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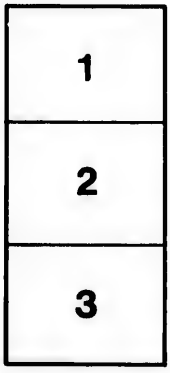

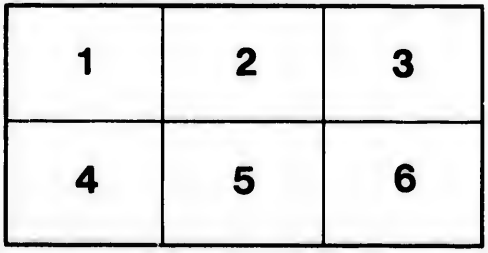

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NOTES AND OBSERVATIONS

ON THE

GOLD FIELDS

OF

QUEBEC AND NOVA SCOTIA.

BY

ALFRED R. C. SELWYN, F. G. S.

DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA,

&c. &c. &c.

HALIFAX, N. S.:
REPRINTED FOR THE "MINING GAZETTE" BY THE "NOVA SCOTIA PRINTING CO."
1872.

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Before coming to Canada, in October, 1869, I had spent the greater part of sixteen years immediately preceeding in Australia, chiefly in Victoria, noted as being the richest gold-producing country in the world. During that period, as Director of the Geological Survey of the Province, a large portion of my time and attention was devoted to investigating the geological relations and the structure of the gold-bearing rocks. I had also previously, as a member of the British Geological Survey, acquired an intimate knowledge of the gold-bearing Silurian and Cambrian rocks of North Wales; and as the gold-deposits of the Dominion have in the last few years attracted a good deal of notice, and a large amount of capital has been invested in their development, I considered it advisable to devote my first season in Canada to visiting some of the gold-producing districts, with a view of comparing them with those of the countries above referred to, and in the hope of being thus enabled to offer practical suggestions for their further development.

CHAUDIÈRE, QUEBEC.

Other matters connected with the Geological Survey claiming my attention, I was not able to commence these examinations till towards the end of June, when I proceeded to the Chaudière, in the province of Quebec, from which river, and from its tributaries, nearly the whole of the gold, which, up to the present time, has been produced in Canada proper has been obtained. None of it so far as I am aware, being the result of mining in the solid veinstone.

On making enquiry to learn what was being done on this gold field, I found that with the exception of desultory and occasional washing operations carried on by resident *habitans* on the superficial gravels in the beds of some of the tributary streams, the only works then in progress were those of the Canadian and Northwest Land and Mining Company, under the immediate superintendence of Mr. W. P. Lockwood, to whose great kindness and readiness to impart information, I am very largely indebted for whatever I was able to learn in the neighbourhood, respecting both present and past operations; as well as for facilities kindly afforded me in visiting all the most noted auriferous localities on the Chaudière and its tributaries, the Du Loup, the Famine, the Gilbert and the Des Plantes.

After spending about a week in these examinations, I proceeded *via* River du Loup, Temiscouata Lake and the Saint John River, to New Brunswick. My observations in this province were confined entirely to the Saint John River, which I descended in a canoe. The unusually low water afforded excellent opportunities for examining the rocks along the course of the river, and by making this traverse I have acquired a general knowledge of the aspect and the succession of the formations between the St. Lawrence River and the northern boundary, near Fredericton, of the great central Carboniferous area of New Brunswick.

NEW BRUNSWICK.

A considerable portion of this region in New Brunswick had recently been explored and reported on by Mr. Robb, under instructions from Sir W. E. Logan, and previously also in 1864, by Prof. H. Youle Hind and by Prof. L. W. Bailey, on behalf of the Local Government.

The little which has hitherto been done towards the discovery of gold in New Brunswick will be found stated in the reports of these explorers,* and the hasty traverse I made does not enable me to add anything of importance on this subject to what has already been stated by them. The rocks certainly present all the external characteristics usually met with in auriferous regions, and there is therefore every reason to hope that intelligently conducted "prospecting," if persevered in, might lead to the discovery of really valuable auriferous deposits. It is, however,

* Report of Mr. Charles Robb, 1869, on a part of New Brunswick, in Geological Survey of Canada, Reports for 1866-69, page 209. A Preliminary Report on the Geology of New Brunswick, &c., Fredericton, 1865, by H. Youle Hind, M.A., F.R.G.S. Report on the Mines and Minerals of New Brunswick, by L. W. Bailey, A.M., Fredericton, 1864.

quite impossible to arrive at any reliable or conclusive opinion on this matter without much more extended and careful research and exploration than has hitherto been made, but which I hope to be able to carry out on some future occasion.

NOVA SCOTIA.

From Fredericton I proceeded to St. John, and crossing the Bay of Fundy, arrived in Nova Scotia on the 5th August. I was then continuously engaged till the 13th September, visiting and examining various gold districts in the counties of Halifax, Hants, Colchester, and Guysborough; including Waverley, Oldham, Moutague, Lawrencetown, Tangier, Mooseland, Musquodoboit, Mount Uniacke, Renfrew, Gay's River, Wine Harbor, Sherbrooke, and Isaac's Harbor.

On the 7th of October I was again in Nova Scotia, and was occupied till the 4th November, examining the southwestern portions of the Province, the route followed being from Digby, *via* Weymouth, to Yarmouth, Tusket, Barrington, Shelburne, Liverpool, Lunenburg, and the Ovens, Gold River, and Chester. From Chester, *via* New Ross, to Dalhousie Settlement, thence down the LaHave River to Bridgewater, returning, *via* Liverpool, to Annapolis. Thus, so far as observations over so large an extent of country made in but little more than two months can enable one to do so, I have endeavoured to gain a general knowledge of the leading features of the geology, and of those affecting the economies of the gold-fields of Nova Scotia, which will enable me to compare them with the gold-fields of other countries, and which will also be extremely useful in conducting a detailed geological survey, such as is essential for the right comprehension of the geological structure of the Province, and by which alone, geology can be made to afford valuable assistance to the practical miner in developing its mineral resources.

ACKNOWLEDGMENTS.

Before proceeding with the general and special remarks suggested by the facts to which my attention has been directed in the localities I have visited, I desire to tender my acknowledgments and thanks to the Hon. Robert Robertson, Commissioner of Mines, for his kindness in placing the resources of his department at my disposal. To Mr. John Rutherford, Inspector of Mines, and to Mr. John Kelly, Deputy Commissioner of Mines, my sincere thanks are due for much valuable and interesting local information, as likewise for the very cordial manner in which they gave effect to the instructions of the Commissioner.

The valuable information, and the kind attention which I received from Mr. H. Y. Hind have been most useful; and I am also much indebted to the various managers and agents of the mines which I visited, for the readiness with which they afforded me all the information and assistance in their power.

PREVIOUS REPORTS.

The reports on the Waverley and Sherbrooke gold districts, in 1869, which have recently been published by Mr. Hind, under the authority of the Department of Mines; the report in connection with the Geological Survey of Canada, "On the Gold Region of Nova Scotia," by Dr. T. Sterry Hunt; the "Acadian Geology," by Dr. Dawson; the "Mineralogy of Nova Scotia," by Prof. How; Mr. Heatherington's excellent "Guide to the Gold Field's of Nova Scotia," all published in 1868; together with the various reports by Messrs. Campbell, Silliman, Poole, and others, leave but little to be said either on the geology, or on the economics of the eastern gold-fields of the Dominion, which has not already been referred to, and ably discussed by one or other of these authors.

VEINSTONES.

In Canada, as in Britain, and in Australia, the known gold-bearing veinstone is confined to strata of eozoic, or palæozoic age; chiefly Silurian, but it is also occasionally found in crystalline rocks of later date, associated with them in the form of dykes, veins, or masses. It consists commonly of vitreous, white opaque or milky quartz; but presents great variety in color, structure, and external appearance, dependant on its more or less ferruginous character, and on other circumstances connected with its position and mode of occurrence. It is almost without exception accompanied by mispickel, or by common pyrites; the sulphurets of lead, zinc, copper, antimony, and rarely bismuth are likewise characteristic accompaniments of many of the veins, as well as bitter-spar, calc-spar, sulphate of baryta, and other minerals, none of which, however, often occur in sufficient quantity to be of much importance.

The palæozoic strata in the gold districts with which I am acquainted, are always more or less intimately associated with divers kinds of crystalline (igneous?) rocks. In Victoria and Nova Scotia these are chiefly granitic and gneissic; while in the province of Quebec, and in Britain, serpentinic, dioritic and feldspathic forms are more prevalent. As above stated, they occur as beds, dykes, veins, or masses, sometimes parallel with, but often intersecting the stratification. I am not aware that any of these crystalline rocks have ever yielded gold either in Britain or in Nova Scotia; and the instances of their having done so in Australia are not numerous; the most noted and remarkable being that of the dioritic dykes with horizontal richly auriferous quartz veins intersecting them, numbers of which were found in the gold district of Wood's Point, Victoria, traversing slates and sandstones, probably of Upper Silurian age. An accurate sectional view of one of them is given in my Notes on the Geology and Physical Geography of Victoria, Plate IV.

DR. GENTH.

In this connection Dr. F. A. Genth, of Philadelphia, states, [American Journal of Science, 2nd Series, vol. xxviii, page 253, 1859.] "Gold "is frequently found in diorite (in smaller "quantities in syenite and granite) and although "it is only rarely observed in the massive rocks, "I have seen specimens from Honduras, C. A., "where it was imbedded in the diorite without "any other association. The result of the com- "plete decomposition of the diorite is a red

"clayish soil, and this has, in the gold region of "North Carolina, etc., a reputation for its richness in gold."

