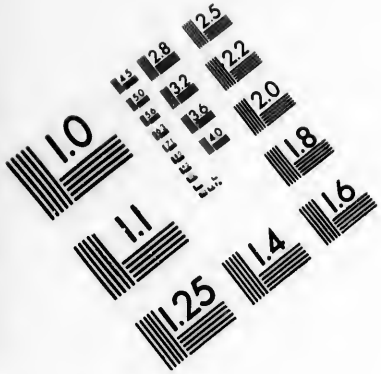

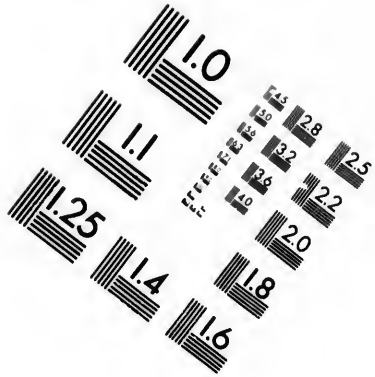

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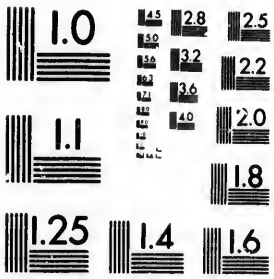

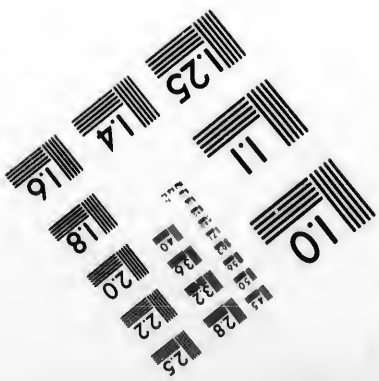

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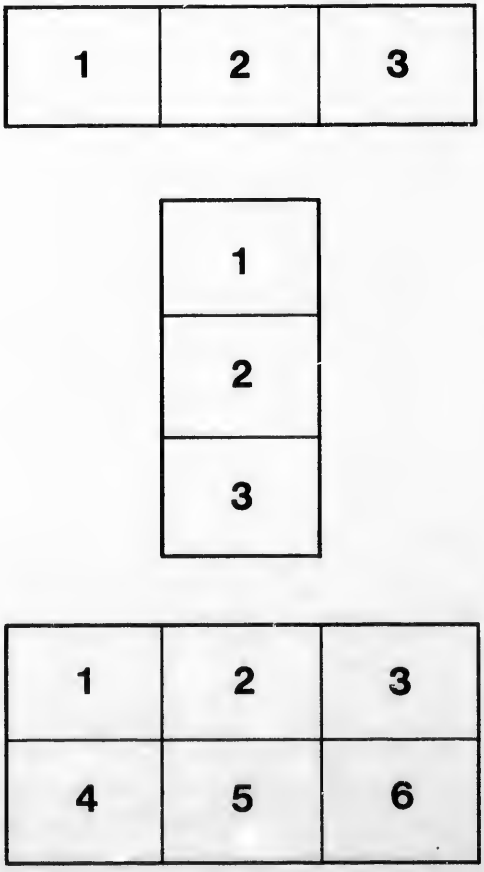

THE

GOLD FIELDS

OF

NOVA SCOTIA.

By EDWIN GILPIN, Jun., A.M., F.G.S.,

Government Inspector of Mines, Nova Scotia.

BY PERMISSION OF THE COUNCIL.

EXCERPT MINUTES OF PROCEEDINGS OF THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS, VOL. XXXI., 1882.

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THE GOLD FIELDS OF NOVA SCOTIA.

By EDWIN GILPIN, Jun., A.M., F.G.S., Government Inspector of Mines, Nova Scotia.

It is proposed in the following paper to lay before the members a brief account of the Gold Fields of Nova Scotia, a district of interest from a geological point of view, although as yet it has occupied but a humble rank as a gold producer.

The age of the rock masses composing this gold field is still conjectural, but the structure of the individual districts is well proved.

The commencement of a thorough geological survey promises the solution of many problems of scientific and practical importance in connection with it.

