestos covering, and I saw an announcement recently in the *Sherbrooke Gazette* that this covering had saved their premises from destruction by a fire which had occurred there. In connection with this part of the subject it may be added that various attempts have been made for the introduction of asbestos into the manufacture of lace curtains, dresses, &c., but I believe that the principal obstacle in the way of success in this line lies in the fact that in its present state, in the shape of curtains, for instance, it is found to be an obstinate holder of dust. This objection will, no doubt, be presently got rid of; and soon we may hope to have heard the last of those fearful scenes which have at times occurred from the firing of ladies' dresses at the footlights in theatres.

The Chevalier Aldini's idea, previously mentioned, has been recently revived in Paris, the firemen there having been furnished with asbestos clothes. Immediately after this was done it was reported in the papers that on a conflagration occurring in the basement of a building there, the firemen arrived, clad in their asbestos suits, and were thereby enabled to descend at once into the basement, where they extinguished the fire in a very short time, and so prevented what might have been a great calamity. And according to the papers it appears that the same course is [Pg 67] now about to be taken in England, and the London firemen at any rate protected in a similar manner; and there can be little doubt that this course will presently be universally adopted for the protection of the men engaged in saving life and property from destruction by fire. Nothing has yet been discovered that will equal asbestos for this purpose. It will neither burn nor smoulder, and is as impervious to fire as well made mackintosh is to water.

Manufactured into cloth and paper, it is in use in sugar refineries, chemical laboratories, &c., for straining and other purposes, especially for filtering acids and similar fluids. A coarser kind of cloth is used for stokers and furnacemen's aprons, for salvage blankets, and gloves. A special quality of glove made of asbestos cloth, lined with rubber, is supplied for electric light work.

A further development of the industry is indicated by the announcement that a New York manufacturing firm has recently taken over a large contract for the manufacture of mail bags out of asbestos cloth.

It is also proposed to be used as an inner sole or lining for boots and shoes with the object of keeping the feet warm in winter and cool in summer, the material possessing the double advantage of being at once a preserver of heat and a protector from cold.

For cold storage buildings it will doubtless be found invaluable. There are buildings in New York, principally for fish preservation, which are built with double walls surrounding the cold chambers, having some kind of non-conducting material between the walls by way of lining. For

this purpose asbestos would be unsurpassed, and the cheap No. 3 quality would answer perfectly well.

Mr. Boyd, in the lecture before referred to, says that some years ago, when resident at Genoa, [Pg 68] he was one of the members of a committee for procuring a new floating chapel for the use of seamen. The old chapel was built on the deck of a hulk, but the extremely high summer temperature caused the repairs to be both frequent and costly. The committee therefore wanted the new chapel to be built of iron, but were deterred by the fear that its roof and sides, exposed to the sun, would get so hot as to render the interior unbearable. He therefore proposed to fill up the space between the outer skin and the inner boarding with asbestos ground to a rough powder; and this suggestion was adopted, the powder being tightly rammed in by the carpenters. The result, he informs us, was so successful that whilst the outside temperature stood at 100°, the temperature inside, when doors and windows were kept shut, did not exceed 70°. And he therefore suggests that asbestos powder might be used in a similar way for rendering the deck cabins of steamers navigating the Red Sea and Suez Canal more comfortable for the passengers.

For wall and ornamental papers it is being largely used, and a superior quality of asbestos writing paper is now being made in Paris. One can easily imagine a great future in this line for asbestos paper written or printed on with asbestos ink for all kinds of registers and permanent records, bankers' and merchants' books, and the like. One of the leading manufacturers in New York already prints his price lists on asbestos paper. And another has on show fine papers as susceptible of receiving good impressions from type as any in use in modern books. Coloured wall papers also are manufactured in great variety, which are not merely incombustible, but practically indestructible by fire; and which retain, even after severe heat tests, their colourings, markings and letterings as clearly impressed and as vividly visible as before. Boards also are made of asbestos, varying from the thinnest and lightest card to heavy shelving, fit either for [Pg 69] partitions in safes or for use in large libraries.

