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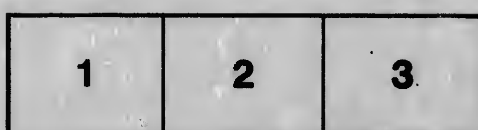

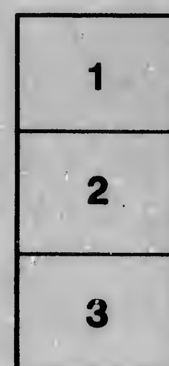

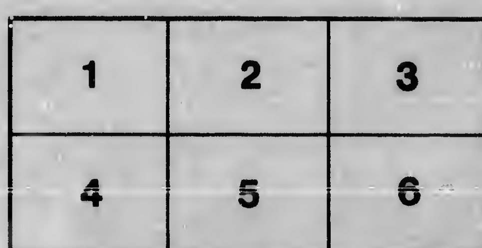

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INCORPORATED 1887.

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PLUMBAGO, AND SOME OF ITS USES.

By John Fraser Torrance, M. Can. Soc. C. E.

To be read Friday, 9th December, 1892.

Plumbago, graphite or black lead is well known to all of us in its various forms of application as stove polish, foundry facings, lubricating powder, pencil leads, graphite grease, graphite packing, graphite paint, etc., etc.

It sometimes occurs in nature in flat hexagonal crystals, but generally it occurs massive or more or less radiated, foliated, scaly or compact. It is of a grayish-black color with an almost metallic lustre and a black shining streak. It is too soft to strike fire with a steel and it is a splendid conductor of electricity. Its specific gravity ranges from 1·8 to 2·24. It is composed chiefly of carbon; but usually it contains more or less alumina, silica, lime, iron, etc., apparently in mechanical mixture rather than in chemical combination. Next to the diamond it is the most incombustible form of carbon. For this reason it is used in combination with fire-clay for the manufacture of crucibles to resist the highest temperatures.

As far as I can learn, all the known deposits of plumbago of any economic value occur in rocks of Laurentian age. The only mine working on a large scale in the United States is operated by the Jos. Dixon Crucible Co. at Ticonderoga, N.Y. In a report by Albert Williams, Jr., of the United States Geological Survey on the Mineral Resources of the United States, it is stated that the deposit now being exploited is a bed of graphitic schists fifteen feet thick, carrying from 8 to 15 per cent. of graphite. This is treated by a wet process, wherein the ordinary practice is reversed; the "heads" being the refuse and the "tails" being the valuable graphite. The average output is placed at 500,000 lbs. valued at an average of 8 cents per lb. at the works. Apart from this Company's output the North American trade is supplied almost entirely from the amorphous earthy deposit near Passau in Bavaria, and the large veins of graphite in the Laurentian gneiss near Travancore in Ceylon. But the finest pencil lead comes from the mines in Irkutsk, Siberia.

Some interesting notes on the geology of Ceylon were published as far back as 1818 by Dr. John Davy, who says: "Graphite is pretty commonly disseminated in minute scales through gneiss. It is worthy of remark that graphite is generally found in company with gems. I have had so often occasion to make the observation that now I never see the former without suspecting the presence of the latter."

The Ceylon graphite is extracted from large fissure veins in the gneiss, which are completely filled by the graphite. It requires to be merely cobbed and sized before going to market. It is known as "dust," "chip" and "lump." Dust sells at 2½ cents per lb. in New York, chip at 3½ cents and lump at 5½ cents. It is used for all purposes except pencil making.

The German black lead is far more impure, containing only 35 to 40 per cent. of carbon, the balance being of the composition of clay. But it is suitable for use in pencil-making. Very refractory crucibles are made by mixing 2 to 3 parts of this impure plumbago with one part of clay. Such crucibles will undergo 70 to 80 meltings in brass foundries, about 50 meltings with bronze or 8 to 10 meltings with steel.

The American and Canadian graphite is used for all purposes of the trade and excels all others as a lubricant. Many tests have proved this conclusively.

As graphite or plumbago is found almost exclusively in rocks of Laurentian age and there is a greater development of these rocks in Canada than anywhere else, we should naturally expect to find many deposits of graphite in this country. It is nearly half a century since two of Canada's most distinguished citizens called attention to the large deposits of graphite in the Laurentian formation both north and south of the Ottawa River, and pointed out the possibility of their profitable exploitation for shipment to the British market. Since the date of this first report by Sir Wm. Logan and Dr. T. Sterry Hunt, the marvellous growth of the American nation has developed a demand for this material on our own continent such as they hardly anticipated. And it is not creditable to the enterprise and skill of our Canadian capitalists and miners that this market is supplied from similar deposits in Bavaria and far-distant Ceylon, while our own lie idle and almost unknown.