What influence the crystalline rocks, or the causes which produced them have had on the formation of the quartz veins with which the gold is generally associated, has not been in any case satisfactorily determined.

GEOLOGICAL AGE OF GOLD.

It would appear however, apart from secondary causes in connection with the alluvions, that a general similarity in the geological conditions and associations under which the gold occurs exists in all auriferous regions, whether the veinstones are connected, as in Canada, Britain, and Australia, with cozoic and palæozoic strata; or as in California and Switzerland, with mesozoic formations; or as in Hungary and Transylvania with rocks of tertiary age; and thus the probability of the occurrence of veins bearing gold, or any other metal or metallic ore in any particular region, can never be determined by the geological age of the rocks alone, but rather by the physical conditions and influences connected with metamorphism, upheaving, fissuring, dislocation and invasion by crystalline rocks, to which they have in each case been subjected since their original deposition.

I have no wish to enter here on the intricate question of the age, origin, and mode of formation of metallic deposits, and mineral veins; and it is unnecessary to refer to the numberless theories which have been propounded to account for the varied phenomena which they present, except in so far as they are more immediately connected with the facts observed regarding the auriferous quartz veins of Nova Scotia, and other parts of the Dominion or appear to have some practical reference to their probable extent and future development.

ORIGIN OF MINERAL VEINS.

It is now generally admitted that direct igneous agencies, in the sense of injection or fused matter, have played very little, if any, part in the production of mineral veins, or in the distribution of the ores found in them, and also that auriferous quartz veins present no features which would serve to distinguish them from any other class of ore-lodes, either in their origin or in their mode of occurrence; and on these grounds I have long held the opinion that there was not *a priori* reason why such veins should not contain gold in sufficient quantity to be profitably extracted at any depth to which ordinary mining operations can be carried.*

It most mineral veins and their ores are due, as I believe them to be,† to infiltration and segregation of mineral matters, chiefly through the agency of subterranean mineral-charged gases and thermal waters, penetrating and percolating under favoring conditions into and through cracks and openings which have been formed in the crust of the earth, either by seismic, plutonic or volcanic action, or through dessiccation and cooling, causing contraction and corrugation; then there appears no reason physical, chemical or geological which should determine all or the greater part of the gold in auriferous veins, towards those particular parts which now constitute their surface-outcrops, but which at some remote earlier period were certainly many hundreds of feet beneath it.

VEINS IN DEPTH.

In some parts of Australia, and doubtless elsewhere also, veins have been traced from their outcrops on hills considerably elevated above adjoining valleys, across these valleys, and up the opposite slopes to equal or greater elevations; portions of the outcrops in the valleys being as rich as other parts of the same vein on the summits of the hills. In such cases the valleys represent at least a great part of the denudation which the strata have suffered since the veins were formed, and if the latter are followed vertically downwards from the hill-tops, there seems no reason why the quartz at the bottom of such shafts should not be as rich in gold as it was at the surface, or at an equivalent depth beneath it, in the valleys; the relative level of the two positions being equal, and the scooping out of the valley an accident comparatively almost as recent as the sinking of the shafts.

DISTRIBUTION OF GOLD IN VEINS.

Again, if there were really any relative and constant proportion between depth and amount of gold, then, in all cases such as that cited, admitting even a much smaller amount of denudation of the vein than would be given by the entire depth of the valley, it ought still to be manifested by the superior richness of the hill-outcrops; but so far as I am aware, no such relation has ever been observed, and indeed no definite law of general practical application seems to be yet known as affecting the distribution of gold in veins, beyond the prevalence of that regular irregularity which is more or less characteristic of ore-deposits of all kinds, and in every region. In the Montague gold district Mr. Brown, manager of the Montague mine, states there are numbers of cross veins, some exceedingly rich, while others are totally barren. Locally, however, there are doubtless indications of various kinds, which, through long practical acquaintance with them, are valuable guides to the miner in directing his explorations; but these are not generally applicable beyond the limits of the district or country in which they have been observed.

AGE OF NOVA SCOTIA VEINS.

Though it is not difficult to show that the great majority of all the worked auriferous quartz-deposits are of more recent origin than the rock in which they occur, it is seldom possible to determine exactly at what subsequent period they were formed. In Nova Scotia there seems good evidence in the well-known occurrence of gold in the Carboniferous conglomerates at Gay's River, that at least some of the veins are of pre-Carboniferous age; but on the other hand there is no reason why many others may not be even of tertiary date or immediately preceding the denudations by which the recent auriferous alluvions were formed.

* My opinions on this point are quoted in Murchison's Silnria, 3rd Edition, 1858, pages 495, 496, 497; and 4th Edition, 1867, chap. xix, pages 464, 465, 466.

† See in this connection Dr. Hunt's remarks, Geology of Canada, 1863, page 735.

It is commonly supposed that when veins cease upwards at the conformable or unconformable line of contact of two formations or rock-masses, this circumstance is in itself a proof that such veins were formed during some period antecedent to the deposition of the superior and younger formation, and doubtless such is frequently the case; but it is, I conceive, by no means an axiom, and should always be applied with caution; inasmuch as it is not only possible, but even probable that conditions favorable for the formation of openings, cracks and fissures, and the introduction of minerals into them, may have affected the sediments of one formation, without operating beyond its limits, either upwards or downwards, in rocks which differed greatly in physical and mineral characters, as well as in geological age.

AGE OF AUSTRALIAN VEINS.

I have elsewhere pointed out certain reasons for supposing that quartz veins differing greatly in age and in mineral contents, but hardly, if at all, distinguishable by external characters from each other, occur in the metamorphic and slaty Silurian rocks of the Australian gold-fields. Mr. W. P. Blake, in quoting my remarks on this subject in his elaborate and comprehensive report on the precious metals, adds: "This fact is a familiar one to American quartz-miners, not only in California, but in the Appalachian gold-fields, and it suggests the possibility of their being quartz lodes of two or more distinct periods in America as in Australia." (Reports of the United States Commissioners to the Paris Universal Exposition, 1867. Vol. II.)

THE GOLD-STREAK.

The distribution of the gold in "streaks," "pipes" or "pay-chimneys" in the quartz-veins is a feature common to Nova Scotia, to Australia, and to California. These streaks are always found to have a dip more or less transverse to the dip of the vein; they sometimes vary greatly in width at different depths on the course of the vein, and are therefore more or less lenticular or wedge-shaped, not unfrequently dying out altogether before reaching the surface. In some veins they are stated to occur at no great distance apart, while in others they are separated by great thicknesses of comparatively barren quartz. Thus in following the veins downwards, if the streak happens to be narrow, it is speedily passed through, and the sudden impoverishment of the quartz causes a mine to be abandoned, when by a little further exploration in the direction of the dip of the streak a very different result might have been obtained. At present there is not much reliable information on this subject, though it is one well deserving of closer investigation. Prof. H. Y. Hind in his "Report on the Waverley Gold District," gives a number of interesting facts concerning it, and states that at Sherbrooke, in some mines the gold streak on the south side of the anticlinal dips to the east at a high angle, and on the north side to the west at about the same angle; and at Waverley, that the streak in the North lead dipped from west to east, and in the North Taylor, South Taylor and No. 6 leads, dipped from east to west. The above leads are all on the north side of the anticlinal.

As regards the mines at Sherbrooke above cited, unless the leads or layers of quartz to which the observations refer have been proved undoubtedly to be parts of the same bed on either side of the axis, very little can be deduced from the facts recorded. On the other hand, if it could be proved that such a reversal of the dip of the gold streak always occurred on the opposite sides of the anticlinal, in quartz layers which had been proved to be identical by being traced continuously round the end of the axis, then indeed we should have the strongest evidence, if not of the quartz layers having been actually deposited at the surface at the same time as the slaty and arenaceous rocks of the country, at least of their having been formed, and the gold distributed in them in bands, in the manner in which it is now found, antecedent to the operation of the forces by which the main anticlinal and synclinal forms of the strata were produced.

INTERSTRATIFIED BEDS.—EMMONS, SILLIMAN.

The theory above alluded to, of the contemporaneous origin with the enclosing strata of certain gold-bearing bands in North Carolina, is advanced by the late Professor Emmons in his report on the Geology of that State, published in 1856; and as early as 1837 Professor B. Silliman seems, from the following extract from his "Remarks on the Gold Mines of Virginia," (American Journal of Science, vol. xxxii, page 100,) to have held a similar view regarding some of the gold-lodes of that region. He says: "The auriferous or gold-bearing quartz of the gold-region of Virginia (and as far as I am informed of the States further south), form not strictly veins, but rather beds or layers, in general not interfering with but conforming to the regular structure of the slaty rocks of the country, and like them descending to an unknown and probably an unfathomable depth. . . . . The quartz is therefore as regular a part of the structure of the country as the slaty rocks themselves, and when it is auriferous, the gold is disseminated through it in spangles, flakes and points, sometimes visible on breaking the quartz, but most usually entirely invisible even with a powerful magnifying glass. . . . . "The gold being generally disseminated in the quartz of this gold-region it is obvious that it must have been laid by in its stony bed at the same time that the quartz and the slate rocks in which it is contained were deposited." The manner in which the gold is disseminated in the quartz, cannot be considered as affording any evidence on this point, because it is as common in true veins which intersect the stratification, as it is in the bedded veins above described.

HUNT, HIND.