In a recent number of "L'Industrie Moderne" I found an account of a new process invented by a Mr. Ladewig for manufacturing pulp and paper from asbestos fibre, which he asserts will not only resist the action of both fire and water, but will absorb no moisture; this pulp, he says, may be used as a stuffing and for the joints of engines. He further proposes to use it in the form of a solid cardboard as a roofing material for light structures.

The process of manufacture consists in mixing about 25 per cent. of asbestos fibre with about 25 or 35 per cent. of powdered sulphate of alumina. This mixture is moistened with an aqueous solution of chloride of zinc. The mixture is washed with water and then treated with an aqueous solution of ammoniacal gas. The mixture is again washed and then treated with a solution composed of one part of resin soap and eight or ten parts of water mixed with an equal bulk of sulphate of alumina, which should be us pure as possible. The mixture thus obtained should have a slightly pulpy consistency. Finally, there is added to it 35 per cent. of powdered asbestos and 5 to 8 per cent. of white barytes. This pulp is treated with water in an ordinary paper machine, and worked just like paper pulp.

In order to manufacture a solid cardboard from asbestos which shall be proof against fire and water and capable of serving as a roofing material, sheets of common cardboard, tarred or otherwise prepared, are covered with the pulp. The application is made in a paper machine, the pulp being allowed to flow over the cardboard. Among other uses, the asbestos paper has been recommended for the manufacture of cigarettes, though its applicability for this purpose is not so readily seen.

Manufactured into paint, the demand for it is continually increasing. It is used in the Houses of [Pg 70] Parliament, as it was in very large quantities at the several recent exhibitions at South Kensington.

In the form of cement there is nothing equal to it as an efficient covering for boilers, steam pipes, hotblast furnaces, stills, &c. For this purpose it is made of about the consistency of mortar and spread on with a trowel in the ordinary way. Certain chemical ingredients have to be added, which, while not injurious to the metal, cause the asbestos to adhere firmly to the plates, so that when dry it becomes quite hard and can be walked over without being injured. With a boiler carrying say 80 lbs. steam pressure, the application of from 1½ to 2 inches of this composition so well retains the heat in the boiler, that a thermometer with the bulb held close to the outer surface of the covering will not indicate more than 80° to 85° Fahrenheit. Boilers, steam pipes, &c., covered in with this composition will, it is asserted by the manufacturers, effect a saving of as much as 33 per cent. in fuel.[10]

This cement, which is made from a very cheap quality of asbestos, is now in common use in Canada and the States, where, as already shown, it is found to operate with a twofold effect, viz. by lowering the temperature of the boilerhouse, to the great comfort of the engineers and [Pg 71] firemen, and also, in a very marked degree, economising the expenditure for fuel. It seems, therefore, strange that its use in this country has as yet made so little headway. In one of the large palatial buildings recently erected in London, where engines are required to be in constant work for pumping water for working the lifts and for general purposes, as well as for the dynamos, the heat from the boilers forms so great a nuisance, and occasions so much loss in other ways, that very considerable expense is about to be incurred, with a view to lowering the temperature. When conversing recently with an expert on this subject I asked whether the use of asbestos would not effect the desired object. Yes, he answered, it would, but it is too expensive. This certainly seems very strange, as I know that the cement composition referred to is made of the very commonest quality of asbestos, of the refuse, in point of fact, which could probably be

used for no other purpose. The expense, therefore, cannot be great, and as to its mode of use, it is simply laid on with a trowel, like mortar or any similar composition, and when once done is singularly effective. I have stood in an engine-house where the boilers were covered with about two inches in thickness of this cement, which then showed a hard, dry, firm surface; and, when the engines were in full work, on placing one's hand on the covering there was little more than a gentle warmth perceptible on the outside surface of the composition, whilst the surrounding atmosphere was scarcely, if at all, affected by the heat from the boilers. The boiler quiltings referred to on a previous page as being manufactured by a New York firm under contract with the United States Government, for use in some of their model war ships, would no doubt be as effectual for the purpose, but naturally they would be more costly, being an altogether different [Pg 72] contrivance, and made so as to be easily removable when required, which, of course, is not the case with the so-called cement. There is little doubt, however, that, although the use of asbestos in this form does not seem to find much favour here, its use for the purpose of coating boilers and steam-pipes will presently become as general in England as it already is on the other side, where its valuable qualities seem to be so much better known and appreciated.

