Prospecting in Nova Scotia.

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The attention of even the most disinterested has often been attracted to the numerous rich gold-bearing boulders which have been found from time to time during the last fifty years in Nova Scotia. The leads from which many of these boulders came, have, in spite of much prospecting, never been found. And it is chiefly for the purpose of aiding in this search that I give this short summary of conclusions bearing on the subject.

In treating of prospecting in Nova Scotia a short description of the structure and historical geology of the gold districts would aid in the better understanding of the duties of a prospector.

Structural Geology.

The gold bearing rocks of Nova Scotia cover an area of about 6000 square miles, reaching from Cape Canso to the western extremity of the province. They consist of thick beds of interstratified quartzite and slate, the quartzite prevailing in the lower and the slate in the upper part. Included are large and small tracts of granite and other metamorphic rocks formed by the melting and crystalisation of the quartzites and slates. These quartzites and slates are folded into dome shaped anticlines which may be grouped into three classes according to form—viz., parallel folds, ellipses, and almost circular domes. The first and second are found in the eastern counties, and only the second and third in the western counties. The anticlines vary in size from small corrugations to great folds 10 miles in width. Their strong resemblance to the gold bearing anticlines of Bendigo, Australia, has led to much discussion on that aspect of the subject.

The position of our gold bearing leads in regard to the anticlines are as follows:—48 are on or very near the apex of the folds, 11 are from $\frac{3}{4}$ to 3 or 4 miles from the apex and a few of uncertain position. Thus while the proximity of a lead to an anticline is no sure indication of value it is an indication pointing to success. All bedded leads of value as a rule are grouped, and though their position in regard to the anticline is a geological accident the same law of distribution of values seem to govern the leads of one district. Mr. Faribault, our best authority on this subject, has designated in his district maps sections which he calls zones of special enrichment. Beyond these zones values seem to depend on the existence of cross veins and angulars. Thus it is very necessary for the prospector to study thoroughly the structural geology of each district. This done he has one of the principal keys to the discovery of the rich leads which the float shows him is there.

Historical Geology.

The following description from a historical point of view, is taken from my "Deep Mining in Nova Scotia," (See Transactions of N. S. Institute of Science, 1899.)

Deposition.—Our gold bearing rocks have been placed provisionally in the Lower Cambrian, decisive fossiliferous evidence being wanting. As before stated they consist of a lower and an upper division. The first of quartzite with a little slate and the last of slate with a little quartzite. The lower division is from 15,000 to 18,000 feet in thickness the upper from 10,000 to 13,000 feet. This conclusion I arrived at while doing Geological Survey work on the Sissiboo River in 1891. where a splendid section is to be seen. The transition from one to the other of these divisions is very gradual. Being the first observer to sett the thickness of the gold series at over 26,000 feet my estimate was ridiculed at the time, but has since been amply confirmed by Mr. Faribault and other workers in that line. A detailed description can be seen in the journal above mentioned.

Folding.—The folding of this immense thickness of rocks did not take place until after the deposition of the Oriskany of Bear River, Digby County, where these later rocks are folded into a syncline of the gold series. But the most surprising thing of all is the fact that this vast thickness of over 26,000 feet was denuded before the deposition of the Lower Carboniferous, which formation in various places overlies the denuded edges of the lowest beds of the gold bearing rocks. There is also some evidence that this vast erosion took place before the deposition of the Devonian fossiliferous rocks, which lie in some places in Bear River on the upturned edges of both the Oriskany and the gold bearing rocks. This stupendous erosion and the accompanying expenditure of time necessary for its completion is one of the wonders of historical geology.

Mineralization.—The formation and mineralization of our gold bearing veins like the folding was probably a very gradual process, as is shown by the successive layers as well as the striated and polished surfaces in the veins themselves. Two facts limit the time of the completion of this process. One is that the Lower Carboniferous conglomerates of Gay's River and elsewhere contain fragments of gold bearing quartz eroded from the gold bearing series. The other is that gold bearing veins pass with little change of size or contents into granitoid rocks especially at Forrest Hill in Guysboro County which limits their formation to no later period than the early Devonian.

Metamorphism.