Dr. T. Sterry Hunt, Mr. Hind and other writers, express views respecting those auriferous quartz lodes in Nova Scotia, (which have been found to be more or less parallel with the stratification of the country, both in strike and dip,) agreeing with those of Prof. B. Silliman in Virginia and Prof. Emmons in North Carolina. A similar mode of occurrence of quartz layers

containing gold has been recorded in California; and I have described it as likewise occurring in Australia. Neither in Australia or in Nova Scotia, however, have I yet met with evidence which I consider of such a nature as to prove with certainty the truth of the supposed contemporaneous origin with the slaty rocks, of such quartz layers; and I am far more inclined to agree with the remarks of

LIEBER,

[Geological Survey of South Carolina, 1856, page 10,] where he says, "All veins are younger than the country; and hence it is without any reason that many writers regard those only as veins which dip or strike unconformably with the country-rocks, for it is evidently quite immaterial what peculiar relative position is occupied by the two as concerns the origin or the general characters of the veins. Crevices may be formed in any direction, and it is but reasonable to suppose that the planes of stratification, being possessed of less cohesion, will at least as readily present themselves for the formation of cracks or fractures, as those planes which traverse the more compact and less fragile portions of the rock."

The bedded quartzite or quartz rock in which the gold is found in North and South Carolina, apparently partakes more of the character of a mechanically deposited siliceous sandstone, and the gold which is distributed in it may very possibly have been mechanically derived from pre-existing auriferous rocks. The auriferous quartz veinstone of Nova Scotia is strictly of the kind ordinarily known as vein-quartz; and on this account is not comparable to the gold-bearing quartzite and quartz rock of North and South Carolina.

NOVA SCOTIA LODES.

Besides this there are numerous facts in connection with the gold-lodes of Nova Scotia, which are opposed to the theory of their having been formed at the surface together with the slaty rocks; and are strongly in favor of the opposite view, which I entertain in common with other observers, viz.: that all the deposits of auriferous quartz in Canada whether they appear as "bedded lodes," "intercalated lodes," "gash lodes" or "true lodes," have alike been formed since the deposition and consolidation of the arenaceous, slaty, crystalline or other rocks, with which they are now associated. This is I believe, equally true of the Australian gold-veins.

INTERCALATED LODES.

The classification of the lodes given above is that adopted by Mr. Hind, in his recent Report on the Sherbrooke gold-district, in which also he defines these different kinds of veins, but says: "The origin of the intercalated lodes is obscure." It appears to me to be no more so than is the origin of all lodes, and I see no sufficient reason for distinguishing the latter from the bedded lodes. Mr. Hind apparently does so chiefly on the ground of their being associated with broad bands of slate; whereas the bedded lodes usually have one wall of sandstone and the other of slate, and are associated with alternating thin bands of slate, and thick beds of the so-called whin, a grey or greenish-grey feldspathic sandstone or grit. Mr. Hind further remarks on this point: "But the conditions required for their formation appear to be in a great part satisfied if we suppose that they represent lines of minimum pressure during the folding, denudation, and faulting of the strata." This, and the reasoning respecting them on pages 24 and 25 of his Report is, I think, equally applicable to the bedded lodes; and indeed, Mr. Hind himself seems to be inclined to this view, when he says: "The same reasoning which is applicable to the formation of intercalated lodes may render it doubtful whether any bedded lode, not clearly a fissure-lode, can strictly be regarded as of contemporaneous age with the enclosing rock."

I have carefully examined the veins cited by Mr. Hind as examples of intercalated lodes at Sherbrooke, and likewise others at Isaac's Harbor and elsewhere in Nova Scotia. These belts of leads are, as Mr. Hind points out, in broad bands of slaty rock, which is often so intimately associated and interlaminated with the bands, layers and strings of quartz that the whole body of the rock, often for twenty feet in width, is taken out and milled; the gold frequently occuring in films between the slaty laminæ, as well as in the quartz and mispickel.

Similar belts occur in Australia, and are worked in a similar manner, but they have not generally proved as permanently profitable as the better defined veins with distinct walls. This arises partly from the great difficulty, danger and cost of taking out the rock to any considerable depth over such wide spaces as twenty feet. The best mines of this description in Australia have been situated on steep slopes, or in more or less isolated hills, which offered facilities for quarrying, rather than mining the material, and for obtaining very large quantities at a very small cost.

BELTS OF VEINS.

In Australia and in Canada, I have observed that where these belts occur, the planes of cleavage and of bedding usually coincide very nearly, both in strike and dip; that the strata are nearly vertical, and afford undoubted evidences of great pressure and of motion of one plane upon another, producing fractures and openings; frequently so much is this the case as to have given rise to the term of "mullocky" reef or lead, expressive of the crushed and fractured condition of the ground. The layers of quartz in these belts are generally thin, from a mere thread to eighteen inches or two feet, but probably do not average twelve inches. They are more or less lenticular, and sometimes are clearly seen to pass obliquely from one plane to another, in such a manner as to preclude the possibility of their having been deposited contemporaneously with the slates. The principal difference between the bedded and the intercalated lodes appears to consist in the greater persistency of the latter over wide spaces, without passing out of the bed of slate in which they occur, although within its limits, (usually a thickness of some three to five feet), they not unfrequently pass from one plane to another; and this appears to be more particularly the case where the slaty band is affected by cleavage, the planes of which are slightly transverse to both the strike and the dip of the strata. It is in such situations that those

curiously contorted and corrugated forms of veins are met with which, though rare and exceptional in Australia, are very common in Nova Scotia, and which may be said to culminate in the noted and often described barrel-quartz of Waverley.

DEPTH OF VEINS.

The greatest depth to which any bedded or other quartz lode has yet been followed in Nova Scotia is less than 450 feet.* What the greatest horizontal distance is through which any one vein has been traced in connected or continous underground workings, I am not aware. But it is certainly very insignificant as compared with what might reasonably be expected if they really represent beds analogous to seams of coal or iron ore in their mode of occurrence, as is implied by the theory under review.

In order to substantiate their origin by contemporaneous deposition at the surface, it would likewise require to be explained in a more satisfactory manner than has yet been done, why they are always found in close connection with anticlinal axes, and never at the outcrops of the main synclinal folds, or associated with strata which have not been subjected either to metamorphic agencies, or to folding or faulting.

ANTICLINALS.

This constant connection with anticlinals seems also to be characteristic of the gold region of California, of which Dr. Hunt states, on the authority of Prof. J. D. Whitney: "These conformable lodes are generally exposed on the upturned edges of eroded anticlinals, but in one case in Nevada County a remarkable lode is mined, which is described as consisting of three distinct floors or bands, having a very flat dip, and seeming to form a kind of basin, apparently a synclinal form." Two instances have been recorded in Nova Scotia, in which the vein is represented to have been traced round the synclinal axis. I have examined these on the ground, and I find that at Isaac's Harbour the so-called synclinal is nothing more than a small undulation near the crown of the main anticlinal axis. At Lawrencetown a similar form is distinctly shewn in the section of the beds which accompanies the report of Messrs. Shelford and Robinson, 1869, on the Werner Gold Mining Property, and I have no doubt the instance of the synclinal form cited in Nevada County, California, is one of a precisely similar occurrence.

HORIZON OF GOLD VEINS.

It has been suggested, in order to account for the general absence of quartz layers, either in connection with the synclinal folds, or at any considerable distance removed from the main anticlinal axes, that the quartz and gold were deposited only along a certain horizon extending upwards from the lowest exposed beds of the series to within 2,640 feet, according to Campbell, of the base of the upper clay-slate group; that these lower beds, with their associated quartz layers, have been brought up by a series of anticlinal folds, and their edges exposed by denudation; whereas the corresponding beds in the synclinal folds are deeply buried, and are overlaid by the upper beds, which are not within the gold and quartz zone, and therefore on their denuded edges present no intercalated quartz bands. This seems to be a somewhat arbitrary limitation of the period during which quartz and gold were deposited, especially as we find that even in the upper black slaty series, where the strata present similar conditions, auriferous quartz layers are not wanting.

The structure of the country has not yet been worked out and mapped with sufficient accuracy however, to prove that quartz layers are limited to any particular part of the series, or that the several anticlinal folds on which the worked lodes are situated in the different districts, do not include beds which belong to all parts of the series; and if they do, then there is no reason why the outcropping edges of the strata in the main synclinals should not be accompanied by intercalated quartz layers as commonly as are those of the main anticlinals.

CLAY SLATES.

There is no doubt that black pyritous earthy slates, to the exclusion of thick-bedded whin or sandstone, and with a very few quartz layers, constitute a very considerable thickness of strata overlying the more richly auriferous sandstone series; but, as before noticed, quartz layers are not absent in the former; and where anticlinal axes occur in them, as at the Ovens, profitable gold workings have been established. Whether the beds at the Ovens, and at Indian Path, in the same neighbourhood, are high up, or low down in the upper slate series has, so far as I am aware, not been determined by any reliable means.

THICKNESS OF STRATA.

The total thickness of the whole series is estimated by Mr. Campbell at nearly two miles, or over ten thousand feet. My observations do not enable me at present to express any opinion whatever on this point; but there seems no reason to doubt the correctness of Mr. Campbell's estimate. The general absence of organic remains, and of str of limestone, or other well marked beds, renders it extremely difficult to identify, for the purposes or correlation, the groups of strata which are exposed in the several districts; it is, therefore, essential, in order to arrive at any sound or practically valuable conclusions, that the distribution of these groups, and the associated granitic and gneissic rocks should be traced out and accurately mapped. Without such preliminary work, the result of any attempt to parallel the rocks of one district with those of another, except in the most general way, must be entirely conjectural. The distance, in each case, from the axis to where the upper black slaty series commences, if carefully measured, might to a certain extent serve as a guide, but this has not yet been attempted; and nothing definite is at present known respecting the distribution of the several groups of strata which constitute the great auriferous series of Nova Scotia.