Improved stove pipings are now being manufactured in the States which in appearance exactly resemble cast-iron. These have the additional valuable properties of extreme lightness, combined with great strength and a capability of ornamentation unobtainable with the usual cast-iron pipes mostly in use; paint in the case of the asbestos pipes not scaling off under heat as it will do in the case of ordinary iron pipes. The manufacturers of these pipes claim for them that they combine the strength of steel with the lightness of paper. Tubes also are made for electrical engineers which provide them with a non-conducting covering for their wires both fire and waterproof, so as to preserve the perfect insulation of the wire.

Asbestos rope is used for fire escapes and similar purposes, as well as for the transmission of power over places exposed to heat. In dyeing and printing cloth it is frequently necessary to hang the fabric in loops from parallel rods for exposure to steam, air or ammonia. In order that it should hold upon the rods, without straining or slipping, rope or strips of cloth are usually wound around the poles, but this does not remove, although it mitigates, the difficulty, because the heat and corrosive action of the vapours will rot any covering; the first notice of the deterioration being generally the appearance of small pieces of rod covering among the cloth which is in process of finishing. Asbestos rope and cloth are now largely manufactured and used for this [Pg 73] purpose in the United States with very beneficial results.

In commenting on the recent loss of life occasioned by the panic at the fire at the Exeter Theatre, a well-known journal, speaking of the various modes of providing for escape, mentions the case of a man of fashion, a millionaire, who died not long ago, and says that he would never go to bed in a strange house without having an apparatus of knotted rope affixed to a ring in the wall, by which he might lower himself to the ground on an emergency. But, asks the journalist, what if the rope itself took fire? The answer naturally is, let it be an asbestos rope, then it will neither burn nor rot.

The use of the fibre in the manufacture of gas stoves is too well known to need any remark.

As a lubricant it is unrivalled.

Another very important use to which it is now being applied is in the manufacture of filters. These are specially useful where the liquid to be filtered is of a caustic or strongly acid nature, or where the filter with residue is to be ignited without consuming the filter, or where the residue is to be subsequently dissolved off the filter by acids or other solvents. In many cases a very finely divided asbestos is desirable. This is accomplished by a process recently patented in Germany by Fr. Breyer, of Vienna. The asbestos is first coarsely ground, and then mixed with some granular crystalline carbonate, which must be soluble in acids. The carbonate should possess a hardness between 3 and 4, 5, according to the mineralogical scale. The mixture is ultimately ground together in a mill. Afterwards the mass is treated with an acid until the carbonate has been dissolved out. The escaping carbonic gas causes the asbestos fibres to be loosened and disintegrated from each other so as to render the mass porous. Of course it must be thoroughly [Pg 74] washed with water before being used.

Again, in the purification of foul gas, as well as for ventilating and deodorizing man-holes for cesspools, sewers, &c., its use is found to be unsurpassed by any other known material.

Mr. Boyd, in the paper so often referred to, says in regard to this, that he was some time previously asked to supply asbestos yarn spun in such a way as to have good capillary action, and, on making inquiry, found it was to be used for the above purpose. In describing the mode of using it, he says that there is placed over the opening rising from the sewer a hood of galvanized wire, interlaced with this asbestos yarn, the ends of the yarn dipping into a receptacle filled with liquid disinfectant, which, as they become saturated, form a disinfecting screen, through the meshes of which the gases rise, and in their passage through are purified and rendered innocuous. The system hitherto previously adopted for deodorizing sewer gas has been to cause it to rise through charcoal, but it is found that the impurities soon clog this up, and simply prevent the passage of the gas, whereas in the arrangement just mentioned (which is that of Messrs. Adams & Co., of York), the gas rises freely, and is perfectly deodorized.

There are, of course, very numerous other applications of the material which might be referred to or described, but probably those already mentioned are the most important and the most interesting; and these, it is hoped, are at any rate sufficient to indicate the great value of this singular mineral product, as well as to confirm the statement with which I started, that this is indeed one of Nature's most marvellous productions.