To the metamorphism of Early Devonian times we must ascribe the origin of the granite and gneissoid tracts which interfere largely with the continuation of the gold bearing leads of Nova Scotia. Evidence for this is seen at Bear River and other places. If as has been maintained our granites were crystallised under great pressure, then the gold bearing rocks were but slightly eroded when the Early Devonian metamorphism took place, otherwise the granite would be deprived of that immense weight necessary to its crystalline form. Under this supposition, the most of this immense denudation would be included in late Devonian and Devo-Carboniferous times, or between the age of metamorphism and the beginning of the Lower Carboniferous. To the prospector one important result of this period of metamorphic activity are the fractures caused by the subsequent shrinking of the fused districts. These are seen at Sherbrooke, Mooseland, Mt. Uniacke and other places. As an example a glance at Mr. Faribault's district map of Mooseland will show the western end of that anticline dragged to the south by the cooling and consequent shrinkage of the granite tract in that direction. The fractures caused by this movement reaches several miles up the Tangier River. These fractures dip to the west their mode of formation being as follows: As the granite cooled and its shrinkage faulted the anticline in the Stemshorn Mine, near the river the aperture was gradually widened, the overhanging western wall of the fracture settling down on the eastern part, and opposing a higher stratum on the western wall to a lower one on the eastern wall. About 1892 or 1893 I saw a prospecting tunnel being driven into the western side of this fault to strike an apex or saddle lead cut off at the same level on the east side. They of course did not find it. It was a costly lesson but it taught the owners nothing and as far as I know this explanation was not hazarded by anyone since.

Denudation.

The Great Ice Age, as the last striking act in the geological drama is called, does not occupy, as has been supposed, a very important place among the many great periods of erosion. The few hundred feet taken from the surface of the province at that time affects few except the prospector and perhaps the farmer. To the prospector however, the Glacial Age is of paramount importance. A knowledge of its operations on our gold fields, when not interfered with by any later modifications, provides a simple and easily understood rule which almost any prospector can understand and apply.

In the Eastern Counties the course of glacial transportation is south varying from a very few degrees east to west of south. Any great variation from this I have usually found to be the result of local glaciation. In the Western Counties the general glacial transportation is always to the east of south. In some of the eastern districts we have great thicknesses of unmodified boulder clay. In this the prospector's lesson is comparatively easy to learn.

Post-Glacial Modification.—But just here is injected into the problem a new and confusing agent. An agent which complicates matters to such an extent that it forces the Nova Scotian prospector to become a geologist as well as a miner. And not only must he be a geologist but a specialist in local glacial geology.

Still looking at our gold fields from the historical view point we see the vast continental ice sheet breaking up into local glaciers and the sunken province rising from the sea. These fragmentary glaciers sliding toward the sea have left their stria pointing toward the west in Digby and Yarmouth, to the north-west in Cumberland and to the east in Guysboro County. Later they gravitated toward the lowlands in every part of the province. Leaving their kames and other deposits behind they confused very much the former regularity of debris distribution.

Following the gradual disappearance of these local glaciers and the farther elevation of the province came another cause of confusion. The rivers and brooks began deepening their channels, cutting away and re-depositing the older deposits and lowering and filling lakes and valleys.

Beds of clay sand and gravel were re-arranged and shifted to all points of the compass. And finally before these modifications were complete a gradual subsidence set in which continues to the present day (see my paper on Post Glacial Subsidence of Nova Scotia in Journal of N. S. Institute of Science.)

Such are the vagaries of deposition which usually govern the distribution of rich float in Nova Scotia and the prospector is expected to decipher correctly the history of its travels ere he can locate its source. Lucky indeed is he if he strikes a spot unaffected to any extent by these later influences.

Requirements of the Prospector.

Prospecting, usually contemned as only an accessory of mining, is in Nova Scotia one of the most important branches of that great industry. It calls into use the science of the geologist and the skill and perseverance of the working miner. The intracacies of drift deposition in Nova Scotia make the simple rules followed by surface prospectors in the west of no avail here. I could give numerous instances in which English or Western engineers, successful men in the lands of their experience, have failed here through lack of local knowledge. Their zeal for doing things as they are done in the west or in England blinded them to our different conditions. This knowledge of structure; of cause, location and dip of paystreaks; of the laws that govern faulting and folding; of the intricacies of Glacial, Interglacial, and Post Glacial deposition, must all be learned from a local standpoint. College-learned generalities will not do without a local experience to make such training effective here. And this local experience is just as necessary to the skilled M. E. as it is to the prospector. The lack of practical knowledge on the part of our scientific men is only equalled by the lack of scientific knowledge on the part of our practical men.