In Canada the graphite is usually found in close relation to some of the large bands of massive crystalline Laurentian limestone that can be traced through Burgess and Elmsley (near the Rideau) and re-appear in Hull, Templeton, Buckingham, Lochaber and Grenville. This mineral generally occurs disseminated in scales in beds of limestone, sandstone or pyroxenite; or else in veins from a few inches to several feet thick. These beds are often interrupted, producing lenticular masses which are sometimes pure and sometimes mixed with carbonate of lime, pyroxene and other minerals. At times it is so finely disseminated through the limestone as to give it a blueish-grey color, which serves to mark the stratification of the rock. In one locality at Grenville sphene, zircon, pyroxene and tabular spar have been found associated with it, reminding us of Dr. Davy's observations about the precious stones in Ceylon. No veins of graphite, however, have been found yet in Canada of sufficient size and extent for profitable exploitation. All attempts at plumbago mining in Canada have been confined to the limestone beds of disseminated graphite in Buckingham, Lochaber and Grenville townships as well as some rich masses where a number of small veins are seen to intersect; and to a sandstone bed near Oliver's Ferry on the Rideau Lake, which is richly impregnated with graphite.

Some ten years ago it was my duty in connection with the Geological Survey of Canada to examine some of the principal deposits of plumbago in Ottawa County of this Province, and enquire the reasons why they lay idle. My report was published in the volume for 1882-83-84. But these reports are so little seen by our members that I may be permitted a few quotations :—

An American manufacturer wrote me that his company tried a great deal of the Canadian graphite some years previously, but were obliged to give it up *because it did not run uniform.* Some of the crucibles made from it were as good as any, but others would crack or melt. They gave it a thorough test and used a great many barrels of it. It contained sulphur and other impurities.

Surely this statement is an ample explanation of the idleness and decay of the Canadian plumbago works. But I did not hesitate to assert then and repeat most emphatically here that "as long as the price of dressed plumbago does not fall below forty dollars per ton, many of our Canadian deposits could be profitably worked, always provided that they are worked by competent mining engineers. But no mining company need hope to succeed in Canada or any other place unless the manager has had a careful technical training or the ore is of phenomenal richness."

The relative value of our Canadian deposits depends not only upon the freedom from lime and iron, as well as their richness and extent, but also upon their situation with regard to easy exploitation, cheap labour and supplies, low rates of freight, etc. On nearly all these counts I am inclined to rank the deposit once worked near Oliver's Ferry on the Rideau Lake as far superior to any in this Province. This deposit occurs in a five foot bed of sandstone which has been opened on the crown of a flat anticlinal. A sample lot shipped from here this autumn and dressed by S. R. Krom's pneumatic jigs yielded ten per cent. of dressed graphite. Men with some experience in phosphate mining can be hired here for $1.25 per day: plenty of dry tamarac can be bought for $1.50 to $1.60 per cord; the wharf at Oliver's Ferry is only one mile distant, and the main line of the Canadian Pacific Railway comes within three miles at "Elmsley," a way station between Perth and Smith's Falls.

The sudden closing of this mine in 1874 is attributed partly to the wide-spread ruin among the iron masters of the United States, who were its chief customers, and partly to an agreement between its owner and some of the large operators in graphite across the boundary. Many facts connected with its closing are not readily explained in any other way. The proprietor Mr. Eaton, of Rochester, N. Y., himself stated to Mr. Morris of Perth, that it took only six months' profits to pay for the property, plant and all.

The quantity of plumbago, graphite or black lead imported into the United States in the year ending 30th June, 1891, amounted to 10,136 tons, valued at $509,809; while it increased in the following year to 13,511 tons, valued at $726,648. This shows conclusively that there is no danger of any properly conducted Canadian plumbago mine failing to market its wares, if it is worked economically and the output is thoroughly uniform and up to standard.

From the valuable report on the Mineral Resources of the United States published in 1884, I quote the proportions of the output, etc., devoted to various uses, as follows:—

Making crucibles and refractory wares	30%
Stove polish	30%
Lubricating graphite	13%
Foundry facings	10%
Graphite greases	8%
Pencil leads	3%
Graphite packing	3%
Polishing shot and powder	2%
Paint ½; electrotyping and miscellaneous ½	1%

But it is altogether likely that this comparative statement will be radically modified, as a result of the general introduction of the wonderful new lubricating composition invented by Mr. Philip H. Holmes of Gardiner, Maine, known as fibre-graphite. My attention was first called to it about twelve months ago by a letter from Mr. J. T. Taylor, M.E., the Mechanical Superintendent for Messrs. W. & J. Sloane, who had been professionally investigating its merits. His claims for this material were almost too strong to be readily believed. But subsequent investigations by Prof. Henry T. Bovey, Messrs. Frank Redpath, R. F. Ogilvy and myself have fully confirmed the immense value of this new anti-friction material. Prof. Bovey was permitted to bring back two boxes bushed with this material, which he set up in the Workman workshops at McGill University last June. They have been running ever since and giving perfect satisfaction without any oiling or special attention.