The gold fields of Nova Scotia occupy a district extending along the Atlantic Coast from Cape Canso to Yarmouth, and varying in width from ten to forty miles. The total area assigned to the auriferous strata and the rocks most intimately connected with them is estimated at from 6,500 to 7,000 square miles, of which about one-half is occupied by what are known as "granite" rocks. The shore presents a low rugged front, diversified by numerous harbours running for long distances inland, and studded with islands. The land rises gradually to a height of 560 feet, and is cut up by numerous lakes and swamps. The soil is generally poor and boulder laden, and there are large areas supporting no vegetation beyond a few shrubs. In the Lunenburg district, and many of the inland valleys there is good farming land, but generally speaking the district is valued only for its timber and gold mines.

The existence of gold in Nova Scotia was conjectured perhaps when Queen Elizabeth in 1578, in a patent granted to Sir Humphrey Gilbert, made a reservation of one-fifth of all the gold and silver he might discover. Later, in a patent issued by Charles I. to Sir William Alexander, in 1621, one-tenth of the precious metal was reserved.

The names of Bras D'or, Jeu D'or (Jeddore), etc., would seem to show that gold was not unknown among the early French settlers, and it appears on good authority that one hundred and fifty years ago, they washed from the sands of the River Avon, near Windsor, small quantities of gold.

Sir Charles Lyell, in his remarks on the "Geology of North America," published in 1842, predicted the discovery of gold in Nova Scotia.

However, public attention was not directed to the matter until the discovery of gold on the Pacific Coast caused a search to be made which was continued by returned Californian miners until 1858, when a man, drinking at a brook near Tangier, picked up a nugget of gold. From this chance discovery, and the excitement which followed, may be dated the beginning of gold mining proper in the province.

The "Granite" rocks of Nova Scotia may be divided into two sections. The western one extends from Halifax to Windsor, a distance of forty-five miles, and stretches in a great belt, interrupted by occasional patches of auriferous measures, nearly to Yarmouth. To the eastward, another band of less width stretches with several interruptions from Waverley to the Cape of Canso. These great masses are but little known and have never been mapped; the outlines given in Fig. 1, Plate XXII., are from the author's notes, and Dr. Dawson's "Acadian Geology."

Some ingenious theories have been advanced as to their being really of Laurentian age, based, it would appear, chiefly on the fact that they have in contact with them at many places bands of gneisses, mica schists, etc., which have been set down as Huronian, as they are more metamorphosed than the ordinary auriferous strata.

So far, however, as these granites have been studied in their relation to the auriferous and newer strata they serve to confirm the views entertained by Dr. Dawson, that they are intrusive masses. Near Sherbrooke, as remarked by Dr. Dawson, the quartzite at the point of junction with the granite, is slightly changed in character, having apparently minute hornblende and mica crystals developed in it, but the granite sends numerous veins into it, and in them becomes coarser in texture, and presents beautiful aggregations of plumose mica.

At Cochran's Hill auriferous measures are found lying close to one of the most persistent of the granite ranges, and are penetrated by bands of granite from one inch to six feet in thickness. The measures have exhibited a metamorphism equal to that found anywhere in the coastal range. The slates have become perfectly crystalline. Mica schists, or micaceous gneisses, with crystals of chiastolite, and staurolite, have been developed in them.

Dr. Dawson similarly describes the granite of Nictaux, as altering the Devonian beds and converting them, for a short distance away from the junction, into gneissoid rocks holding garnet. The granite sends veins into the strata, and near the junction, holds numerous angular fragments of altered slate. In the case of both the auriferous and Devonian strata, the gradual passage from gneissoid rock into the normal metamorphosed quartzite and argillite, can be frequently observed.

The Nova Scotia granite has all the characters of a plutonic rock in its want of stratification, its frequent porphyritic appearance, its passage into graphic granite, etc., and closely resembles in lithological characters the intrusive granites of the Eastern Townships of Quebec and of New England, some of which belong to the Montalban Series of Hunt, while others are later than the Upper Silurian; and it differs materially from the typical Laurentian of Canada. In the latter the gneisses are usually hornblendic, laminated, and interstratified with diorites, pyroxene rock, limestone, serpentine, etc.

These granites are evidently older than the Carboniferous, for at Horton their débris is found in the Lower Carboniferous. At Nictaux they penetrate rocks of Oriskany age. They are therefore much more recent than the auriferous strata, to which, as will be shown, a greater age must be assigned.

The pre-Carboniferous age of the gold veins is proved later on in this paper. From the relation which appears, from the map, to exist between the granites and the gold districts, it may be inferred that as the veins, as at Cochran's Hill and elsewhere, cut the granite bands, the granite intrusions and the formation of the veins are, as Dr. Dawson expresses it, "roughly contemporaneous."