How often have I heard an enquiry for a good prospector met with such an answer as the following:—"Well, I guess old Peter Brown should be a pretty good man for that work. He's always puttering around the woods with a pick." This may have done when rich leads cropped out on the surface and prospecting consisted of tearing off turf and picking up loose ore. But now the chance finds are all made and what remains will tax the science of the geologist. Hidden deep beneath a mantle of glacial debris the finding of these veins necessitates a wide knowledge of the structure of each and every district with their local peculiarities. It needs also a judgment capable of guiding one through the complications of fold and fault as well as the perplexities accompanying the unravelling of riddles in much modified drift deposition. Withal he must have a capacity for persevering work with the pick and shovel, for to him each pebble, fragment of ore, or organic remain has a history often bearing strongly on the task in hand. At least his constant personal supervision should guide every step in the work to attain success. He should be prepared for surprises and should be able to detect and read new revelations in the mysteries of drift deposition.

Once while prospecting on the usual "go north" rule at West Caledonia where the glacial striations ran s 12 e. I found a piece of ore wedged in a crack in which it could not have been thrust except from the south. At once much contradictory evidence was reconciled and the vein searched for was found a short distance to the S. W. Further prospecting revealed the fact that while the first drift transportation was to the south, Post Glacial action had excavated and refilled a stream flowing from the S.W. which had deflected the float ore to the n. n. e. It taught me more than ever the value of a knowledge of Post Glacial action, for with every square yard of earth thrown from our prospecting trenches we meet with new problems.

Several Glacial Epochs.

We have in Nova Scotia evidence of at least three periods of glaciation (see Glacial Succession in Lunenburg Co., Transactions of N. S. Institute of Science, 1896). The distinguishing points in the deposits during these periods are, different degrees of oxidation, different courses of transportation, and difference of composition, stratification and position. For example at Blockhouse where I found a long searched for gold bearing vein, the earliest glacial deposit was a much oxidised kame of waterworn pebbles course of transportation unknown. The next was an unoxidised bed containing the same rocks as before, course of transportation S. 22 E. Both these deposits were without gold, their course of transportation not being over the vein searched for. The third and upper bed contained much angular debris with gold bearing float. This is explained when we know that the course of transportation was about S. 50 E, bringing the debris from the rich vein which was farther west than the source of the other deposits.

This kind of evidence is seen in various parts of the province as at Halifax and Bridgewater. The oldest and lowest beds are easily distinguished, being a firmly cemented and highly oxidised conglomerate. Then comes boulder clay with northern rocks, and finally more local debris from the high lands close by. The work of Post Glacial influences is not as evident in the eastern as in the western Counties. therefore the eastern Nova Scotian prospector has a comparatively easy task.

Old Methods.

Ever since the first Nova Scotian gold discoveries when our engineers formulated the rule "go north" our prospectors have faithfully and blindly followed that dictum. To the majority of them the matter was forever settled, and the rule became as unalterable and as unimprovable as the constitution of the United States. Very little attention is paid even yet to Post Glacial modification of boulder clay by prospectors, and thousands of dollars have been spent in searching for rich leads in deep, much modified drift.

Another useless expenditure of time and money occurs when every foot of trenching is bottomed with the idea of doing the work thoroughly. This, often when owing to modification by sub-aerial influences, the course of the rich float has been almost at right angles to the general course of glacial transportation. Many miners have exhausted their means and wasted the best years of their life searching for rich veins in the firm belief that all drift comes from the north, when a little knowledge of local glacial geology would show that the most valuable part of it probably came from another direction. Veins have been found and pronounced worthless when a knowledge of the exact course of the float transportation would have led the finder to cut it in another and richer place.

An Example in Economy.

