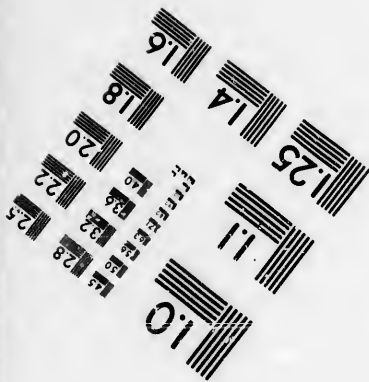
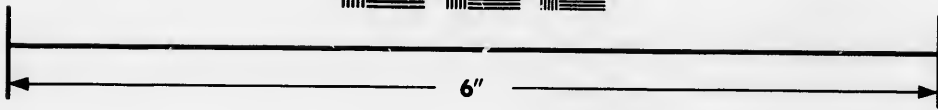
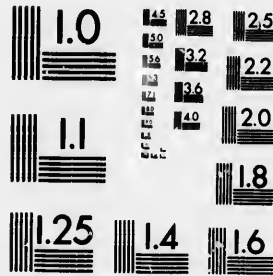


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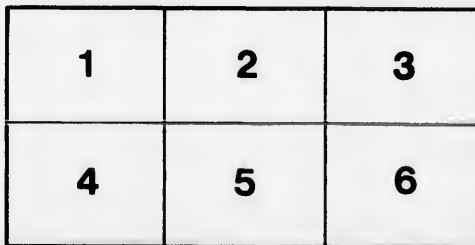
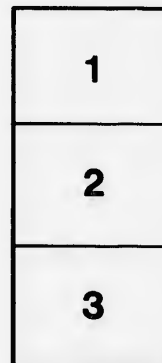
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A. Thos. Drummond
from the author

ROOFING SLATE,

AS A SOURCE OF WEALTH TO CANADA.

A VISIT TO THE WALTON SLATE QUARRY.

BY ROBERT BELL, C. E.,

Of the Geological Survey of Canada, and interim Professor of Natural Sciences in Queen's
College, Kingston.

(Read before the Natural History Society.)

The rarer treasures of the mineral world are not always those which yield the largest returns for the working. According to Darwin, it is remarked in South America, that "a person with a copper mine will gain; with silver, he may gain; but with gold he is sure to lose." Continuing this sort of comparison to the rarer mineral products, it could not be difficult to show that there are many of them which pay better, even than copper. In the midst of the excitement about copper and gold in the Eastern Townships, our valuable treasures in roofing slate have not been altogether overlooked. But before proceeding to point out the importance of this source of wealth, let us consider for a moment the value of slate quarries in other parts of the world, and ascertain how others turn their advantages, in this respect, to profitable account. The slate quarries of Wales are perhaps the most extensively wrought in the world. The Penrhyn Quarry, six miles from Bangor in North Wales, and owned by the Hon. Colonel Pennant, has been worked to a depth of nearly 900 feet by successive benches or chambers, each sixty feet below the next above. The lowest of these have been reached by sinking shafts and running horizontal adits or drifts, from which the material has to be raised perpendicularly. The cost of working is thus much increased, but notwithstanding this circumstance, the quarry is believed to pay nearly a hundred per cent. profit, and the annual net gains amount to upwards of £100,000. This quarry was opened about fifty years ago. It employs 2,500 men in the

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various operations connected with its working, and produces 13,000,000 of slates a year. The Lanberris quarry employs 2,000 men, and returns a net annual profit of about £70,000. The Welsh Slate Company's quarry, owned in part by Lord Palmerston, employs 400 men, and yields an annual profit of about £25,000. The Rhewbryfdair Slate Company's quarry, gives employment to 350 men, and affords an annual net profit of £18,000, or fifty per cent. on the original capital. A quarry belonging to the Festiniog Slate Company is now being further developed, and it is proposed to make it furnish 50,000 tons per annum at a profit of £37,000 and a minimum dividend of from 37 to 40 per cent. These and other quarries, employing from 250 to 300 men, and yielding equally great returns, in proportion to their production, are situated on a slate band or "vein," as it is locally termed, in the Festiniog district in North Wales.* There are besides, about a dozen other quarries in operation in Wales, all making the most satisfactory returns, when judiciously worked, although some of them have to contend against great difficulties, arising from the unfavorable underlie of the cleavage for working, or from disadvantages in the positions and locations of the quarries, some of which are between twenty and thirty miles distant from a port or railway. The slates are paid for at the quarries by the thousand, but the Welshmen reckon 1,200 to the "thousand." The Welsh quarries are estimated to produce an aggregate of from 350 to 400,000 tons of slate every year, of which fully one-half is furnished by the two first mentioned. The selling price of manufactured slates is about fifty shillings a ton, so that if the latter figure be correct, the yearly value of the slates produced in Wales, will be equal to a million of pounds sterling.