Around and between these granite masses the gold bearing strata are spread, with a general strike parallel to the line of the shore, and are now presented in a series of undulations, such as would be expected from a pressure acting against the trend of the coast.

Denudation on an immense scale has swept away the crests of the anticlinals, and presented the strata in a succession of elliptical curves, the axes of which are variously inclined.

The gold bearing strata may be divided into two great sections. The upper is composed principally of black earthy pyritous slates with few beds of quartzites, and not many quartz veins. These veins are auriferous when exposed in the anticlinals similar to those in the lower section to be described further on. An instance of this auriferous character of the veins is met at Lunenburg, but it is not known at what horizon they occur. Its thickness has been estimated by Professor Hynd to be about 3,000 feet.

The lower section is composed of alternating beds of quartzites and compact sandstones, sometimes felspathic, and argillites, and is estimated to be 9,000 feet thick.

The following section, exposed in perspecting trenches at Mount Uniacke, will show the general succession of the measures in the gold

districts. It must, however, be remembered that in other districts larger lodes are found, and a much greater thickness of auriferous ground. Thus at Waverley, gold bearing lodes are known through a thickness of 3,500 feet, and at Renfrew the thickness of the known and worked gold belt is 5,000 feet.

The measurements are at right angles to the stratification, and the assays by the Connecticut State Assayist.

SECTION IN ASCENDING ORDER FROM THE AXIS OF THE ANTICLINAL MOUNT UNIACKE GOLD FIELD.

Strata.	Thickness.		Veins.		Gold Value.		
	Ft.	In.	Ft.	In.	Oz.	Dwt.	Grn.
Sandstone	15	6		2		12	7
Quartzose slate	42	0	...			...	
Slaty sandstone, with bands of slate	19	0	6	0		...	
Slate	1	0	...			...	
Sandstone	8	6	...			...	
Slate	1	3		2		3	0
Sandstone and slatebands	125	6	...			...	
Slate	38	6		3		...	
Quartzite	18	0	...			...	
Slate	16	0	...			...	
Quartzite	4	0	...			...	
Slate and bands of sandstone	6	0		2		...	
Sandstone and thin bands of slate	19	0	2 5 5			...	
Sandstone and band of slate	11	0	1	7		16	8
Sandstone and slate bands	8	0		7	1	2	1
Quartzose slates	13	0	...			...	
Quartzite	18	0	...			...	
Quartzite and slate bands	20	0		5	1	6	11
Sandstone and thin bands of slate	14	0	2	0		17	9
„ „ „ „	36	0	5 8 2			... 8 7	3 3
„ „ „ „	42	0	1	5		12	14
„ „ (disturbed)	29	0	...			...	
Quartzite	32	0	...			...	
Slate	12	0	3	0		5	9
Sandstones with bands of slate carrying several veins up to 8 inches	203	0	...			...	
Sandstones, grit at base passing into very fine grained massive sandstone, not auriferous	380	0	...			...	

This is succeeded by 1,630 feet of measures composed of quartzites with a few bands of slate and carrying fifteen non-auriferous veins.

THE AGE OF THE GOLD BEARING ROCKS.

It is to be regretted that as yet the age of these rocks cannot be definitely determined. There has been no systematic survey of the district, and the strata cannot be continuously followed into connection with well defined horizons further west. The following opinions are those advanced by Dr. Dawson, and they seem to the writer to be, so far as his present experience indicates, based on the only available data.

The following is his general comparative table, taken from the supplement to his "Acadian Geology:"—

CAMBRIAN.

England, etc.	Nova Scotia and New Brunswick.
Tremadoc slates and Lingula Flags.	Miré and St. Andrew's Channel Series in Cape Breton.
Menevian Series.	Acadian Series, St. John, N.B.
Longmynd Series.	Quartzites and slates of the Atlantic Coast of Nova Scotia.
Harlech grits and Llanberis slates.	

The Acadian Series of St. John, so carefully examined by Professor Hartt, forms, with its well characterised fauna, the typical representative on the Western Continent of the formation known in England as the Menevian or Barrande's Etage C. of the Primordial in Bohemia.

The Atlantic Coast Series, with the two divisions of quartzite and clay slate, so divided from the respective predominance in each of the rocks named, are considered by Dr. Dawson, Mr. Selwyn, and Professor Hynd, to precede these.