FOOTNOTE:

[10] There is a Patent Removable Covering now manufactured in New York which is said to be entirely formed of pure asbestos fibre, made in cylindrical sections of three-foot lengths of the exact size of the pipes to be covered. In this the asbestos fibres are so interlaced, that the sections, whilst possessing strength and flexibility, afford so large a number of air-cells as to give the covering the very highest non-conducting quality, whilst at the same time it cannot char or be in any way injured by the most intense heat from without or within. Fire Felt sectional coverings for boilers and large surfaces are made in convenient forms in sheets, &c. The same Company also manufacture what is called a Superator Jacket, both fire and waterproof, being in fact a flexible sheet of asbestos strengthened with wire netting, the asbestos being waterproofed by a special process, and provided with patent lacings, so that the jackets may be effectually kept in place, whilst being readily removable without cutting or loss of material.

INDEX.

Asbestos, meaning of, 5
- description, 7, 9
- origin unknown, 12
- only found in serpentine, 12
- places where found, 13
- first successful experiments with, 15
- difference between Canadian and Italian, 16, 22
- where used, 18
- analysis, 20
- Italian kinds, 21
- sources of supply, 13, 24
- marketable value, 28
- first discovery of, 29
- profitable nature of mining for, 31, 51
- annual production, 52
- aggregate output, 51
- uses of, 55

Aldini, Chevalier, 15, 18, 66
Amiante, 8
Anecdotes, 5, 13, 54, 60
Anglo-Canadian Company, 27, 36
Antimony, 48

Ballooning, military, 58
Bastard asbestos, 27
Boiler coverings, 58, 70
Boot soles, lining for, 67
Boston Company's mine, 31
Breeches of big guns, 56
Broughton mines, 42
Building operations, use in, 61

Canadian mineral estates, typical, 48
Carriage of explosives, 60
China, strange use of asbestos in, 15
Cement, 70
Chrome iron, 28, 36, 51
Chrysotile, 8
Cloth and paper, 67
Clothing for firemen, 66
Coating ironclads, 57
Cobbing, 52
Cold storage, 67
Coleraine group of mines, 36

Coleraine mines of Dr. Reed, 41
Cost of extraction, 36, 40
Coste, Eugène, report of, 52
Crocidolite, 9, 10
Curtains in theatres, 62

Danville, mine at, 46
Deck cabins of steamships, 68
Discolouration, 27, 33, 37
  removable, 38

Ells (Mr.), report of, 12, 31, 41, 50
Exeter Theatre, fire at, 63
Exhibition, American, 9
Extraction, cost of, 36, 40

Faults in veins, 47
Filters, 67, 73
Firemen's clothing, 16, 66
Fires at theatres, 62
Fireproof boxes, 58
  curtains, 62
Frechette-Douville mine, 39
French-Canadian labour, 53

Genoa, floating chapel at, 68
Geology of Canada, 7, 9, 26, 48
Gold at South Ham, 49

Heath, Captain, experiments of, 61

Immature asbestos, 32
Impurity of rock, 27
Ink, asbestos, 68
Italian asbestos, 15
  paper on, 19
Italy, experiments in, 15
Italian asbestos, three kinds of, 21
Iron-mining in Russia, 13
Irving's safety theatre, 63

Johnson Company's mine, 30
Journal of Society of Arts, 19

Kennedy's discovery at Coleraine, 42
King's mine, 32

Limestone at Templeton, 29
Lint, 61

Magnetite, 33
Mailbags, 67
Main sources of supply, 24
Marketable value, how determined, 28
Martin mine, 38
Merchants' and bankers' books, 68
Military ballooning, 58
Mineral wool, 11
Miner's lamps, 56
Mining in Canada, 24
  profitable nature of, 31, 51

Packing, 52
Paint, 69
Paper, 67, 68
Peculiarity at Thetford, 33
Pélé's hair, 11

Pierre-à-coton, 7
Places where used, 18
Profitable nature of asbestos-mining in Canada, 31, 51
Printing papers, 68
Pulp and paper, 69
Purification of foul gas, 74