As an example of the amount of labor that can be saved by float tracing as opposed bottoming as the work proceeds. I may give a record of work at Blockhouse in 1896. The rich float there appeared on the top of deep surface about 600 feet S. E. of its source. Here I sunk a test shaft to bed rock. From this shaft I learned that the gold bearing drift reached to a depth of about 5 feet, the lower 10 feet being barren. East and west of this 50 feet distant I sunk shafts, constantly searching and panning for gold. Gold was found in the west shaft to a depth of 4 feet and in the east shaft to a depth of 2½ feet. About 50 feet farther N. I sunk 3 more shafts. The middle and west shaft showed gold to a depth of 5 feet but the upper 1½ feet was barren. Thus guided the next 3 shafts were sunk farther west but never going to bed rock. Here the middle and east shafts showed gold from 2 to 4 feet, but the west shaft was barren. This decided the course of the float as about S. E. Two pits N.W. of the last both contained gold at depths of from 2 to 4 feet and deeper than that I did not go. One pit still farther along the line of drift contained gold from 2 to 3 feet reaching bed rock at 4 feet. Farther on 3 feet of drift showed gold only in the last foot, and the next hole only a few yards farther had only 2 or 3 small fragments of quartz on the bed rock. This hole was lengthened and a 2½ oz. lead struck 6 feet farther. The total cost was less than $130.00. This example shows the economy of systematic work. In the deepest surface only one shaft was bottomed and the information furnished by it sufficed to carry on the work to a successful conclusion without sinking another shaft to bed rock when deeper than 4 feet. This vein had been searched for during the previous 10 years by several old and experienced prospectors whose only reward was some more age and experience.

Labor Saving Methods.

A necessary preliminary to trenching in some places is a system of panning, that I have found very useful. In this the number of pans from each spot selected is noted. Then the number of colors in each pan are counted and graded into colors, sights, shotty gold, and nuggets, with a further assortment into sizes say 8 to 16 in all. The results are then mapped on a plan of the areas to be trenched and in this way the centre or line of greatest values is determined. This will save much laborious and expensive work in shaft sinking as was usual when sinking was done in the old hap-hazard way.

A method of economical timbering for prospecting shafts which, as I have hardly ever seen it in use in Nova Scotia, I will give here. It may perhaps be new to some. Some such method is imperative in quicksand or loose clay and gravel walls and in this way the same lot of lagging may be used, withdrawn, and used again in each succeeding shaft. 1½ inch deal is cut into 4 foot lengths sharpened with a bevelled edge. The pit is started, two setts of timber framed, put together, and lowered. The upper sett is hung to the timbers the windlass rests on and the second sett hung to the first, 3 feet below. Then the lagging is put in and wedged back with wedges 2 inches thick at the top. Thus between the upper 4 foot pieces and the second sett is a space of 2 inches through which the next lot of 4 foot lagging is driven bevelled side inward, the wedge being withdrawn and driven in front of the second lot of lagging. This leaves a space of ½ to ¾ inches between the deal and the second sett. Then the third sett of timbers is lowered and put in below the second sett and 2 inch wedges driven between the third sett and the lower end of the 2nd lot of 4 foot lagging. If the ground is liable to cave the lagging is driven in advance of the work, and the third sett lowered as the depth increases. When 3 feet below the second sett it is hung there and new 4 foot lagging put in the wedges being taken out and driven front of the lagging as before. Thus there will be a space of at least ½ an inch all round between the timber and deal. When the shaft is deserted the wedges can be driven up with a small hammer and the loosened lagging thrown into a tub and hoisted with little trouble. With the help of one man I have taken all the lagging from a 22 foot shaft in less than ½ an hour preparatory to using it in another shaft.

Leads have been found in the old rule of thumb way when exposed or nearly so but the deeply buried leads still remaining must be searched for after laying down a carefully planned programme. Of course no programme is infallible, and we must always be guided to some extent by circumstances, but in a choice between a programme or no programme we choose the first.

1st. A map of the district in question on a scale of at least 1″ to 100′ On this entered details of contour, geological structure and depth and course of drift transportation. 2nd. An intelligent system of panning with results carefully tabulated and indicated on the map. 3rd. A test shaft to bed rock to furnish data for future work. In this shaft every detail of stratification, composition, presence of gold or drift quartz should be noted and entered on a sectional plan to be carried through every shaft sunk in the search. 4th. Then should follow a regular system of shaft sinking for the purpose of tracing the float gold to its source. This to save cost need not be sunk farther than sufficient to decide the presence and course of transportation of the float gold, unless strong evidences of Post Glacial action leads us to suspect that the original course of the surface float has been deflected or reversed.