It is to be regretted that hitherto the light thrown on the subject by fossil evidence has been of the most meagre kind. Mr. Selwyn has recognised in the Lunenburg slates markings of the nature of those named in Sweden, Eophyton. Dr. Dawson, however, considers them the trails of aquatic animals named by him Rhabdichnites, which are characteristic of the Acadian Series. Professor Hynd discovered at Waverley nodular bodies and markings, which Mr. Billings referred with doubt to the genus Eospongia, and casts of Orthis. Dr. Dawson states that they may be compared with the problematical object from the Eophyton sandstone of Sweden, described by Linnarson under the name of Astylospongia radiata, but considers them fucoids with radiating fronds, allied in form to Hall's Phytopois from the Bird's Eye limestone, or to Linnarson's Scotolithus from the Eophyton sandstone, and has given them the name of Astropolithon.

The only other fossil forms observed are tubes from St. Mary's River resembling Scolithus.

So far as the above fossils give any information, they serve to confirm the supposition that the measures in question are to be referred to the Cambrian period. Within that period the fossils may be compared with those of the Fucoidal or Eophyton sandstones of Sweden, which underlie the equivalent of our Acadian series. They may therefore be regarded as probable equivalents of the Lower Cambrian or Longmynd Series of Europe.

Mention has been already made of the anticlinal folds of the auriferous measures, and their denuded summits. The veins of auriferous quartz, more particularly the subject of this paper, occur in them, and run parallel to the strata, having usually quartzite on one side and slate on the other. They follow the dips and turns of the encasing rocks, and to a casual observer appear to be really beds of quartz, formed at the same time as the beds containing them. They have, therefore, been considered by numerous writers to be true aqueous sediments.

Others again who have considered the reason of their formation, and the characteristics of the deposits, affirm with great show of reason that they are true veins.

Imagine these alternating layers of slate and quartzite ridged up under the influence of a pressure acting in a horizontal direction, and possibly to some extent confined by the more unyielding granite masses, it will be readily conceived that, at points of least resistance, which would be the crests and sides of the flexures, the strata would separate most readily at the junction of beds of differing toughness, leaving fissures closely following the outlines of the undulations. Denudation has swept away the crests of these anticlinals, and now presents these concentric fissures filled with quartz, as shown on the plan of the Waverley district. (Plate XXIII.)

A different effect, however, is noticed when the ends of the anticlinals are penetrated. Here the pressure acting on the layers not capable of escaping the pressure by flexure as readily as those already described, has caused the beds to form corrugations, accompanied, doubtless, in many cases by a slight movement of one bed on another. The larger of these corrugations, when filled with quartz, present the appearance of logs of wood laid side by side and connected by threads of the same mineral, and are called "barrel quartz."

In Plate XXIV. is given a sketch of one of these corrugated lodes, worked last year at Moose river. The lode varied in thickness from ¾ of an inch to 4 inches, and presented the apex of an anticlinal dipping to

the east. The lode was accompanied by a similar one a few inches below it. Both lodes carried gold, iron, and lead sulphides, and a little calcite, and gold showed through the intervening slates. The corrugations in the slates were parallel to those of the lodes, and extended as far as a section was exposed by the excavations. Similar, but less strongly marked, corrugations occur in many of the straight running lodes, and in some instances their transverse axes point to the line of pressure.

Other effects are recognisable as caused by this pressure. Thus veins called "anglers" are observed breaking abruptly across the quartzites, and obliquely across the slate beds, and in some instances proving rich sometimes in one rock and sometimes in the other (see Plate XXV.) Numerous feeders, sometimes auriferous, radiate from the lodes into the surrounding beds, and in some cases connect them. The thin layers of slate found in most instances on one side of the lode are frequently so soft and broken as to be readily removed by the miner's pick. The wider beds of slate are frequently penetrated by several irregular veins, sometimes uniting and again diverging, and the whole mass is filled with a net work of spurs and threads of quartz.

These fissures were filled presumably by the deposition of the quartz and associated minerals from aqueous or other solutions, in a manner similar to that in which Mr. J. A. Phillips described the formation of the auriferous quartz veins of California. There have been certain facts observed in connection with the auriferous values of the lodes in this province which may be worthy of mention.

It is found that, as a rule, in wide bands of slate the veins are feebly auriferous as is also the case in massive sandstones, or in sections composed principally of quartzites. The most productive veins are found where bands of quartzite and slate of moderate thickness alternate. This may possibly be due to the slates being readily penetrated by solutions owing to their original lamination, and its increase by the pressure alluded to above, and to the fact that the original deposition of the gold may have been dependent on this alternation of beds of differing minerals.