4
Reed & Hay properties, 40
Reed's (Dr.), mine, 40
Registers and records, 68
Relative merits of Canadian and Italian asbestos, 17
Rope, 72
Russia, asbestos found in, 13, 14
  iron-mining in, 13

Scottish Asbestos Company, 36, 38, 44
Serpentine, 12, 24, 41
  often impure, 27
  ornamental, 29
Shipton mine, 46
Singular statement, 20
Slag wool, 11
Soapstone (steatite), 46, 49
  enormous quantity of, at South Ham, 49
South Ham, mines at, 47
Steam-power, 34
Steam-pipe coverings, 70
Stove pipings, 72

Theatres, fires in, 62
Thetford group of mines, 29
  district rich in minerals, 36
Time fuzes, 67
Tunnelling impracticable in Canada, 21

Underwriters, offer of, 62
United Asbestos Company of London, 16, 60
Ural region, large quantities found in, 14

Wages at Canadian mines, 53
Wall papers, 68
Want of foresight in mining for asbestos, 35
Ward's mine, 31
Whitehead torpedoes, 56
Willimott (Mr.), report of, 26
Wolfestown mines, 50

PRINTED BY J. S. VIRTUE AND CO., LIMITED, CITY ROAD, LONDON.

Transcriber's Note

Some inconsistent hyphenation and spelling in the original document has been preserved.

Typographical errors corrected in the text:

Page 40 Haydon changed to Hayden

Page 50 Balmina changed to Belmina
Page 58 Nary changed to Navy

*** END OF THE PROJECT GUTENBERG EBOOK ASBESTOS, ITS PRODUCTION AND USE ***

Updated editions will replace the previous one—the old editions will be renamed.

Creating the works from print editions not protected by U.S. copyright law means that no one owns a United States copyright in these works, so the Foundation (and you!) can copy and distribute it in the United States without permission and without paying copyright royalties. Special rules, set forth in the General Terms of Use part of this license, apply to copying and distributing Project Gutenberg™ electronic works to protect the PROJECT GUTENBERG™ concept and trademark. Project Gutenberg is a registered trademark, and may not be used if you charge for an eBook, except by following the terms of the trademark license, including paying royalties for use of the Project Gutenberg trademark. If you do not charge anything for copies of this eBook, complying with the trademark license is very easy. You may use this eBook for nearly any purpose such as creation of derivative works, reports, performances and research. Project Gutenberg eBooks may be modified and printed and given away—you may do practically ANYTHING in the United States with eBooks not protected by U.S. copyright law. Redistribution is subject to the trademark license, especially commercial redistribution.

START: FULL LICENSE

THE FULL PROJECT GUTENBERG LICENSE

PLEASE READ THIS BEFORE YOU DISTRIBUTE OR USE THIS WORK

To protect the Project Gutenberg™ mission of promoting the free distribution of electronic works, by using or distributing this work (or any other work associated in any way with the phrase “Project Gutenberg”), you agree to comply with all the terms of the Full Project Gutenberg™ License available with this file or online at www.gutenberg.org/license.

Section 1. General Terms of Use and Redistributing Project Gutenberg™ electronic works

1.A. By reading or using any part of this Project Gutenberg™ electronic work, you indicate that you have read, understand, agree to and accept all the terms of this license and intellectual property (trademark/copyright) agreement. If you do not agree to abide by all the terms of this agreement, you must cease using and return or destroy all copies of Project Gutenberg™ electronic works in your possession. If you paid a fee for obtaining a copy of or access to a Project Gutenberg™ electronic work and you do not agree to be bound by the terms of this agreement, you may obtain a refund from the person or entity to whom you paid the fee as set forth in paragraph 1.E.8.

1.B. “Project Gutenberg” is a registered trademark. It may only be used on or associated in any way with an electronic work by people who agree to be bound by the terms of this agreement. There are a few things that you can do with most Project Gutenberg™ electronic works even without complying with the full terms of this agreement. See paragraph 1.C below. There are a lot of things you can do with Project Gutenberg™ electronic works if you follow the terms of this agreement and help preserve free future access to Project Gutenberg™ electronic works. See paragraph 1.E below.