At first sight perhaps the solution of the question, how and when the leads were formed, may

*At the Clunes mine, in Victoria, Australia, veins which strike and dip conformably with the slaty rocks are now being worked profitably at a depth of 690 feet; the yield being 12 dwts. to the ton.

appear to be of no practical importance; but on further consideration it will be seen that it is so in two ways; first, as regards the surface area over which the leads may probably be found; and secondly, in regard to the probable depth to which such intercalated veins or leads are likely to extend.

HIND ON EXTENSION OF LODES.

Mr. Hind, in his report on the Waverley Gold District, 1869, says: "The Waverley leads are indefinitely prolonged in all directions, like the interstratified slates and white:" and, infers that they extend in unbroken sheets from one district to another. If they are beds, such should of course be the character of their distribution, in which case their occurrence might reasonably be expected to be co-extensive with the accompanying slates and sandstones, irrespective of the attitude which the latter happen locally to present, whether horizontal, slightly inclined, or sharply folded. If on the other hand, they are of subsequent origin, and due to infiltration and segregation of mineral matter into openings which have been formed along lines of minimum pressure, while the forces were operating which resulted in the upheaval, corrugation and cleavage of the strata, then we should expect to find them developed to any considerable extent, only along and in proximity to the anticlinal axial folds; and only rarely and accidently where the strata were horizontal or very slightly inclined, or in connection with main synclinal axes, representing the lines of maximum pressure; and we might also expect the beds to diminish gradually in number, and to be less permanent in depth as we recede from the lines of minimum pressure indicated by the main anticlinal ridges.

The facts observed appear, to a great extent, to bear out these theoretical deductions; the vein-like character of the quartz; the comparatively limited distances through which the layers have been traced; their more or less lenticular form; the evidences of motion in the enclosing rocks; the constant connection with anticlinal axes, and the absence of corresponding quartz layers through great thicknesses of strata which do not present evidences of much disturbance and corrugation, are circumstances, all of which are strongly opposed to the theory of contemporaneous deposition, and as strongly in favor of the opposite conclusion.

ANTICLINALS.

Mr. Campbell has recognized six principal east and west anticlinals, and he groups them, according to Dr. Hunt, (Report on the Gold Region of Nova Scotia), in the following order from south to north: 1st, Ovens and Tangier; 2nd, Lawrencetown and Wine Harbour; 3rd, Old Tangier (Mooseland), and Sherbrooke; 4th, Waverley and Isaac's Harbour; 5th, Oldham and Country Harbour; 6th, Renfrew. The principle by which the above grouping of the gold-fields on the several anticlinals has been determined, is not very apparent. If the average strike of the rocks is assumed to be about N. 80° E., and S. 80° W., magnetic, it will then be seen, supposing the positions assigned to the several localities on McKinlay's map of Nova Scotia to be approximately correct, that the Ovens, instead of being on the southernmost or first axis, would be on the most northerly but one; and the grouping from south to north would be—1st, Wine Harbour and Isaac's Harbour; 2nd, Tangier and Sherbrooke; 3rd, Lawrencetown and Old Tangier; 4th Waverley and Jennings's Diggings; 5th, Ovens and Oldham; 6th, Renfrew and Mount Uniacke. In the above grouping Montague would come in between Waverley and Lawrencetown, and near the parallel of Jennings's Diggings.

STRIKE OF ROCKS.

As regards the Ovens and Indian Path leads, they are on anticlinal folds which there affect the upper black clay-slate series, and it is exceedingly doubtful whether these can be paralleled with any of those which affect the districts on the western side of the great granitic and gneissic belt which, terminating in Mount Aspotogen and Cape Sambro, completely separates the whole of the eastern gold districts in the counties of Hants, Halifax and Guysborough, from those of the western counties of Lunenburg, Queen's, and Yarmouth. In the southwestern districts from Yarmouth to Chester, the strike of the rocks ranges between S. 10° W., and S. 80° W., or within 35° of southwest and northeast. In the eastern districts it ranges from N. 75° E. to S. 55° E., magnetic; the most southeasterly dips being in the districts of Sherbrooke, Isaac's Harbour and Wine Harbour.

The nature and the probable age and origin of the great granitic and gneissic belt above alluded to, and of other smaller but similar bands in the eastern districts, are questions of considerable interest and importance. They have been alluded to and discussed by Dawson, Hind, Campbell and other writers, and considerable diversity of opinion exists respecting them, which is not likely to be cleared up or removed by further discussion, or indeed by any method short of actual survey.

GRANITIC BELT.

The granitic belt certainly occupies a much more prominent place in Nova Scotia geology than has hitherto been assigned to it on any published geological map of the Province; although Mr. Hind alludes to it in the introduction to his recent report "On the Sherbrooke gold-field, and on the gneisses of Nova Scotia," where he says:—"Throughout the length of Nova Scotia, from the Gut of Canso to the Tusket Islands, there exists an interrupted axis of granitic rocks, which have hitherto been regarded as almost altogether composed of eruptive granite." And again, on page 6, he mentions that he has traced it from near Windsor to Cape Sambro, and that he believes it to extend thence to the Tusket Islands, near Yarmouth, a distance of 135 miles in an air-line. It may properly be described as a continuous crescent-shaped band, of varying width, sweeping in a bold curve from its commencement, or eastern horn, at Cape Sambro, through the counties of Hants, King's, Annapolis, Digby, Yarmouth and Shelburne, to its termination or southwestern horn, at Cape Sable. I have examined it in all the above-named districts, and the impression I at present have, is that it is strictly of an indigenous character, and neither an old

granitoid gneissic series of Laurentian age, nor an intrusive mass. Dr. Dawson has shewn (Acadian Geology, 1868), that in different parts of its course it comes successively into contact with Lower Silurian, Upper Silurian and Devonian rocks, and the manner in which these sedimentary strata are affected at the lines of contact scarcely leaves room to doubt the posterior origin of the granite; but whether as an intrusive mass, or by the metamorphism *in sitû* of the stratified rocks, (in part by a process of molecular re-arrangement of their original component particles,) is perhaps uncertain. From personal observation, I have not much knowledge of the distribution and relations of the granitic and gneissic rocks in the eastern counties. They have, however, been observed at so many points from near Waverley, eastward to Cape Canseau, that it seems probable they will eventually be found to constitute a band almost as uninterrupted as they do in the western counties. But in any case they undoubtedly occupy a much more extensive area than is assigned to them on the published geological maps.

RELATIONS OF GRANITE TO GOLD ROCKS.

The relations of the granite and gneissic rocks in Nova Scotia to the surrounding auriferous strata, are perfectly analogous to what is observed in this respect in the Australian gold-districts, most of which are in close proximity to similar granitic centres. In one instance an auriferous quartz vein, which had been worked close up to the boundary of a large granite area, was found to pass gradually, by the addition of feldspar and mica, into granite, losing its auriferous character and becoming a vein of ordinary grey granite exactly resembling the rock of the neighboring granite mass, into which it eventually merged. It will be interesting to trace out the manner in which the quartz beds in Nova Scotia terminate in their strike towards granite masses. This could probably be most advantageously studied at Mooseland, where massive quartz veins occur only a few hundred yards distant from the granite.

BARREL-QUARTZ.

In reference to the peculiar barrel-quartz already adverted to, and which, in various modified forms, is very characteristic of numbers of leads in Nova Scotia, though it has frequently been described, no very satisfactory explanation has yet been given of the cause to which it may probably be ascribed. During the past summer I have made some observations which will perhaps help to throw a little light on this question: much careful observation, and the collection of a much greater number of facts is, however, yet required for the complete elucidation of the subject, which is one involving intricate questions of geological dynamics. The facts I have observed, however, all seem to lead to the conclusion that the corrugation of the quartz is intimately connected with, and dependant on the operation of the forces which produced the slaty cleavage; the same forces have likewise, in all probability, caused the openings between the beds in which the quartz has been deposited; and also the great parallel east and west synclinal and anticlinal foldings of the strata.

In every corrugated vein which I have examined, the axes of the corrugations or barrels always coincide with the strike of the cleavage. If the walls are of sandstone (whin), they are rarely corrugated, and seldom show any cleavage-planes; though their surfaces, especially if in immediate contact with the quartz, frequently show ridges or parallel undulations, which strike with the cleavage and seem to have impressed corresponding swells or undulations on the quartz. Where cleavage and bedding coincide in strike and dip, no corrugations occur, nor are they observed in layers which are enclosed between walls of hard whin.

CORRUGATED LODES.

All those veins which are sharply corrugated and contorted, lie within the limits of beds of highly cleaved soft slates of from three to five feet wide, between beds, either of whin and a hard compact slaty rock, which constitute the walls of the veins, but in no instance exhibit corrugations corresponding with those of the vein, and are commonly perfectly smooth and even throughout. Beautiful examples of such veins occur at Oldham in the Schaffer lead; in the Fish lead; and in the works at No. 1 Shaft of the Stirling Company. Also in the Free Claim at Renfrew; and in the Dominion Company's mine at Sherbrooke.

In veins of this character the distance between the corrugations, as well as their size is very irregular, producing forms resembling a number of badly shaped letters S strung together, or like the course of an exceedingly tortuous brook in its windings through an alluvial flat. The slaty laminæ in proximity to the quartz conform more or less to the convolutions of the latter, and the beds in which the veins lie afford abundant evidence of great pressure, and of motion of one plane upon another, the surfaces being all more or less polished, striated, and slickensided.

The cleavage intersects the stratification at all angles, but is invariably at a higher inclination than the bedding. It varies in strike from about N. 10° E. to east and west, but is generally much more nearly east and west than north and south.

JOINTS IN LODES.