These remarks apply to the lower section of the auriferous measures. The overlying slates, although pyritous and containing numerous quartz lodes, undistinguishable from those already considered, have not yet yielded any containing enough free gold to warrant working by the present systems of milling.

The worked veins vary in thickness from one half-an-inch to six feet. The usual width being from 4 to 8 inches, and a 20-inch vein is considered a large one. Their length varies from a few hundred feet to over two

miles. They show frequently a banded structure with cavities filled with quartz and calcite crystals. Other veins show a compact oily quartz, or are slightly granular, and break most readily across the vein. Pieces of slate constantly occur in them, and there are also "horses." The fissures have been seen to extend after the quartz filling them has run out.

The undulations of the auriferous strata were subsequently disturbed by numerous faults. From the map of the Waverley gold field, it will be seen that it is disturbed by two heavy faults, running north and south, and throwing the measures 180 to 570 feet. Numerous small faults are met, and they are found, as a rule, to belong to either of two sets of faults, the one having a north and south and the other an east and west course.

These heavy faults seldom hold veins, but there have been disturbances, subsequent to the filling of the veins, which have produced fissures also holding veins, sometimes themselves auriferous, and generally influencing the gold values of the veins they intersect or touch.

An instance of this is shown at Mount Uniacke, where the Nugget Lode (Plate XXVI., Fig. 1), which has been traced for about 2,500 feet, has, in the main openings a "bull" lode lying on one side of it, and touching it at intervals of several feet. The thickness of the "bull" lode is from 3 to 6 inches, and it consists of hard white quartz holding little gold and few minerals, except where the nugget lode runs against it and pinches, when it carries gold enough to warrant its being crushed. The true lode is from 3 to 8 inches thick, composed of dark-coloured quartz, and carries much iron and arsenical pyrites. The foot wall is a dark laminated slate, succeeded by a slaty quartzite. This lode has yielded profitable returns to a depth of 200 feet, when it was abandoned as it had got too deep for a horse to raise the ore. Another of these later lodes is shown at the Belt Mine, Montagu (Plate XXVI., Fig. 2), where the cross lode made the vein very rich at the point of intersection. In every district large barren white quartz lodes are met, which have been considered to be a result of these later disturbances.

There seems to be but one true igneous dyke cutting the gold measures. This occurs at Strawberry Hill, Tangier, and is about 40 feet wide, and runs at right angles to the measures, cutting the veins without, to any appreciable extent, influencing their positions or metallic contents. Bedded diorite dykes are met in the Lunenburg district.

The period at which the veins were filled cannot be precisely ascertained. From its occurrence in the lower carboniferous conglomerate, to be referred to, it would appear that the greater part had been deposited previous to that era. The date of the subsequent faults and of the filling

by quartz, etc., of the fissures they formed is not clear. There are no measures in the Province of a date later than the Triassic sandstones of Truro, and it is not known if they are faulted by the extensions of the sets of dislocations in the gold fields which have been described.

It is known that the strata succeeding the carboniferous limestones up to a period as late at the Upper or Permo carboniferous are intersected by sets of faults corresponding to those of the gold districts. It may, therefore, be conjectured that the filling of the second set of fissures was not earlier than the latest period to which can be referred these systems of faults.

The minerals usually associated with the gold are sulphides and arsenides of iron, galena, blende, copper pyrites, oxide of iron, copper glance, molybdenite, native copper, sulphur, chlorite, felspar, garnet, mica, calcite, felsite, etc., not, however, in quantities of economic importance. The presence of these minerals, especially of the sulphides and arsenides of iron, appears to be essential to the value of the lodes. It is true that numbers of lodes have been worked causing but trifling quantities of pyrites, etc.; but if not present in the vein they are found in the enclosing walls, which, in this case are sometimes rich enough to warrant crushing.

The gold occurs chiefly as free or coarse gold in grains visible to the naked eye, and in strings or filaments between the planes of the quartz. A considerable quantity is enclosed in the nodules and nests of the associated minerals, as will be noticed further on. Crystals have occasionally been found not exceeding one-third of an inch in diameter. One from Tangier was a rhombic dodecahedron with bevelled edges, and brilliant finely striated faces. Others are octahedra, sometimes elongated and flattened, with dull and rounded faces.

The distribution of the gold in the veins is to a certain extent capricious. Few lodes carry a uniform yield over a space exceeding 500 feet. There is in almost every vein one or more zones or "pay streaks" of quartz much richer than that surrounding it. These zones do not appear to be the effect of any law that has yet been applied to our mines. They lie at every angle, and appear to be of very varied length and width.