1.C. The Project Gutenberg Literary Archive Foundation (“the Foundation” or PGLAF), owns a compilation copyright in the collection of Project Gutenberg™ electronic works. Nearly all the individual works in the collection are in the public domain in the United States. If an individual work is unprotected by copyright law in the United States and you are located in the United States, we do not claim a right to prevent you from copying, distributing, performing, displaying or creating derivative works based on the work as long as all references to Project Gutenberg are removed. Of course, we hope that you will support the Project Gutenberg™ mission of promoting free access to electronic works by freely sharing Project Gutenberg™ works in compliance with the terms of this agreement for keeping the Project Gutenberg™ name associated with the work. You can easily comply with the terms of this agreement by keeping this work in the same format with its attached full Project Gutenberg™ License when you share it without charge with others.

1.D. The copyright laws of the place where you are located also govern what you can do with this work. Copyright laws in most countries are in a constant state of change. If you are outside the United States, check the laws of your country in addition to the terms of this agreement before downloading, copying, displaying, performing, distributing or creating derivative works based on this work or any other Project Gutenberg™ work. The Foundation makes no representations concerning the copyright status of any work in any country other than the United States.

1.E. Unless you have removed all references to Project Gutenberg:

1.E.1. The following sentence, with active links to, or other immediate access to, the full Project

Gutenberg™ License must appear prominently whenever any copy of a Project Gutenberg™ work (any work on which the phrase “Project Gutenberg” appears, or with which the phrase “Project Gutenberg” is associated) is accessed, displayed, performed, viewed, copied or distributed:

> This eBook is for the use of anyone anywhere in the United States and most other parts of the world at no cost and with almost no restrictions whatsoever. You may copy it, give it away or re-use it under the terms of the Project Gutenberg License included with this eBook or online at www.gutenberg.org. If you are not located in the United States, you will have to check the laws of the country where you are located before using this eBook.

1.E.2. If an individual Project Gutenberg™ electronic work is derived from texts not protected by U.S. copyright law (does not contain a notice indicating that it is posted with permission of the copyright holder), the work can be copied and distributed to anyone in the United States without paying any fees or charges. If you are redistributing or providing access to a work with the phrase “Project Gutenberg” associated with or appearing on the work, you must comply either with the requirements of paragraphs 1.E.1 through 1.E.7 or obtain permission for the use of the work and the Project Gutenberg™ trademark as set forth in paragraphs 1.E.8 or 1.E.9.

1.E.3. If an individual Project Gutenberg™ electronic work is posted with the permission of the copyright holder, your use and distribution must comply with both paragraphs 1.E.1 through 1.E.7 and any additional terms imposed by the copyright holder. Additional terms will be linked to the Project Gutenberg™ License for all works posted with the permission of the copyright holder found at the beginning of this work.

1.E.4. Do not unlink or detach or remove the full Project Gutenberg™ License terms from this work, or any files containing a part of this work or any other work associated with Project Gutenberg™.

1.E.5. Do not copy, display, perform, distribute or redistribute this electronic work, or any part of this electronic work, without prominently displaying the sentence set forth in paragraph 1.E.1 with active links or immediate access to the full terms of the Project Gutenberg™ License.

1.E.6. You may convert to and distribute this work in any binary, compressed, marked up, nonproprietary or proprietary form, including any word processing or hypertext form. However, if you provide access to or distribute copies of a Project Gutenberg™ work in a format other than “Plain Vanilla ASCII” or other format used in the official version posted on the official Project Gutenberg™ website (www.gutenberg.org), you must, at no additional cost, fee or expense to the user, provide a copy, a means of exporting a copy, or a means of obtaining a copy upon request, of the work in its original “Plain Vanilla ASCII” or other form. Any alternate format must include the full Project Gutenberg™ License as specified in paragraph 1.E.1.

1.E.7. Do not charge a fee for access to, viewing, displaying, performing, copying or distributing any Project Gutenberg™ works unless you comply with paragraph 1.E.8 or 1.E.9.