A cubic yard of slate rock weighs about two tons, and when we know the proportion to allow for waste in quarrying and dressing, we can calculate approximately the quantity of slates which can be produced in a volume of slate rock whose dimensions are given. As these dimensions can be ascertained in each case, the profits of slate quarrying may be reduced to a certainty, and thus it has the character of a sure branch of business—a great advantage over the more hazardous enterprise of mining. Some of the slate quarries in Wales have a horizontal surface of from 1000 to 2000 square yards, and are capable of being worked, in many

* The above figures are taken from authentic statistics, first published in the *Cambriais* (a Swansea Journal) in June 1862.

instances, to great depths. It will presently be shown that some of the workable slate bands in Canada are very much more extensive.

In Britain all the best slate quarries have been opened long ago, and capitalists are now spending large sums in developing indifferent locations; still with proper management, fortunes are being made in working even comparatively new places. The large yearly profits derived from roofing slates have already enabled the owners of the quarries to amass immense sums of money, and the increasing demand, not only for roofing, but also for sanitary and other purposes to which slate has been applied, for shadows, the brightest prospects for the future. Great as is the number of slates manufactured, the supply is not equal to the demand, and hence the producers have of late, been able to dictate all the terms and conditions of purchase to the buyers. The "rules and regulations" respecting the sale of slate at some of the quarries have very much the tone of the laws in the statute books.

Some quarries have orders booked for forty to sixty weeks in advance. In consequence of the enormous demand, prices have lately advanced several times, and if they were again raised 20 per cent, (says the Mining Journal from which these facts are principally derived) the sale would not be affected—so many new markets are continually opening. In addition to the rapidly increasing demand in Britain itself, orders for slates are sent from all parts of the world. Large numbers are constantly shipped to Russia, France, Spain, Germany, Denmark, Prussia, Austria and America, although the demand from the last mentioned quarter has not been so great for the last two years.

Slates, equal to those of Wales, are obtained in the west of Scotland and in the Delabole district, parish of Tintagel, in the north of Cornwall, where quarries are now worked paying 30 per cent. profit on the outlay. It would be needless here to enter into the merits of the slates of these regions, since my object is merely to shew the great value of this source of wealth in Great Britain, for which it is hoped the facts given in regard to Wales are sufficient.

The roofing slates of Great Britain and France belong to Lower Silurian strata, which are believed to be equivalent to the Quebec group of this continent, and which comprises many of the slate bands of Eastern Canada and New England.

Since competition in the slate market of this continent, and per-

haps also to some extent in that of the old world, is to be expected mainly from Vermont, it may not be uninteresting here to refer to the slate resources of that state. Three belts of slate rock occur in the state, running southward down its eastern, middle and western portions. In the first, which keeps near the boundary of New Hampshire, the slate is of a dark color, and the cleavage generally corresponds with the planes of stratification. Although the belt has a great thickness, but little of it is available for working owing to contortions, the presence of foreign ingredients, imperfect cleavage and cross joints. An occasional band, however, is found to be suitable for roofing slates, and upon one of them the Guilford quarries are situated. The slates of this locality are sufficiently durable, but owing to their thickness, require a heavily timbered roof to support them. They are also liable to become rusty from the presence of oxide of iron. The situation of these quarries is such as to prevent their produce competing successfully with the slates imported from Wales. The slate bands in the eastern belt dip at high angles to the horizon, and thus have an advantage for working, over those of the western belt.

The middle slate belt extends from the Canada line at Lake Memphremagog about half way down the middle of the state. In places it is found to split into thin sheets, and is of a uniform color, —nearly black, —differing in these respects from the slate bands of the eastern belt. Northfield, near the centre of the state, is the only place at which it has been worked. Here the price of slate delivered on the cars is \$3.75 a square, or 50 cents more than Mr. Walton's price, on the Grand Trunk cars at Richmond. It may not be generally known that a square of slates is a hundred square feet, and that the greater the number required to make this area, the smaller the price per square.