At the Wellington mine in Sherbrooke, one of these streaks has been followed nearly 600 feet from the surface without showing signs of exhaustion. The surrounding quartz varied from 2 to 6 dwts. to the ton, while the "pay streak" ran as high as 20 ounces.

Plate XXVII. shows this distribution of the gold, from a record kept for three years of the yield of each parcel of quartz, at the Lawson mine in the Belt lode, Montagu.

The richest part of the lode at the surface was at the main shaft, and it dipped to the westward. Finally the vein was found to thin out to $1\frac{1}{2}$ inches to the eastward, and was worked to the western boundary of the property where it was 6 inches thick. The effect of a cross lode, shown in the section, Plate XXVII., Fig. 2, was to greatly enrich the main lode, some lots of quartz from a point below its intersection yielding 40 ounces to the ton. The greatest depth reached was 300 feet, and it was abandoned as soon as the "pay streak" showed signs of lessened value, without any attempt being made to prove its extension. During the five years it was worked by the last proprietor, about 200,000 dollars* worth of gold was taken out, which yielded a handsome return over and above all working expenses.

Another parallel "pay streak" was worked in the same lode, a few hundred feet away, on an adjoining property.

The following brief description of the Waverley gold district will answer for the rest as they present no distinctive features. It is condensed from a report and survey, made a few years ago for the Provincial Government, by Mr. H. Y. Hynd.

The measures as shown on the plan, Plate XXIII., were originally thrown into an immense fold the base or east end of which rests on the "granitic" series, while the western production can be traced for several miles. Subsequent faults have shifted the axis to the north, and the eastern fault has made a subordinate anticlinal by bringing up lower beds. It was in this eastern section that the "barrel" quartz was first met.

In some districts the undulation has become an overlap, thus at Tangier and Wine Harbour, some of the lodes when exposed have a dip to the north at their crop, on following them downward they reverse and dip to the south.

The lowest bed met in the Waverley district is a thin bed of slate, of a greenish and grey colour, lying 24 feet below the "barrel" quartz. In the better known part of the Waverley series are met massive beds of quartzite, sandstones, etc., interstratified with thin beds of clay slates.

The following is a general section in ascending order:—

1.—*Barrel quartz group.*—Comprising 120 feet of quartzite with slate belts and holding four lodes.

2.—*Rose group.*—Containing three lodes, and comprising 60 feet of quartzite with greenish gray and bluish slates, with numerous minute crystals of iron pyrites.

* The English pound being equal to 4·87 dollars.

3.—*Taylor group.*—This group is characterised by a bed of concretionary quartzite, 70 feet thick, already referred to as fossilferous, and by thin bands of curly and finely laminated plumbaginous slates of brilliant metallic lustre. It contains no fewer than 27 lodes, the thickest of which averages 18 inches; and has a total thickness of 320 feet.

4.—*Tudor group.*—Characterised by two massive beds of gray quartzite holding large crystals and nodules of mispickel, and pebbles of slate. Its thickness is 190 feet, and it holds 3 lodes.

5.—*The south lode group.*—This group is 600 feet thick and holds numerous lodes not yet worked to any extent.

The lodes in Waverley have been in some instances extensively and successfully worked. One or two have been traced around the anticlinal axis, but as might be expected the identification of individual lodes on reverse dips can be accomplished only by means of the accompanying beds as their small size and great number render mineral characters and physical properties an unsafe guide.

ALLUVIAL GOLD.

As yet alluvial gold has not been worked in this Province to any noteworthy extent, the total yield being estimated at about 4,000 ounces. The geologist at once marks the traces of severe and prolonged ice action in the Nova Scotia gold districts. The markings of the striæ are from S. 20′ W. to S. 28° E. magnetic, nearly at right angles to the general course of the strata, and the edges of the harder beds are presented in long rounded ridges.

There appears to have been two periods of attrition and transportation. The effects of the earlier one are now visible in immense "boars backs" from 50 to 150 feet in height, and sometimes a mile in length, following a general north and south course. These may be seen on the road from Halifax to Montagu, at Musquodoboit, Tangier, etc. They hold immense boulders of granite and quartzite, fragments of slate and quartz imbedded in clay, sometimes with layers of sand and gravel. The nearest localities furnishing the granite are from two to six miles to the north. In some cases the original site of the enclosed rocks must be sought for at much greater distances. For example, at Halifax, the drift contains fragments of amygdaloidal trap, identical in appearance with that found *in situ* at Blomidon, on the Bay of Fundy, fifty miles away.