Some veins have a structure as if two sets of different sized corrugations crossed each other diagonally, dividing the vein into a series of rhombic or rhomboidal blocks. A cross section however shows that this structure is not due to the corrugation of a quartz layer of uniform thickness, but that the whole vein is composed of a very regular series of bulges, and that the longitudinal furrows are thinnings of the vein corresponding to the strike of the cleavage-lines in the wall-rock; and the similar, though smaller cross furrows correspond with a set of close joints which intersect the strata in directions more or less parallel to the dip of the latter. In such veins the quartz breaks out in blocks resembling in form the well-known septarian nodules or "turtle-stones" of the English Lias.

LEARY LEAD.

The Leary lead at Tangier shows a good example of this kind of structure. The foot-wall is of dark lead-grey slate, and has a perfectly smooth even face through the entire length of the workings, dipping S. 5° E. ∠70°. Between it and the quartz there are about two and-a-half or

three feet of broken, cleaved, and slickensided slate, the surfaces coated with yellow sulphuret of iron in thin films. The under surface of the veins presents a flat mammillated appearance, and is divided by joints into large rhombic blocks. The joints in the quartz correspond in strike and dip with the divisional planes in the wall-rock due to cleavage and jointing. In the hanging-wall thin strings of quartz are seen in many of the joints, and the lines of the joints are marked by more or less prominent ridges, which correspond to the furrows in the main vein, and dip on the wall or plane of bedding at angles dependant on the difference between the strike of the latter and of the other divisional planes. Through the kindness of Mr. Crossland, the resident manager of the mine, I obtained some very interesting specimens from this lead, showing the occurrence of the gold in the fractured slate, in the quartz, and in the mispickel, which occurs in large quantities both in the veins and in their slaty walls.

Having shown what I believe to be the probable origin and character of the bedded gold-leads of Nova Scotia, we may now consider what is likely to be the effect of these on their extent and permanence in depth. If their origin and character is as suggested, it is hardly to be expected they will follow exactly the laws which are applicable in this respect to either true fissure-lodes, or to contemporaneous interstratified deposits. I have already alluded to this subject, (page 7), where it is stated that we might expect the leads to diminish gradually in number, and to be less permanent in depth the further they are removed from the axes of upheaval. I do not, however, think this, even if correct, is likely to affect injuriously the prospect of any of the leads now being worked.

PERMANENCE IN DEPTH.

The depth to which mining can be successfully carried is, under any circumstances, so infinitesimally small when compared with the distances through which the forces supposed to be the cause of the vein-fissures must have operated, that there need be no apprehension of the limit of the latter in depth, being reached at distances less than those through which we know them, (from surface evidence) to extend horizontally in directions parallel and transverse to the anticlinal axes; and as these distances are reckoned by thousands of feet, it may very safely be conjectured that there is practically no limit to the depth to which the leads may be successfully followed. At the same time the facts observed would suggest the probability that the largest, best, and most permanent veins will, as a rule, be those which are nearest to the anticlinal axes; and, likewise, that veins of this character are not likely to occur either in synclinal outcrops, or where there are great thickness of strata nearly horizontal or uniformly inclined in one direction. But in such situations true fissure-veins and cross-lodes, either in dislocations or in shrinkage-cracks may be abundant, and of such a character as to be capable of being mined with profit. These are matters which can, however, only be determined by extended and careful exploration, and are alluded to only to show that however true the foregoing conclusions may be, they are not intended, and should not be permitted to discourage "prospecting" and intelligent exploration in all parts of the auriferous region.

EXTENT OF GOLD ROCK.

The extent of the Atlantic coast series, of stratified gold-bearing slate and quartzite has been variously estimated at from 5,000 to 7,000 square miles. My observations during the past summer induce me to think that this estimate is very considerably too large. The mistake has probably arisen from defective information respecting the area occupied by the granitic rocks; which, as I have already pointed out, is very largely in excess of that assigned to it on published geological maps, from which the computations referred to have probably been made. The area represented on Sir W. E. Logan's large map of Canada as occupied by strata of Lower Silurian age on the Atlantic sea-board of Nova Scotia is about 5,400 square miles, and of this probably fully more than 1,400 square miles are occupied by granitoid rocks. Exclusive of Cape Breton Island, 3,500 square miles would, therefore, probably represent the total extent of the area over which the stratified slaty and quartzose auriferous rocks are distributed.

GEOLOGICAL AGE.—DAWSON AND HIND.

The geological position and the age of these rocks has been fully discussed by Dr. Dawson† and by other of the authors whose observations I have alluded to, and all are agreed that they probably belong to the Lower Silurian period. Certain portions of them Mr. Hind has recently assigned to an older date; the possibility of which had already previously been suggested by Dr. Dawson, Acadian Geology, 2nd Edition, page 620.

CAMBRIAN AND LOWEST SILURIAN.

My first impression of them, formed after personal examination last summer, and based on mineralogical and stratigraphical considerations only, was what they represented the groups known in Britain as the Harlech grit or quartzite, and the Lingula-flag series; the former mapped as Cambrian by the British Survey, and the latter as the lowest member of the Silurian system.

FOSSILS, EOPHYTON.

In confirmation of this view I subsequently detected in the grey sandy and flaggy pyritous slates at the Oven's Bluffs, in Lunenburg County numerous specimens of the genus *Eophyton*, regarded by Mr. Billings as characteristic of the Primordial Silurian epoch. This genus is common in the sandy dark slates of the city of St. John, New Brunswick; in rocks hitherto referred to the Quebec group, on the Island of Orleans; and in Newfoundland. In all these localities it is accompanied by other well marked Primordial Silurian forms, which further diligent search will doubtless also disclose in Nova Scotia.

MR. BILLINGS.—DISTRIBUTION OF EOPHYTON.

Mr. Billings has supplied the following remarks on these fossils:—"The fossils discovered at the Oven's Bluffs are generically if not specifically identical with those described by the Swedish geologists, Torrel and Linarsson, under the name of *Eophyton Linnæarum*. They suppose them to be plants, but as none of the specimens exhibit any internal structure, this view does not meet

†Acadian Geology, 2nd Edition, pages 613 and 614.

with general acceptation, and the theory that they are trails or tracks of marine animals seems to find more favour. Upon the question of their true nature I do not at present venture to give an opinion; whatever they may be, they seem to be confined to the lower portion of the Silurian system.

"The following is the geological position of the genus *Eophyton* in other countries, so far as it is yet known:—

SWEDEN.

"1. In Sweden, where the *Eophyton* was first discovered, it occurs in the rock long known as the Fucoidal sandstone, which immediately underlies the alum-slate; this latter formation is undoubtedly the representative of the Lingula flags of Wales.

NEWFOUNDLAND.

"2. In Newfoundland it was discovered in 1867, by Mr. Murray, on Great Bell Island, Conception Bay. It is there associated with two new species of *Lingula*, a *Cruziana* closely allied if not identical with *C. semiplicata*, (a Lingula-flag species) and several fucoidal forms. Mr. Murray considers the rocks of Bell Island in which these fossils occur to lie above the beds holding *Paradoxides*, and they would thus probably represent the upper portion of the Lingula-flags.

NEW BRUNSWICK?

"3. It occurs at Milkish Passage, near St. John, New Brunswick, and also in the city of St. John, in sandy shales. At the Milkish Passage the beds are said to be older than the trilobite beds of Drury's Cove; these latter are the Lower Lingula-flags.

ORLEANS ISLAND.

"4. On the south side of the Island of Orleans, near the village of St. Laurent, *Eophyton* was found last spring by Mr. Weston. It is there associated with several species of fucoids identical with those that occur on Great Bell Island. The rocks here are referred to the Quebec group, but as they are considerably disturbed, it is not impossible that they may be older and brought up by a fault. There is a small lenticular mass of limestone in these rocks in which Sir W. E. Logan and I found, several years ago, three species of trilobites which I have always considered to be of a more ancient type than any known to me in the Quebec group. These fossils occurred in pebbles of limestone imbedded in the calcareous rock which constitutes the lenticular mass itself.*

"5. In the Geological Magazine, vol. 6,(1869,) a fossil is described by Mr. Hicks, from the Lower Arenig rocks of St. David's, under the name of *Eophyton? explanatum*. Mr. Hicks considers it to be distinct specifically from the Lingula-flag form, and even refers it doubtfully to the genus.

HORIZON OF EOPHYTON.

"So far as my own experience goes during the twenty-five years that I have collected fossils in the Lower Silurian, from the Potsdam upwards, I have never seen a fragment of any thing that could be referred to *Eophyton*. Neither has any ever been described or figured by any author as occurring in beds above the Lingula-flags, with the exception of the doubtful form by Mr. Hicks, above mentioned. If it be true, therefore, that *Eophyton* is merely a track, I am inclined to the opinion that the animal that made it belonged to a very ancient genus, which appeared during the earliest Primordial Silurian period, attained its greatest development during the era of the Lingula-flags, and died out at the close of that era. It is a remarkable fossil, and wherever found, it occurs abundantly, and it is therefore almost impossible that if the animal lived on through the Silurian period its traces could have so long escaped the notice of the great number of workers in Silurian geology."

Hitherto, except the very doubtful and obscure forms detected by Mr. Hind in the quartzite at Waverly, and referred by him to the genus *Palæotrochis*, but in which Mr. Billings states that no distinctly organic structure can be discerned, no organic remains whatever had been detected in the Nova Scotian gold-bearing rocks, and therefore their geological position remained uncertain.

CAMBRIAN OF WALES.—LINGULA-FLAGS.