The workable seams of the westerly belt are largely quarried for roofing and other purposes in the southwestern part of the state, where slate manufacturing forms a leading branch of industry. The slate is of a more uniform character than that of the eastern or the middle belt, and more exempt from foreign matter, which renders it capable of being sawn, as slab slate, and used for a great variety of purposes. The color of most of the western Vermont slates, like that of the Welsh, is dark purple, sometimes mottled with green spots. Bands of green, and sometimes of red slate are likewise found in this part of the state. Whatever may

be the cause of the green spots in the purple slate, they form a very objectionable feature, being liable to decompose under the weather, and allow the rain to leak through the roof. A small speck of iron pyrites can generally be detected in the centre of each of the spots, and these may have had something to do with their formation. The slate quarries of western Vermont have a common disadvantage, in the low underlie of the cleavage, which in several cases is less than 20 degrees, thus requiring a much larger expenditure in working, than when the cleavage is vertical, or underlying at a high angle to the horizon. In some of the quarries the underlie, which is always to the eastward, is from 20 to 40 degrees, but unless the angle is sufficiently high to give a self-supporting hanging wall, a great loss is incurred in removing or supporting the superincumbent mass.

About a dozen quarries are worked on the western belt. The principal one is the Eagle Slate Quarry, situated a mile south of Hydeville, and which produces about 10,000 squares a year. Here the underlie of the cleavage, which nearly coincides with the dip of the strata, is at an angle of only 17 degrees. Roofing slates alone are made at this quarry, and bring from \$2.50 to \$3.50 a square at Hydeville depot. In the town-ship of Castleton, the West Castleton Railroad and Slate Company manufacture 150 squares of slate a month, besides sawing from 15 to 16,000 square feet of slab slate. The cleavage here underlies to the eastward at an angle of 40 degrees. In 1857, the second year of operation, the sales of the produce of this quarry amounted to \$60,000.

A planed surface of slate is found to retain remarkably well the compounds used in enamelling, even in the presence of heat or acids, and hence slab slate can be marbled and used in a great variety of ways. The western Vermont slate is marbled for jambs and mantelpieces, table and bureau tops, billiard beds and kerosene lamp bottoms. These are successfully made to imitate all kinds of ornamental marble, and are sold in immense numbers at one fourth the price of real marble. The cost of marbled mantels varies from 10 to 125 dollars, according to the workmanship which has been expended upon them. Writing slates are also prepared in great numbers at the western quarries; and there is a large demand for unplaned slabs for sanitary and other purposes. The foregoing facts in regard to the slates of Vermont are condensed from Prof. Hitchcock's report on the geology of the state.

In Canada, no clay slates have yet been discovered among the Laurentian rocks, the strata of this series which approach nearest clay slates in composition, being always massive, and usually of a crystalline character. Slaty rocks, approaching argillites, have been found in several places among the Huronian series. For example, specimens from the Montreal River, about five miles from its junction with Lake Temiscaming, have the characters of roofing slate, but the plates into which they split are scarcely as thin as desirable. Among these rocks, on the north side of Lake Superior, greenish-black and greenish-blue slates, some of which may be fit for roofing, are found on the Kaministiquia River above the Grand Falls, and slates which are said to be available for this purpose, occur on the Slate Islands, and at Anse à la Bouteille.

In Eastern Canada the argillaceous bands of the Quebec Group, in many places yield good roofing slates, which have already been successfully wrought in a few localities. The most important of these is the Walton Slate Quarry, in Melbourne, to be described further on. The Melbourne Slate band, in its northeastward extension, crosses the St. Francis River into Cleveland, where, in 1854, a quarry was opened on the 6th lot of the 9th Range, but after a time abandoned, from the band being too narrow to pay to overcome the difficulties in the way of working it. The slate produced was nearly black in color and of the best quality. The locality is on the Grand Trunk Railway, about three miles south of the village of Richmond. On the 4th lot of the 1st range of Kingsey, reddish-purple slates of a good kind are found in the high eastern bank of the St Francis River, about seven miles below Richmond Station. The Kingsey slates are not so hard and smooth as those of Melbourne and Cleveland. A Montreal company attempted to work this quarry, but abandoned it after grading a railway track down the bank of the St. Francis from the Grand Trunk at Richmond. The failure to carry out this enterprise, appears to have prejudiced Montreal capitalists against slate quarrying generally, and to Mr. Benjamin Walton remained the honor of first demonstrating its profitable nature, and of developing a great slate quarry in Canada—a quarry which is unsurpassed by any in the world, either in the quality of the slates produced, or in the facilities for working. The Kingsey slate band is continued into the Township of Durham, on the west side of the St. Francis, and has been worked to a small extent on the 6th lot of the 4th range. At the slate rapids on the Black River,