A second and more local action is also visible, and by its agency the auriferous veins are usually found. This action has carried the quartzite

and slate boulders from 100 to 1,800 feet on a course corresponding very closely with that of the striæ. Thus "prospectors" finding auriferous quartz boulders, costean to the north and frequently trace the boulders to lodes corresponding in every respect to the boulders first found. As an instance it may be mentioned that at Montagu the Rose lode, so called from the red colour of its quartz, was found by tracing the boulders through the drift on the line of the striæ for a distance of 1,200 feet.

In consequence of this limited transportation the surface covering of many of the gold districts is auriferous enough to work. So local is this drift that in several districts numbers of men have made a living by breaking up and amalgamating the quartz boulders in hand mortars, when a few yards away a day's search would not afford the smallest "sight" of gold.

The writer is not prepared to account for the limited distance to which these boulders have been carried, except it be by the action of ice on a coast line gradually changing its level, and he does not anticipate that, in Nova Scotia, discoveries will be made of alluvial deposits as extensive as those of Australia and California, owing to the proximity of the gold districts to the ocean, and their comparatively low average elevation (200 feet) above the sea level. Still the limited explorations that have been made in the bottoms of the innumerable lakes which occur all through the coast section, and from still waters in the various rivers, have shown that they are frequently auriferous. The expense of drainage has deterred attempts to test them, but some adaptation of the vacuum or steam dredges lately introduced in the United States may enable this to be done at a cheap rate.

At Gays River is presented an ancient auriferous alluvium in a lower carboniferous conglomerate, similar to that described in the writer's paper on the Gypsum of Nova Scotia* as characterising the base of the carboniferous formation at many points in the province. Here the conglomerate resting on the upturned edges of the auriferous slates, carries considerable amounts of gold near the junction, and the crevices of the slate frequently carry the same metal embedded in clay and oxide of iron. The deposit appears to form part of an ancient river bed, and was worked for some time by drifts driven on the slate, and a sort of long-wall work taking out the conglomerate as high as it showed gold.

At Lunenburg the beach, open to the Atlantic, was found for several hundred yards to be highly auriferous, and considerable quantities of gold

* Vol. XXX., page 53.

were washed out from the sand, but, as may be imagined, operations could not be carried on long. The measures at this point belong to the series of slates forming the upper division of the auriferous strata. They are penetrated by numerous veins showing gold, but the attempts made to work them did not prove profitable. It has been conjectured that this deposit of gold was accumulated by the disintegration of carboniferous conglomerates similar to those of Gays River, as considerable patches of lower carboniferous measures are known to occupy the shores of Chester Basin, remnants of some great carboniferous continent formerly extending where the Atlantic now reigns.

Having thus briefly noticed the chief points of geological interest connected with the gold fields, the part the miner has played in the working of the treasures spread out before him alone remains to be referred to. This may be divided under the two heads of Mining and Milling.

MINING.

In the earlier operations many companies were started with schemes too ambitious for their means and broke down before they could get into working order. Others paid large dividends for a few years, but having no reserve funds abandoned the work when they encountered the trial of poor ore, which must be faced by every miner sooner or later. Other properties again have been continuously worked and have made handsome returns.

On the failure of many of the large companies their properties were sublet to tributers, some of whom have done well by systematic mining, and others have effected little beyond robbing the richer parts of the lodes within a few yards of the surface.

During the past two years a number of the more promising properties have been purchased by American capitalists, and it is expected that their mining experience gathered in the Western States will lead to a much larger output than has been obtained for some years past.

When it is determined to work a vein, a main shaft is sunk, at first to a depth of about 60 feet, and a shaft on each side from 50 to 150 feet from the central one. At a depth of 40 feet these shafts are connected by levels, and stoping started from six points and continued in some cases to the surface. Then commencing 15 or 20 feet below the levels, a breast of two or more underhand stopes is carried from shaft to shaft. Frequently, when it is not desired to work to any depth, shafts are sunk at close intervals, and the rock raised through several of them. All these shafts are sunk on the vein so that they vary from perpendicular sinkings to slopes at various angles, as low as 45 degrees.

This work is continued as long as the quartz pays, and some of the mines have reached a depth of 600 feet. Usually in the more systematically worked mines each stope has the following scaffold low enough to permit of convenient stowage.