In general aspect, and in the succession of the beds the whole series in Nova Scotia closely resembles the Cambrian and Lingula-flag series of North Wales, which is likewise characterized by holding auriferous quartz veins. The Lower members of the series (Cambrian) there consists of a succession of thick bedded greenish-grey feldspathic grits and sandstones or quartzites, with intercalated slaty bands; and these are conformably overlaid, as the similar beds are in Nova Scotia, by a set of black earthy and pyritous slates and sandy beds (the Lingula-flags) with quartzose mineral lodes. Numerous associated diorite dykes are likewise characteristic of the series in both regions. Thus mineralogical characters, physical aspect and palæontological evidence all combine to prove the above view to be correct regarding the age of the Atlantic-coast series of Nova Scotia.

OLDER ROCKS.—YARMOUTH.

I have seen no evidence in the eastern gold-districts of the existence of any formations which are certainly older than the lowest members of the quartzite group, although doubtless such are quite likely to occur without their having been observed by me in the very cursory examination which it was possible to make during a part of only one season over so large a tract of country. On the southwestern coast, between St. Mary's Bay and Tusket, there is a set of rocks exposed which, especially in the immediate vicinity of Yarmouth, differ greatly in aspect, and generally in their mineralogical characters, from any met with in the eastern auriferous series. They are probably of a different age; but to what group they belong is at present uncertain. At Yarmouth, between Yarmouth and the Chegoggin River, and on Cape Fourchu Island the strata are well exposed. I did not visit Chegoggin Point; but at Cranberry Head, the next point to the northward, where the only gold-mine in this district is situated, we find, associated with the vein, soft grey and olive-green fissile slates, and also

*This fact would indicate that the age of these rocks is younger than that of the imbedded fossils.

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bands of whitey-brown micaceous sandstone. On the shore immediately underlying the beds in which the vein occurs, there are thick-bedded hard grey and whitey-brown feldspathic sandstones, with scales of silvery white mica. Associated with the sandstones are bands, from six inches to two feet thick, of blue and greenish-grey slate. These continue for about three quarters of a mile along the shore, nearly with the strike, when a massive diorite dyke cuts the beds nearly at right angles, without disturbing them beyond causing a slight curve in the strike. The dyke is 150 yards wide, and is succeeded by similar sandstones and finely cleaved slates for a quarter of a mile further. Some of the sandstones enclose pebbles of a grey quarzite. At the mine the beds dip S. 55° E. $<$ 60°, and at the end of the section about one mile to the north, S. 60° E. $<$ 60°. From the mine southward, there is a gradually ascending section, consisting of grey slates, olive-green slates, and grey sandy, and blue and black papery crumpled slates. The highest beds in the section are the fine black earthy pyritous slates. The dip continues S. 60° E., but the angle gradually increases from 60° at the mine to 85°, and becomes vertical at the southernmost end of the exposure.

CAPE FOURCHU, DIORITES, CHLORITIC AND EPIDOTIC ROCKS.—IRON ORES AND EPIDOTE.

The rocks at Cape Fourchu Island, and thence to Yarmouth, consists of hornblendic, chloritic, epidotic, and micaceous strata, with dark greenish and black slates; also massive crystalline epidotic diorites, with large enclosed patches of epidote rock. Near the extreme west point of the island, there is a thick bed of coarse conglomerate, on the weathered and sea-worn surfaces of which the pebbles are well seen; while in a fresh fracture they can with difficulty be distinguished from the matrix, (which is a greenish-grey micaceous schist,) except by a slight difference in colour. The pebbles are all flattened and more or less elongated in the direction of the cleavage-planes. They consist chiefly of a grey fine grained micaceous gneissic rock; some are of a brown-weathering feldspathic sandstone, and and others of an epidotic rock similar to the immediately adjoining strata. The schistose beds occasionally contain crystalline grains of magnetic and of titantiferous iron ores, and epidote is often very abundant in them. This, from the weathering of the softer matrix, is left projecting in small lumps and irregular ridges over the exposed surfaces, giving these a singularly fretted and rough appearance. Veins and large lenticular masses of vitreous white quartz are not uncommonly associated with the more slaty beds. One very prominent mass of this kind is known as the Canoe. It lies in a joint nearly at right angles to the stratification, on the west shore of the island, and from a little distance, especially seaward, has the appearance of a large canoe stranded on the rocks. In the eastern part of Yarmouth, within the town-limits, there are some thick beds of massive grey or whitish-brown quartz rock, (with large irregular reticulating veins of white quartz,) interstratified with the green chloritic, hornblendic and epidotic schists. On the road between Milton and Arcadia (Church's map) similar chloritic and hornblendic beds occur, and also some bluish grey feldspar-porphyries or felsites.

JEBOGUE POINT.—CHROMIUM.

At Jebogue Point there are several quartz veins from six inches to three feet thick, associated with black crumpled slates, and the rocks exposed are similar to those at Cranberry Head. Samples from one of the most promising looking of the above veins have been assayed by Dr. Hunt, but afforded no trace of gold, though containing a good deal of arsenical sulphuret of iron. It is reported in the neighbourhood that gold has been found in some of these veins, but no attempts have been made to work them.

To the north, at Cape Cove in the county of Digby, a few chains east of Cape St. Mary lighthouse, there is a small exposure of green chloritic rocks, like those at Yarmouth, associated with light grey quartz-rock, brecciated white, brown, and silicious schist, and black earthy pyritous slates. The green schists here contain imbedded white calc spar in considerable quantity. Their dip is S. 55° E. $<$ 80°,—84°. In specimens of these green schists, and likwise of those from Yarmouth, Dr. Hunt has found traces of chromium. He remarks that in their general mineralogical characters, as well as in the presence of chromium, these rocks resemble the crystalline schists of the altered Quebec group of the Canadian Survey, and also similar schists referred to the Huronian series around Lakes Huron and Superior. In other respects the rocks of Digby and Yarmouth counties, above described, are not unlike the hornblendic, epidotic, chloritic and other strata of certain divisions of the Quebec group, which, in connection with the facts above noticed, suggests the possibility that the former may occupy the position of the Quebec group. If so, we may hope to find a gradually ascending series in Nova Scotia from the Primordial Silurian slates at the Ovens in Lunenburg County, northwestward to the Upper Silurian and Devonian rocks of the northern parts of the counties of Annapolis and Digby, perhaps interrupted to some extent by the great central granitic band.

ALLUVIAL GOLD.

As regards alluvial gold-deposits, and the prospects in Nova Scotia of what is known in California as "placer" mining, I cannot do better than recommend the perusal of Mr. Hind's remarks in paragraph 6 of the prefatory letter addressed to the Hon. Robert Robertson, Commissioner of Mines, which accompanies his recent report on the Gold District of Sherbrooke. I fully concur in all the observations and suggestions made by Mr. Hind in this letter, and anything I can say respecting it, must be more or less a repetition of what has already been pointed out by him.

AUSTRALIA AND NOVA SCOTIA COMPARED.

In comparing the physical features of the Australian gold-districts with those of Nova Scotia, in their bearing on the question of the occurrence of alluvial gold, the principal difference appears to be the prevalence in the latter of long narrow lakes, pools and swamps in place of the similarly shaped dry grassy "flats" and flat-bottomed "gulleys," (often almost as level as

lakes,) which characterize the Australian districts, and in which the rich "runs," "leads" or "gutters" of alluvial gold are found by sinking through the alluvions to the bed-rock, which generally protudes in ledges along the margins of the flats and in the adjoining hills. If we assume the lakes and swamps in Nova Scotia to represent the flats and gulleys in Australia, there are no apparently important differences in the geological conditions presented in the two regions. It becomes a question, therefore, whether rich deposits may not underlie many of the lakes and swamps of Nova Scotia, as they do the flats and gulleys of Australia; and if so whether they could be profitably mined. To do so it might be necessary to drain the surface-water, but this would depend entirely on the depth beneath the lake-bed of the old channel or gutter.

TANGIER.

At Tangier, works were commenced, as described by Professor Silliman in his Report published in 1864, [See Dr. Hunt's Report on the Gold Region of Nova Scotia, page 40,] to drain Copper Lake, in order to explore the deposits in its bed; but the enterprise appears to have been abandoned before any result had been arrived at, and nothing was being done at the time of my visit to the locality last summer.

NOVA SCOTIA.

The reason which has been given, and apparently very generally believed, why no considerable quantity of alluvial gold is likely to be found in Nova Scotia, viz.: that over the greater part of the country the superficial accumulations of gravel have been removed by comparatively recent denuding agencies, has certainly no foundation in fact; and I can confidently assert that bare rock-surfaces are not more prevalent in the gold-districts of Nova Scotia than they are in similar districts in Australia.

It is incredible that in the latter country the the gold-bearing veins should be invariably accompanied by rich alluvial deposits, while in Nova Scotia the detrital deposits, which certainly occur under precisely similar conditions, should be almost as invariably unproductive. I do not believe in any such anomaly, but think that the whole secret of the matter lies in the fact that, owing to obvious local circumstances, they have never yet been sought for with that degree of enterprise, intelligence and perseverance, which the investigation demands.

It is stated that surface-leads have occasionally been found, and have been followed for limited distances into gradually deepening ground, with highly promising indications, when the influx of water being too great to be overcome by manual labor with an ordinary bucket and windlass, the ground was at once abandoned. Under such circumstances it is not surprising that no alluvial leads have been developed in Nova Scotia.

At Tangier, at Oldham, at Sherbrooke, at Waverley, and at Renfrew, I observed places that appeared to present all the conditions required for the occurrence of rich alluvial "diggings;" but, so far as I could learn, no attempts had been made to test them, although they lie in close proximity to quartz veins which have afforded large returns, and the abrasion of which in past times must have contributed to form the detritus in the adjacent depressions.

WORKING ALLUVIONS.