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on the 12th lot of the 10th range of Ely, an attempt was made some years ago to open a quarry on a band of very fossiliferous bluish-black slate. The cleavage is vertical and strikes S. 50° W. Bands of apparently good roofing slate are met with on the 14th lot of the 1st range of Halifax, and further to the northeast, in the Township of Frampton. For some distance above and below the junction of the Rivière du Loup with the Chaudière, good clay slates are largely developed. On the Rivière du Loup, half a mile above the junction, a band of the rock exceeding half a mile in breadth, would, in several places, afford good writing and roofing slates. A locality for slate occurs on the 18th lot in the 3rd range of Tring. In the continuation of the Quebec group to the northeastward, slates apparently fit for roofing, are found on the Marsouin River in the northern part of the County of Gaspé, a few miles back from the St. Lawrence. The above mentioned slate bands in the Eastern Townships also belong to the Quebec group of the Lower Silurian System. In the Upper Silurian rocks, on the 2nd lot in the 5th range of Orford, dark blue roofing slates are found, not unlike those of Melbourne, but less smooth in cleavage; and again on the 29th lot in the 5th range of Brompton, on what appears to be a continuation of the last mentioned band. Similar slates occur in West Bury on the St. Francis River. Blackish slates, which may be suitable for roofing, are met with among rocks of the same age on the Patapédia River in the county of Bonaventure. The information just given in regard to the slate rocks of Canada is to be found in the reports of the Geological Survey.

The Walton Slate Quarry.

A short time ago the writer accompanied Mr. Walton from Melbourne village on a visit to his slate quarry, and obtained most of the following notes respecting it when on the ground.* For the information of those not acquainted with the geography of this part of the country, it may be stated that Melbourne is on the west side of the St. Francis River opposite to Richmond, from which the Grand Trunk Railway diverges in three directions—to Montreal, Quebec and Portland; the branch to the last mentioned, running for a number of miles up the east side of the river.

After a drive of three miles along the main road upon the west bank of the river, we come to the quarry road, turning west at right angles,

* Mr. Walton's property has been examined by Charles Robb, Esq. Mine Engineer, and his report, (an abstract of which was published in the Journal of the Upper Canada Board of Arts and Manufactures) has been consulted in preparing this article.

while the scow-ferry, by which the slates are conveyed to the railway depot on the other side of the river, lies on the left. Following the quarry road we ascend a steep incline all the way, which, although difficult to surmount, is, as Mr. Walton remarked, a necessary feature in order to have a good slate quarry. A strip of the woods has been cleared on either side to allow of the access of the sun and wind to dry the road. In making these clearings and constructing the road, the proprietor expended about twelve hundred dollars. At the end of about a mile, we come to the cluster of buildings attached to the quarry, and leaving our conveyance at one of the boarding houses for the employés, proceed to inspect the works.

The quarry itself is not seen from the approach, being concealed by a band of serpentine which flanks the slate band on the north. It was found necessary to drive a tunnel, a hundred feet in length, from the slope of the hill through the serpentine, in order to expose a workable face of the slate rock behind. In front of the tunnel are the sheds for manufacturing the slate, and a dump or spoil bank, composed of the refuse from the dressing process. Beautiful specimens of asbestos are seen on either side in passing through the tunnel, from which we emerge on the level of the floor of the quarry and find ourselves in a great roofless chamber, the four walls of which rise to the height of seventy feet. The cleavage of the slate is about perpendicular, and runs in the direction of the greatest length of the quarry. As in the best quarries in other countries, the slate is found to improve in all the desirable qualities in descending, and the waste, due to surface influences, to diminish continually. Owing to the vertical cleavage the surface influences have penetrated to an astonishing depth. In the upper forty feet the rock was injured to such an extent, that fully half the material quarried was wasted, and even at the present depth, the same influences are still discernible, but rapidly dying out.