This fibre-graphite is simply an intimate mechanical mixture of finely divided plumbago and mechanical wood pulp in varying proportions according to the purposes of the special bearing. These materials are mixed in water and pumped with a hand-pump into the moulds, which are made of brass with grooves on the outside and small holes possibly $\frac{1}{16}$ inch in diameter spaced about $\frac{5}{8}$ inch apart. Each mould is inclosed in a heavy case made of a steel casting. The mass is compressed by hydraulic pressure to about $\frac{1}{3}$ its original bulk, while the water escapes through the hole and along the grooves. (The inventor considers this system of drainage very important, as the flow of water tends to arrange the wood fibres radially from the centre of the bearing.) After sufficient pressure the piece is removed from the mould and dried. It is then immersed in a bath of hot linseed oil and finally subjected to a slow baking in a gas oven.

This product can be cut and tooled with ease. But it takes and retains the form of the mould so perfectly that any tooling is unnecessary.

In August, 1891, a committee of the Franklin Institute composed of H. R. Hoyl, Chairman, and Messrs. J. Sellers Bancroft, Thos. P. Conard, Philip H. Fowler, Luther L. Cheney, Stockton Bates, H. W. Spangler and S. H. Vanclain made a very exhaustive investigation of the merits of this invention, which resulted in the award of the Elliot Cresson gold medal to Mr. Holmes. In the award they state that there is nothing in the Holmes compound that can be injured by any degree of heat that can arise from frictional causes, or can cause surrounding objects to ignite, therefore the fire risk due to the over-heating of journals will disappear in direct proportion to the use of these graphite bearings." They say:—"We find further that the ratio of friction with the Holmes' bearings is much less than with well oiled metal bearings, and greatly superior to the results obtained in common practice, thereby effecting a great saving in power even in comparison with the most carefully attended metal bearings. The co-efficient of friction of the Holmes' bearing is practically constant, being no greater at starting than when running at any speed. * * *

"The remarkable qualities of this bearing material are strikingly exhibited in its application to the spinning frame, when the spindles are run at very high velocities. In this direction your committee has taken special pains to verify, by personal tests, the excellent results vouched for by others. Spindles running with unusually tight belts constantly for ten hours a day for three weeks, at a speed of 8,400 revolutions per minute, did not heat or show any perceptible wear either of the spindles or the graphite bearings. Thus, through Mr. Holmes' invention, it has become practicable to run an entire spinning plant without using a single oiled bearing, which means in economy, cleanliness and freedom from fire risk, conditions of inestimable value. Your committee have also practically tested the brushes made of this material for use upon dynamos, and found them practically indestructible, that they do not wear the commutators, and give most satisfactory results in every way."

The history of this invention was told to me very simply by the inventor himself, who is also the inventor and maker of one of the most successful turbine water wheels in the New England States. Mr. Holmes was experimenting with wooden steps for these wheels, when he reflected that plumbago was the best known lubricant for wooden cog wheels and that it would probably be the best for his wooden steps also, if he could devise some means of fixing it there. Suddenly the idea occurred to him that he might incorporate the plumbago in the step. A series of careful experiments with plumbago and wood pulp gradually led him to a more complete success than he could have hoped for.

One of the facts cited in a paper by Mr. John H. Cooper, M.E., on this subject read at a recent meeting of the American Society of Mechanical Engineers, shows how perfectly Mr. Holmes solved the problem of his water-wheel. Mr. Cooper says:—

"When used as a step bearing in water upon which a loaded vertical shaft runs, it is proven that 300 lbs may be supported in revolution of 470 turns per minute upon an obtuse angled cone 2 inches in diameter, which is the equivalent of 100 lbs. per square inch of surface covered, in which case the tool marks were not all worn out nor any detrimental effect of submersion or abrasion observed after three months of running."

In conclusion let me add that, if my lengthy presentation of this subject has not exhausted your interest in the matter, I hope next session to be able to lay before you the record of some practical experience in mining and preparing our Canadian graphite for market, and also some observations on actual work done by the Holmes' fibre-graphite bearings in Canadian industrial establishments.