1.E.8. You may charge a reasonable fee for copies of or providing access to or distributing Project Gutenberg™ electronic works provided that:

- You pay a royalty fee of 20% of the gross profits you derive from the use of Project Gutenberg™ works calculated using the method you already use to calculate your applicable taxes. The fee is owed to the owner of the Project Gutenberg™ trademark, but he has agreed to donate royalties under this paragraph to the Project Gutenberg Literary Archive Foundation. Royalty payments must be paid within 60 days following each date on which you prepare (or are legally required to prepare) your periodic tax returns. Royalty payments should be clearly marked as such and sent to the Project Gutenberg Literary Archive Foundation at the address specified in Section 4, “Information about donations to the Project Gutenberg Literary Archive Foundation.”
- You provide a full refund of any money paid by a user who notifies you in writing (or by e-mail) within 30 days of receipt that s/he does not agree to the terms of the full Project Gutenberg™ License. You must require such a user to return or destroy all copies of the works possessed in a physical medium and discontinue all use of and all access to other copies of Project Gutenberg™ works.
- You provide, in accordance with paragraph 1.F.3, a full refund of any money paid for a work or a replacement copy, if a defect in the electronic work is discovered and reported to you within 90 days of receipt of the work.
- You comply with all other terms of this agreement for free distribution of Project Gutenberg™ works.

1.E.9. If you wish to charge a fee or distribute a Project Gutenberg™ electronic work or group of works on different terms than are set forth in this agreement, you must obtain permission in writing from the Project Gutenberg Literary Archive Foundation, the manager of the Project Gutenberg™ trademark. Contact the Foundation as set forth in Section 3 below.

1.F.

1.F.1. Project Gutenberg volunteers and employees expend considerable effort to identify, do copyright research on, transcribe and proofread works not protected by U.S. copyright law in

creating the Project Gutenberg™ collection. Despite these efforts, Project Gutenberg™ electronic works, and the medium on which they may be stored, may contain “Defects,” such as, but not limited to, incomplete, inaccurate or corrupt data, transcription errors, a copyright or other intellectual property infringement, a defective or damaged disk or other medium, a computer virus, or computer codes that damage or cannot be read by your equipment.

1.F.2. LIMITED WARRANTY, DISCLAIMER OF DAMAGES - Except for the “Right of Replacement or Refund” described in paragraph 1.F.3, the Project Gutenberg Literary Archive Foundation, the owner of the Project Gutenberg™ trademark, and any other party distributing a Project Gutenberg™ electronic work under this agreement, disclaim all liability to you for damages, costs and expenses, including legal fees. YOU AGREE THAT YOU HAVE NO REMEDIES FOR NEGLIGENCE, STRICT LIABILITY, BREACH OF WARRANTY OR BREACH OF CONTRACT EXCEPT THOSE PROVIDED IN PARAGRAPH 1.F.3. YOU AGREE THAT THE FOUNDATION, THE TRADEMARK OWNER, AND ANY DISTRIBUTOR UNDER THIS AGREEMENT WILL NOT BE LIABLE TO YOU FOR ACTUAL, DIRECT, INDIRECT, CONSEQUENTIAL, PUNITIVE OR INCIDENTAL DAMAGES EVEN IF YOU GIVE NOTICE OF THE POSSIBILITY OF SUCH DAMAGE.

1.F.3. LIMITED RIGHT OF REPLACEMENT OR REFUND - If you discover a defect in this electronic work within 90 days of receiving it, you can receive a refund of the money (if any) you paid for it by sending a written explanation to the person you received the work from. If you received the work on a physical medium, you must return the medium with your written explanation. The person or entity that provided you with the defective work may elect to provide a replacement copy in lieu of a refund. If you received the work electronically, the person or entity providing it to you may choose to give you a second opportunity to receive the work electronically in lieu of a refund. If the second copy is also defective, you may demand a refund in writing without further opportunities to fix the problem.

1.F.4. Except for the limited right of replacement or refund set forth in paragraph 1.F.3, this work is provided to you ‘AS-IS’, WITH NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PURPOSE.

1.F.5. Some states do not allow disclaimers of certain implied warranties or the exclusion or limitation of certain types of damages. If any disclaimer or limitation set forth in this agreement violates the law of the state applicable to this agreement, the agreement shall be interpreted to make the maximum disclaimer or limitation permitted by the applicable state law. The invalidity or unenforceability of any provision of this agreement shall not void the remaining provisions.