At first the rock was so fissile that it could with difficulty be split into sufficiently thick sheets, but now the plates can be split to any required thickness with perfect uniformity and beautifully smooth surfaces. No difficulty is to be apprehended from imperfect cleavage in slate of this character, at the greatest depth to which the quarry can be worked. Since it is always found that in working a good band of slate the quality improves in respect to smoothness, regularity of cleavage, color and hard-

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ness, in going down, it will be perceived that a first rate quarry requires to have such a situation that it can be advantageously worked to a great depth. The great depth of the principal quarries in Wales is one of the reasons which cause the Welsh slates to be so highly prized.

The peculiarly favorable position of the Walton Quarry and the perpendicular cleavage of the slate, offer every facility for the most extensive and advantageous working. The top of the quarry is 451 feet above the St. Francis River at the depot, so that ample room is afforded for working by horizontal galleries driven from the side of the hill, thus avoiding all expense for pumping and hoisting. For future working, it is proposed to run an adit at a level of forty feet below the present one, and ultimately, one from the bank of the river at about 360 feet below the same level. From this last an almost unlimited supply of the finest slates might be taken out at the level of the railway. The quarry, in its present state, is capable of yielding 20,000 squares a year, so that the galleries referred to may be looked upon as work to be performed by another generation. It measures 24 yards in depth, 14 in breadth and 32 in length, giving a total of 10,752 cubic yards which have been excavated. The yield of slate up to the present time has been about 10,000 squares. The proportion of waste to manufactured slate has of course very much diminished in the lower portion of the quarry, and there now remain 381 feet between the bottom of the quarry and the level of the St. Francis, in which even better slate may be expected than that hitherto obtained.

The position of the quarry is about the centre of the 22nd lot in the 6th range of Melbourne township. The property to which it belongs comprises 1180 acres, extending in every direction from the quarry—as far as the railway, to the eastward—and including the ground around the depot. The great band of serpentine in contact with the slate has a steep slope to the north, while to the south of the slate band, the ground falls away gradually, and the rock is seldom seen. The roofing slate has been ascertained to have a breadth of at least a third of a mile at the broadest place, and the whole of it appears to be equally good, as far as can be determined from surface trials. The quarry is situated on the widest part and the band is traceable on the surface (westward from the river) for about a mile and a half; at the end of which distance it appears to be cut off by the serpentine, but

reappears further on. East of the river, it is again met with in the strike, with a greatly reduced thickness. It was on this part of the band that the quarry in Cleveland, already mentioned, was opened.

The whole series in this neighbourhood is tilted to a vertical attitude, and strikes S. 45° to 55° W., or at right angles to the river. The serpentine affords many varieties of green and greenish-black marble, of which a few have been proved by Sir William Logan, to be of good quality; and the specimens in the Geological Museum are generally admired. On the west end of the quarry lot, there occurs a bed of chromic iron, of the hard, dark, crystalline variety, worth fifty dollars a ton in the English market, containing, as it does, 53 per cent. of the sesqui-oxide of chromium.* It appears to be obtainable in sufficient quantities to work at a profit. On the north-east end of the adjoining lot (22 in the 5th range—part of the same property) vitreous copper ore is found along a crack or vein in the serpentine; and further on in the strike, larger deposits of copper ore are found in the township of Orford, associated with the same rock.

The average price of the Melbourne slates delivered at the railway is \$3.25 per square. They are made by contract at the quarry at \$1.75, leaving a difference of \$1.50 per square. From this is to be deducted 25 cents for cost of carriage to the railway. All other contingencies are covered by 15 cents more, giving upwards of a dollar a square, or 50 per cent. as the net profit to the proprietor. It is to be observed, that this calculation of profit is based on the present working expenses, and makes no allowance for past expenditure or future development. The quarry is now brought into good working order, and, at the present rates the contractors are making large profits. It is calculated that in future, by a different system of working, the proceeds to the proprietor will be not less than 100 per cent. upon the cost after delivering on the cars.

It is scarcely necessary to notice the superiority of slates, both in regard to appearance and excellence, as a roofing material, over shingles, compositions, and even metals. The original cost of slate is about one-third more than shingles, although cheaper in the end; it is one-half less than tin and one-third less than galvanized iron. The reason of slate not being adopted in preference to these latter, is often attributable to prejudice, arising from examples

*Mr. Robb's analysis.