The great quantity of water which would probably be encountered in all the deep and low-lying drift-deposits in Nova Scotia doubtless constitutes a serious hindrance to their being explored, inasmuch as it almost precludes the success of individual effort, to which, in Australia, the original discovery of nearly all the principal gold-fields is due. They offer however, I consider, a legitimate and exceedingly promising field for combined capital and labor skilfully applied, and it is certainly remarkable that so little attention has hitherto been bestowed upon them.

MR. MICHEL.

As will be seen in Dr. Hunt's Report (page 14), Mr. Michel insisted strongly upon the importance of searching for alluvial gold beneath the glacial drift or boulder-clay of the coast; where, as Dr. Hunt remarked, the gold alluvions "may reasonably be expected to be of great richness."

Wherever valleys filled with detritus are found crossing the strike of the veins, as is the case at Waverley, at Oldham, and doubtless in many other places, explorations should be made immediately below such lines of intersection, as being the most likely to afford satisfactory results. In the few places where alluvial gold has been detected, the discovery has been purely accidental. The search has never been conducted on any defined system or principle, and was, therefore, not likely to effect more than it has done; viz.: prove the presence of particles of gold in almost all the superficial sands and gravels which have been examined, and occasionally to such an extent as to be capable of being profitably extracted.

HYDRAULIC METHOD.

I have not seen any localities in Nova Scotia where the hydraulic methods of washing in use in California and Australia could be successfully adopted, because the recent gravels appear for the most part to lie in depressions which are below the present drainage level of the country; and seldom on hills, or in elevated terraces along the sides of the valleys. I am not aware whether this is also the case in New Brunswick.

CHAUDIÈRE, QUEBEC.

In the province of Quebec, on the Chaudière and its tributaries, the drift appears in some cases to rest at considerable elevations above the main water-channels, and this was long since pointed out by Sir W. E. Logan. Nothing, however, has ever been done to test the value of the gravels. Recently, through the enterprise of the manager of the Company already mentioned as being the only one at present operating in that district, it has been proved that they likewise extend to depths of one hundred feet beneath them. It is in these old deep channels and depressions that the heaviest particles of gold may be looked for, and with the requisite appliances for draining the ground there seems every reason for hoping that a very extended and valuable field for gold-mining enterprise will be opened up

in the province of Quebec, especially when considered in connection with the known wide distribution of gold in the region, which has been abundantly proved by the researches of Sir W. E. Logan, the details of which are given in a pamphlet entitled Notes on the Gold of Eastern Canada, issued in 1864 by the Geological Survey. This contains a summary of all the information on the subject up to that date; and in the report of Mr. A. Michel, addressed to Sir W. E. Logan, and published in the Geology of Canada, in 1866, further and more recent information has been gi[illegible].

MR. LOCKWOOD'S WORKINGS.

On the 14th February last, Mr. Lockwood informed me that in their shaft then sinking the bed-rock had been struck at 100 feet below the level of the Gilbert River, dipping three feet in the width of the shaft. This indicates still deeper ground, as does also the character of the gold met with, of which he states, "We took out nearly one ounce of gold yesterday, and six pennyweights, thirteen grains to-day. It is all fine scaly gold and, I fancy, all from the gravel. We have found "colors" since first striking it, about twenty-eight feet." This must be considered an exceedingly satisfactory commencement, and quite sufficient to warrant further exertion.

ANCIENT CHANNELS.

The worn and comparatively heavy character of much of the gold which has hitherto been procured from the shallow washings in the Chaudière district, does not, I think indicate that it has been derived from distant sources, so much as that it has been subjected to repeated and long continued abrasion in the drifts. I believe it to be strictly of local origin, and to have come from the quartz veins in the neighbourhood. The chief reason why the rich spots where it has hitherto been worked are so limited in extent is that they represent the places where the old channel or river-bed has been intersected by the existing one, and cut into, down to the bed-rock; re-distributing its contents along the present river course, and thus enriching, for a limited distance, the recent alluvions. If instead of extending explorations, as has commonly been done, solely in the direction and along the course of the present river, they are pushed boldly into every part of the adjacent banks where no rocky ledges are seen in place, there is but little doubt that the old channels from which the present streams have derived most of their gold would speedily be discovered, and often richly reward the enterprise of the explorer. These are facts which are well known in Australia, and acted upon frequently with the most successful results. Here no one appears to have directed attention to them, and they have not been alluded to in any published descriptions of the gold fields of this country.

Mr. Lockwood states in his report to the Directors of the Company, dated 4th August, 1870: "During the last five years I have observed closely all the work done, and have not seen one intelligent attempt made to obtain a knowledge of the nature and origin of the rich alluvial deposits; no man except myself has done anything to establish the fact that the alluvions have their origin in the local reefs, or that we have a distinct system of old river-channels at a considerably lower level than the present ones."

"On lot fifteen the lead leaves the present river-channel and strikes under the high ground; here an old river-channel was discovered; it is from thirty-five to fifty feet below the present river-bed. A drive has been run across this channel 250 feet. The water being heavy, and the ground dipping, we were unable to determine its width. The whole of the gravel found in this channel is auriferous, and it is composed entirely of the material from the local rocks. In the sand of the roof drift-wood was found about eighty-five feet below the present surface."

From the returns already obtained, Mr. Lockwood estimates the average yield per acre of the old channel at $45,000, and the cost of working at $12,500 per acre. It is, however, next to impossible to make an estimate of this kind, which shall be at all reliable for practical purposes.

CHAUDIÈRE QUARTZ VEINS.

The quartz veins of this district have already been examined and reported on, and their auriferous character has been established.* I examined the out-crops of several of those from which samples were taken by Mr. Michel and carefully assayed by Dr. Hunt. No efforts appears to have been made since the date of the reports above referred to, for their further development. The result of Dr. Hunt's assays was certainly not very encouraging, but when compared with other assays made by Dr. Hayes of Boston, they only serve, as he remarks, to prove the "irregularity with which the gold is distributed in the gangue."

Some of the veins are well situated for working, and so far as can be judged from the very limited extent to which any of them have yet been opened there would be no difficulty in raising very large quantities of quartz. Considering the heavy and often nuggety character of much of the alluvial gold of the Chaudière district, it is in the highest degree improbable that none of the veins from the abraded portions of which this gold has without doubt been derived, should be sufficiently rich to yield a fair profit to well directed enterprise applied to their exploitation, and it seems extraordinary that so little has hitherto been done in this direction.

GOLD MINING IN NOVA SCOTIA.

The system on which mining and mining business is conducted in Nova Scotia, like all other subjects connected with the gold-fields, has been commented on in numerous publications. Its many defects have been repeatedly pointed out, and much sound advice and a number of practical suggestions for its amendment have from time to time been offered, without however, having produced any very marked effect; notwithstanding that the success of a very large majority of the mining enterprises in the province is unquestionably in a great degree dependant on these remedial measures being adopted; and their total

* Reports of Mr. A. Michel and Dr. T. Sterry Hunt addressed to Sir W. E. Logan, in the Report of Progress, Geological Survey of Canada, 1866, pages 69-90.

neglect is as undoubtedly the chief cause of the numerous failures which mark the history of the gold-fields.

CAUSES OF FAILURE.

Among the causes which may be considered as most prejudicial to the permanent and healthy progress of mining industry, the following may be mentioned:—They are not in any way especially characteristic of Nova Scotia, but prevail more or less in every mining region of which I have any knowledge, particularly in the early years of their development.

1st. The rash expenditure of capital in the purchase of mining-rights respecting the actual value of which nothing is known with certainty.

2nd. The hasty and inconsiderate erection of costly machinery for mining and treating the ores, before their quantity or their probable value has been determined.

3rd. The attempts frequently made to enhance the value of the stock by declaring dividends, sometimes paid out of capital, but often by means of a process commonly known as "picking the eyes out of the mine," or in other words selecting all the rich material to secure a few high yields which are far in excess of anything likely to be the future average.

4th. The too common, almost universal practice of devoting the whole of the net proceeds to the payment of dividends, and having no reserve fund to meet expenses when poor ground has to be worked through. This improvidence frequently necessitates the closing of a mine, and the abandonment of a property as worthless, which, under a more judicious system, would have become extremely valuable.

5th. The small size of the "areas" or claims, not as regards actual acreage, but in relation to the position and thickness of the veins. This necessitates a wasteful multiplication of shafts and plants of machinery for crushing and dressing the ores. In some districts in Nova Scotia these are out of all proportion to the actual requirements.

6th. The disregard of the natural features of the ground, shewn in locating the crushing and dressing machinery without reference to the easy delivery of the material from the mine and the fall required for the perfect treatment of the ores, and for getting rid of the tailings. This want of foresight necessitates subsequent heavy outlay for re-handling the material, all of which might be saved.

7th. The almost universal want of any appliances for saving pyrites and fine gold.

WASTE OF GOLD IN TAILINGS.

On this point Mr. Hind remarks in his recent Report on the Sherbrooke district:—"From careful assays of numerous parcels of tailings in Nova Scotia as they came from the mill, and selected indiscriminately, the average quantity contained was found to exceed 4 dwts. per ton. In many instances the assay gave a very much larger yield. These tailings lie around the mill in every direction, or are allowed to run into the nearest stream; in no instance known to me are they concentrated even to save the pyrites, or are any really valuable appliances used to save the free gold they contain, which has escaped from the stamping-boxes or the amalgamating-tables.

"A year ago, attention having been called to the escaped gold in the tailings of one of the mills at Waverley, portions were re-crushed and passed over amalgamating-tables; and in the official return for 1869, we find the following statements: 288 tons of waste from the dump, gave 32 oz. 5 dwts. 11 grs.; 63 tons of waste from the dump, gave 13 oz. 12 dwts. 16 grs. From this experiment some idea may be formed of the amount of gold allowed to escape in the tailings from upwards of 190,000 tons of quartz, the quantity already crushed in Nova Scotia."