1.F.6. INDEMNITY - You agree to indemnify and hold the Foundation, the trademark owner, any agent or employee of the Foundation, anyone providing copies of Project Gutenberg™ electronic works in accordance with this agreement, and any volunteers associated with the production, promotion and distribution of Project Gutenberg™ electronic works, harmless from all liability, costs and expenses, including legal fees, that arise directly or indirectly from any of the following which you do or cause to occur: (a) distribution of this or any Project Gutenberg™ work, (b) alteration, modification, or additions or deletions to any Project Gutenberg™ work, and (c) any Defect you cause.

Section 2. Information about the Mission of Project Gutenberg™

Project Gutenberg™ is synonymous with the free distribution of electronic works in formats readable by the widest variety of computers including obsolete, old, middle-aged and new computers. It exists because of the efforts of hundreds of volunteers and donations from people in all walks of life.

Volunteers and financial support to provide volunteers with the assistance they need are critical to reaching Project Gutenberg™’s goals and ensuring that the Project Gutenberg™ collection will remain freely available for generations to come. In 2001, the Project Gutenberg Literary Archive Foundation was created to provide a secure and permanent future for Project Gutenberg™ and future generations. To learn more about the Project Gutenberg Literary Archive Foundation and how your efforts and donations can help, see Sections 3 and 4 and the Foundation information page at www.gutenberg.org.

Section 3. Information about the Project Gutenberg Literary Archive Foundation

The Project Gutenberg Literary Archive Foundation is a non-profit 501(c)(3) educational corporation organized under the laws of the state of Mississippi and granted tax exempt status by the Internal Revenue Service. The Foundation’s EIN or federal tax identification number is 64-6221541. Contributions to the Project Gutenberg Literary Archive Foundation are tax deductible to the full extent permitted by U.S. federal laws and your state’s laws.

The Foundation’s business office is located at 809 North 1500 West, Salt Lake City, UT 84116, (801) 596-1887. Email contact links and up to date contact information can be found at the Foundation’s website and official page at www.gutenberg.org/contact

Section 4. Information about Donations to the Project Gutenberg Literary Archive Foundation

Project Gutenberg™ depends upon and cannot survive without widespread public support and donations to carry out its mission of increasing the number of public domain and licensed works that can be freely distributed in machine-readable form accessible by the widest array of equipment including outdated equipment. Many small donations ($1 to $5,000) are particularly important to maintaining tax exempt status with the IRS.

The Foundation is committed to complying with the laws regulating charities and charitable donations in all 50 states of the United States. Compliance requirements are not uniform and it takes a considerable effort, much paperwork and many fees to meet and keep up with these requirements. We do not solicit donations in locations where we have not received written confirmation of compliance. To SEND DONATIONS or determine the status of compliance for any particular state visit www.gutenberg.org/donate.

While we cannot and do not solicit contributions from states where we have not met the solicitation requirements, we know of no prohibition against accepting unsolicited donations from donors in such states who approach us with offers to donate.

International donations are gratefully accepted, but we cannot make any statements concerning tax treatment of donations received from outside the United States. U.S. laws alone swamp our small staff.

Please check the Project Gutenberg web pages for current donation methods and addresses. Donations are accepted in a number of other ways including checks, online payments and credit card donations. To donate, please visit: www.gutenberg.org/donate

Section 5. General Information About Project Gutenberg™ electronic works

Professor Michael S. Hart was the originator of the Project Gutenberg™ concept of a library of electronic works that could be freely shared with anyone. For forty years, he produced and distributed Project Gutenberg™ eBooks with only a loose network of volunteer support.

Project Gutenberg™ eBooks are often created from several printed editions, all of which are confirmed as not protected by copyright in the U.S. unless a copyright notice is included. Thus, we do not necessarily keep eBooks in compliance with any particular paper edition.

Most people start at our website which has the main PG search facility: www.gutenberg.org.

This website includes information about Project Gutenberg™, including how to make donations to the Project Gutenberg Literary Archive Foundation, how to help produce our new eBooks, and how to subscribe to our email newsletter to hear about new eBooks.