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where slates had been unskillfully employed. In our towns and cities they are now displacing these materials, and since good wood for shingles is becoming scarce in the agricultural districts, we may look forward to the time when slates will form the principal roofing material used in Canada.

But outside of our own country, the market for slates is unlimited. For instance, after being sold at Richmond, at the large profits just mentioned, they can be delivered in Portland for \$4.14 per square and sold in Boston and New-York at from \$8 to \$10. The western cities in the United States could be more easily supplied from the slate quarries of Eastern Canada than from any others and the prices in the old world are such, that our slate could probably be sent there and sold to advantage.

Among the desirable qualities of a good slate, are uniformity of color, smoothness of surface, durability and strength with lightness all of which are possessed in an eminent degree by those of the Walton Quarry, the slates from it being equal to any in the world. They are of a bluish-black color, contain no carbonate of lime. are unaffected by acids and almost perfectly non-absorbent, and thus can, in no way, be affected by the weather. The rock is fine grained and splits with great facility when newly taken from the quarry, but the slates harden rapidly and acquire great toughness and strength. From analyses by Dr. T. S. Hunt, the Melbourne slates are shown to have a very striking resemblance in composition to those from Bangor in Wales, and also to those from Angers in France. Slates from the latter place have been exposed for a hundred years, without perceptible deterioration, on the roof of the seminary building at the corner of Notre Dame and St. François Xavier Streets in Montreal, which proves that a slate covering is well adapted to resist the influence of the Canadian climate.* It is to be regretted that no analysis of the Vermont slates is available for comparison, but the purple varieties are more liable than our bluish black slates, to fade and give the roof a checkered and unsightly appearance, and hence the latter are the more desirable, especially where artistic arrangement is required. While the bands or "veins" of workable slate in the principal Vermont quarries are said to be only about 18 to 24 feet thick, the Melbourne band has been ascertained to have a thickness of at least 1700 feet, opposite the Walton Quarry, and to occupy a

* Descriptive Catalogue of the Economical Minerals of Canada sent to the International Exhibition of 1862.

surface area in this neighborhood of about a hundred acres. Such a volume of slate is practically inexhaustible, and judging from appearance it is all of a uniformly good quality. Mr. Walton contemplates manufacturing writing and slab slates at his quarry, for both of which the Melbourne band is admirably adapted.

It may not be out of place here to describe the process of manufacturing the roofing slates at the Walton Quarry. The rock is blasted by experienced workmen, in such a way as to give regularly shaped masses, which are conveyed on a tram-way to the dressing sheds. Here, the blocks, fresh from the quarry, are split by a mallet and chisel into sheets of the required thickness and thrown into a heap ready for trimming. The slate dresser, who is seated, places the sheet upon a horizontal steel bar in front of him, and with a thick-bladed knife or cleaver, cuts off at a blow the part projecting over the edge of the bar, the knife and the bar forming, as it were, a pair of shears. The undressed sheets are received on the left side, and the finished slates piled on the right, each size being kept separate. Mr. Walton has adopted sixteen sizes, varying from 6 by 12 to 14 by 24 inches. From long experience, the slate dresser perceives at a glance the largest size that a sheet will produce, and in a second, trims two of its edges, and having marked off the other two with a measuring gage squares them with two blows, the whole process being performed in a twinkling.

Mr. Walton commenced opening his quarry in 1860, and having himself every confidence in the undertaking, pushed it steadily forward, in the face of many obstacles, to the present successful result. The outlay incurred in buying and developing the property, amounted to about \$36,000, but the quarry and all its machinery are now in a condition for profitable working for a long time to come. At first it yielded no adequate returns, and Mr. Walton was obliged to work on through many a dreary day, without sympathy or encouragement. It must therefore be a great satisfaction to him, that his most sanguine hopes have been realized. The quality of the slate has proved to be all that could be desired, and the demand is already in excess of the supply, the proprietor having been obliged, just the other day, to refuse, amongst others, an order for a thousand squares. We admire the enterprise and perseverance, and rejoice at the success of the gentleman, who embarked his fortune, and bestowed his time and attention, to develop so important, but hitherto untried source of wealth to our country.

Melbourne, Canada East, October 8, 1863.

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