HUNT, ASSAY OF TAILINGS.

As indicating further the probable value of some of these heaps of tailings the following analyses by Dr. Hunt, are here given of three samples which I collected from Yarmouth, Montague and Renfrew respectively. He says, "the proportion of arsenical pyrites or mispickel (other sulphurets being rare), was determined by dissolving it out from the quartz; and the following figures give under A, the amount of gold per ton of tailings; under B, the amount of gold per ton of pyrites; and under C, the proportion of pyrites in the tailings: The determinations under A and B, were made by the ordinary fire-assay upon the roasted tailings."

	A	B	C
Montague	5½ oz.	12 4-20 oz.	43 per cent.
Renfrew	2½	4	64 "
Yarmouth	5½	7 15-20	65 "

The sample from Montague was taken at about eighty feet from the last amalgamating-plate, and at about seven or eight inches below the surface of the heap.

The sample from Renfrew was taken from six inches below the surface of the heap, and at about ten or fifteen yards from the last amalgamating-plate.

The sample from Yarmouth was given to me by the owner of the mill; I have no knowledge of the circumstances under which it was collected.

A sample of tailings from Moosecland, taken from the fourth mercury-trap, Dr. Hunt found to contain 58 per cent. of arsenical pyrites. A portion concentrated to 88 per cent., gave one and one-half ounces of gold to the ton: equal to 1 oz. 14 dwts. to the ton of pure pyrites.

In digging into the surface of the heaps of tailings, I noticed that the pyrites was not equally distributed through the mass, but almost always in layers, giving a regularly stratified appearance to a vertical section of the sand; the pyritous layers being from one-eighth to one inch in thickness, and the more sandy layers considerably thicker. The samples were taken rather to show the value of the pyrites, than the quantity of pyrites or gold in the tailings; and therefore the figures under A and C are not a correct average of the heaps; but even supposing the tailings to contain no more than one-half the above amounts, the value of the gold which is being annually lost is enormous, and the subject is well worthy the serious consideration of every mine owner in the country. This fact of the richness in gold of the arsenical pyrites of the lodes in Nova Scotia is not new.

SILLIMAN ON ARSENICAL PYRITES.—HUNT.—ROASTING ARSENICAL ORES.

Prof. Silliman, in his Report on the Tangier district, in 1864, found the pyrites extracted by washing from the tailings of three lodes at Tangier to yield respectively $93, $125, and $180 of gold to the ton: while a mass of the pyrites, of several pounds weight, from Montague, according to the same authority, yielded at the rate of $276 of gold to the ton, of which about two-thirds only were coarse gold. These facts are cited by Dr. Hunt in his Report already referred to (page 20), and he there adds,—"Notwithstanding these results, the tailings are generally entirely neglected in the Nova Scotia mines, and with them no doubt large quantities of gold are lost which might be advantageously extracted by concentration and roasting, followed by amalgamation, either in the Chilian mill, the Wheeler, or Hepburn pan, or perhaps, better still, by the use of Plattner's process, in which the gold is dissolved out of the roasted ore by chlorine. Prof. Silliman has suggested that the arsenic may be profitably extracted from the arsenical pyrites by roasting in properly constructed furnaces. By this means it might be made to yield half its weight of white arsenic, which has a considerable commercial value, and would probably pay the expense of roasting the ore. By thus condensing the arsenic, the injurious effects which would otherwise result from the escape of the poisonous arsenical vapours into the air during roasting would be prevented."

WORKING OF STAMP MILLS.

Reverting to the wasteful multiplication of plants of machinery in the various districts of Nova Scotia, above alluded to, this will perhaps be best appreciated by a comparison of the number of stamps, and the quantity of quartz crushed in Nova Scotia with similar work in Australia. According to the tables in the Report for 1869, by the Commissioner of Mines in Nova Scotia, the total quantity of quartz crushed that year in all the districts was 38,424 tons. The number of mills employed was fifty-four. The number of stamps is not given; but if we allow an average of twelve for each mill (which is probably an under-estimate),* we have 648 stamps. They weigh generally from 550 to 600 lbs. each, and are worked at an average speed of 65 to 70 blows per minute, with a nine-inch lift.

The quantity crushed per stamp-head in twenty-four hours is stated to be one ton; the average in Australia and California is from one and one-quarter to two tons; there seems no good reason why it should not be as large in Nova Scotia. However, taking it at one ton, and allowing 250 working days, the 648 stamps ought to crush 162,000 tons, or more than four times the work actually done, which amounts to less than sixty tons per stamp-head per annum.

VICTORIA, AUSTRALIA.

At the Port Philip Company's mine, at Clunes, in Australia, there were crushed in 1870, in fifty-two weeks, 55,240 tons; and in the same time in 1869, 64,273 tons. This work is performed by eighty stamps; (twenty-four of 800 lbs., and fifty-six of 600 lbs. each;) worked at a speed of seventy-five blows per minute; and they each crush from two to two and a quarter tons per day of twenty-four hours. The quartz is as hard as any I have seen in Nova Scotia.

At the Black Hill mine, at Ballarat, which commenced working in January, 1862, 250,575 tons of quartz had been crushed up to December 31st, 1869; being an annual average of 31,321 tons. This is done by sixty stamps, of 700 lbs. each, worked at a speed of seventy-five blows per minute, with a litt of about nine inches.

Thus, in Australia, we find two mills with 140 stamps, crushing 86,561 tons of quartz in the year; or considerably more than twice as much as is crushed in Nova Scotia, in fifty-four mills, with more than four times the number of stamps. The fineness to which the quartz is reduced is about the same as in Nova Scotia.

COMPARATIVE YIELD OF GOLD—PRICE OF LABOR.

If we compare the average yield of the quartz in Nova Scotia with that in Australia, both of which are given in Heatherington's "Practical Guide to the Gold-Fields of Nova Scotia," we find the former is 1 oz. 3 dwts. 5·8 grs.,* and the latter 11 dwts. 17·4 grs. If we also consider the relative prices of mining-labor in the two countries, (averaging in Victoria $2.00 to $3.50, and in Nova Scotia only $1.25 to $1.50, per diem,) the reason why two-thirds of the crushing-power in the latter is standing idle seems at first sight somewhat inexplicable. It is evidently not the poverty of the quartz; neither is it, as I can vouch from personal observation, owing to any deficiency in the quantity which the veins, if properly worked, are calculated to produce; and we are therefore forced to conclude that it arises from the causes above enumerated, and from the unskilful, wasteful, and improvident manner in which the business has ordinarily been conducted, creating general apathy, and utterly destroying the confidence of investors.

VICTORIA.—PROFITS OF MINING.

In the two mines in Australia above cited, the average yield of gold to the ton of rock, of late years, has never exceeded 10 dwts. At the Black Hill mine it is stated to have been only 2 dwts. 21 $\frac{81}{100}$ grs. per ton; but even this low yield has proved sufficient to pay the proprietors ten per cent. on the capital invested; the amount paid in dividends in eight years being £21,730 sterling, or $108,650. At Clunes, the average yield in 1869 was 7 dwts. 8 grs., and in 1870, 4 dwts. 20$\frac{1}{2}$ grs. Many more instances could be given of yields far less per ton than the quantity now lost at every mill in Nova Scotia, having sufficed, under careful management, to give a fair profit to the adventurers. These results are due to the practical and intelligent application of the lessons taught by experience; and if this experience is utilized, and as intelligently applied

* In sixteen mills, of which particulars are given in an Appendix to "Heatherington's Guide," there are 199 stamps.

* This yield for Nova Scotia is considerably greater than that which is given as the average by Mr. Hind, page 57 of his Report on the Sherbrooke District, viz., 15 dwts. 16 grs.

in Canada as it has been in Australia, there is no reason why equally satisfactory results should not be achieved.

The want of any even approximately correct topographical maps of the gold districts is likewise a serious hindrance to their development. It renders accurate geological observations impossible; and thus the structure of the country cannot be worked out or understood, as it must be before either the probable course, or the extent of the mineral-veins can be ascertained with precision, or the localities determined in which farther developments may be looked for.

CONCLUSIONS.

In conclusion, I may state, that the general impression produced on my mind by what I have seen of the gold-districts of Canada during the past summer is, as regards their natural capabilities, exceedingly favorable, and equally unfavorable as regards the enterprise and intelligence which has hitherto been devoted to their development. At the same time it should not be forgotten that the most favorable indications are not always reliable, and the sanguine prognostications they so frequently give rise to are often not borne out by the result of actual working; wherefore I should, even under the most favorable circumstances, not advise any one to invest in such enterprises to an amount beyond what he can afford to lose without serious embarrassment.

WANT OF MAPS.

The need above alluded to, of good topographical maps, is one which cannot be too often pointed out, and is well deserving the serious consideration of the Government. Such maps are not only necessary for geological and mineralogical purposes, but for agricultural, sylvicultural, engineering, military, political, and statistical purposes they are likewise indispensable; and every dollar expended towards their production eventually becomes an annual saving to the country; a fact especially obvious when such periodically recurring works as the census have to be undertaken. The subject is dwelt upon here because it is one which seriously retards the progress of the geological explorations with which I am specially charged; and it seems not out of place to call attention to the fact that hundreds of dollars which are debited to these investigations are really unavoidably expended in making additions to the topography of the country, for which, however valuable, extensive, and important, but little credit accrues to the Geological Survey.

ALFRED R. C. SELWYN.

MONTREAL, *May*, 1871.

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