As we can see, the way of the prospector in Nova Scotia is not an easy one. It calls for an amount of good judgment and local knowledge not necessary to the Western prospector whose training has been obtained chiefly in mountainous regions. While in the west the powers of observation are most relied on, here the hidden nature of the problems involved require something more. This opinion is not given to discourage prospecting here but to offset the old idea that prospecting is a job that any miner can do to fill in his spare time. Nova Scotia with her narrow but rich paystreaks will amply repay any intelligent young man for devoting a few years to solving the problems of local glacial geology, providing, of course, the funds for doing so are forthcoming. For it is needless to say that no ordinary prospector can go far in work of this kind without help. And again, after a man has spent half a life time in gaining knowledge which is really of a deeply scientific as well as practical nature, and calls for good judgment and superior powers of observation at every turn, it is an injustice to ask him to work for the wages of an ordinary miner. He would be doing a work that the most competent engineer without local training would be incapable of.

The most common objection to prospecting in Nova Scotia is the risk of failure—that is failure to find the lead searched for. The only risk I can see is when prospecting is begun without a previous knowledge of former geological conditions or without sufficient funds to finish the job in hand. I refuse emphatically to believe that there is any such thing as failure in prospecting in Nova Scotia, providing the money and practical knowledge is forthcoming. And I am of the opinion that every hidden rich lead in Nova Scotia at a cost of from $400.00 to $4000.00 unless covered by lake, river or sea.

The following is a partial list of the prizes in gold mining yet to be won in Nova Scotia.

District.	Size of lead.	Milling value per ton.
Fifteen Mile Brook (Hall	5″ to 10″	Very rich
“ “ “ (Shaw)	9″ to 15″	1 to 3 ozs.
Broad River (Cross lead)	?	Severl ozs.
Mill Vilage (Prest areas)	10″ to 16″	2 to 3 ozs.
“ “	1′ to 2½′	1 to 1½ oz.
Gold River Lunbg. Co. (Torquay)	8″ to 18″	2 to 12 oz.
“ “ “ (Mill Lead)	?	Very rich
“ “ “ (Clinton)	?	2 to 3 oz.
West Caledonia Queens Co. (Freeman)	Over 1 ft.	Severl oz.
Centre Lunenburg Co.	2 ft.	2 to 3 oz.
Rawdon, Hants Co.	8″ to 12″	10 ozs.
West Chezzetcook	3″ to 6″	8 to 10 oz
Copes Hill, Halifax Co	6″ to 11″	Rich.
Gold Lake “ “	Very large	Good.
“ “ “ (Bunker)	?	Rich.
Mooseland Halifax Co (Hilchey)	3″ and over,	500 ozs.
“ “ (2nd Hilchey)	?	Severl oz.
“ “ Stemshorn	10″ to 14″	Up to 14o
“ North	1½′ to 2′	1 to 2 ozs.
“ “ “	Small	Very rich
North Renfrew, Hfx Co (Wall)	?	Rich.
Beaver Dam “ (Gladwin)	?	Very rich
Killag “ (Red lead)	6″ to 8″	2 to 3oz.
“ “ (Striped l'd)	10″	Good
“ “	16″	7 ozs.
“ “	2′	Up to 4 os
“ “ (Horn lead)	9″	1 to 2 ozs.
Ekum Sekum “	?	Rich

District.		Size of lead.	Milling value per ton.
Fifteen Mile Stream Rd	(Indian ld)	5″ to 8″	Very rich
" " "	Hfx Co, (Williams et al)	?	1 to 3 ozs.
Ardoise Hants Co.		?	Very good
Gegogan, Guysboro Co.		?	Very rich
Sonora		?	Rich.
Fifteen Mile Brook Queens Co.		1″ to 2″	Very rich

There are other localities in which rich gold bearing boulders have been found, but as I had no definite information concerning them I did not enter them.

In the conservation of natural resources in Nova Scotia nature is doing her duty to the coming generations. These hidden leads await the coming of the trained prospector who in turn awaits financial backing.

No amount of toil can compensate for the want of a thoroughly local knowledge of the structure of our gold districts and their surface deposits. But again no amount of geological knowledge will ever find a hidden vein without a solid backing of money and muscle.

We want geology but only its most practical side. We want labor but only its intelligent use, and last but not least we want solid financial backing. With these three at our command, there is no reason why the whole of the rich veins before mentioned should not be uncovered in time.