Formerly it was customary to take out at one operation the lode and enough of the slate, etc., to allow working room of from 2 to 3 feet. This was found to lead to serious loss of gold, both by theft and by mixture of the quartz with the rock, which had nearly all to be sorted at bank. Now the slate, etc., on one side of the vein is first taken out, and the vein allowed to stand untouched until several hundred square feet of it are exposed. Then it is removed at one operation and sent directly to the surface. This method costs rather more, as the width of the ground removed is increased by the thickness of the lode, but the quartz is not so much exposed to the workmen, and very little of it is lost.

As might be expected from the nature of the strata, the mines are as a rule very free from water. It may be said that at a depth of 300 feet they are perfectly dry whenever proper care has been taken to puddle the shafts on the rock bed, and not to carry the stopes too near the surface.

The most noticeable exception to this rule that has come under the writer's notice occurred recently at the Rose Mine, Montagu, where at 150 feet the main shaft struck a flat throw to the south of three feet. This throw evidently came to the surface under an adjacent swamp, and passed the water so rapidly that the men had to immediately leave their work, which was not resumed until more powerful pumps had been set up.

The pumps used are of every variety, from Cornish patterns to steam ejectors.

The explosive used is chiefly powder, but in many of the lodes having narrow slate bands, or very tightly bound, dynamite is used. Formerly English dynamite and powder were exclusively used, but local factories now supply both these requisites at fair rates and of good quality.

The drilling is entirely two-handed, and the system of single-hand drills never succeeded in establishing itself here. Machine drills are but little used, and the narrow inclined workings, which necessarily characterise our gold mines, almost forbid their application except for driving levels, etc. They will, however, be found economical when attention is turned to working the broad belts of banded slate and quartzite, which are met in many of the districts, and offer an abundant supply of low grade ores.

The cost of extracting a ton of ore varies between wide limits. In the narrower veins it frequently costs as high as 15·00 dollars per ton of 2,000 lbs., while in veins three feet wide and upwards it is raised for

1·50 dollars a ton, and in slate bands from three to ten feet wide the cost has been known not to exceed ·95 cents. The wages of miners being 1·25 dollars, and of labourers 90 cents to a dollar a day.

MILLING.

The quartzite from the mine is passed directly to the stamp mill. At the commencement of gold mining here attempts were made to roast the ores before they were stamped, but as the ordinary circular open kilns were used with wood for fuel, the heat was not more than sufficient to drive off part of the sulphur in combination with the iron, and to coat the free gold with arsenic from the almost omnipresent mispickel, and they were abandoned.

The following description, and the Plate XXVIII., for which the writer is indebted to Messrs. J. F. Torrance and L. W. Scaife, of the Pittsburgh Gold Mining Co., showing one of the best mills in the Province, will give an idea of the general principles on which the quartz is treated.

A "battery" consists of an oblong cast iron box, *a*, containing four or five stamps placed at regular intervals, and large enough to allow a space of several inches between the stamps and the sides of the box. The stamps *b* and the stems are of iron, and weigh from 450 to 750 lbs., the stems *c* pass through vertical guides *d d*, and are provided with tappits *f*. A shaft fitted with four or five double cams *e e*, lifts these stamps from six to nine inches, and the quartz in the box is crushed by their unaided fall. Two or more batteries are frequently driven from the same shaft. Apertures *j* are provided for introducing the quartz and water into the boxes, and gratings *h* allow of its escape when crushed to the desired fineness. The crushed quartz is passed over copper plates amalgamated with mercury, and subjected to other contrivances for extracting the gold.

The mill was made by Fraser and Chalmers, Chicago, and the total weight (including no wood, except the guides and props) is 29,450 lbs. Each of the two "batteries" contains five stamps, and weighs 5,500 lbs. Each stamp has a maximum weight of 750 lbs., and falls for each blow about 9 inches. The mill was designed to run at the rate of from 85 to 90 drops for each stamp per minute, crushing 20 tons of quartz in 24 hours, but owing to the fact that copper amalgamated plates are placed in the batteries to catch the gold, it does not generally exceed a speed of 50 drops per minute, crushing about 15 tons in 24 hours to the finest perforated plate. Each "battery" contains front and back copper plates, and outside the gratings are reversing and splash plates, and the usual long copper plate, about three feet in length, all amalgamated with mercury.

Finally there is a mercury trap, for arresting any mercury or amalgam that is not caught by the plates, which consists of a pyramidal box base upwards, into which the battery tailings fall as they leave the plates. A stream of fresh water enters the apex and forms a sort of quicksand in the box, wherein the mercury is caught and gradually settles to the bottom whence it is drawn off. The tailings then pass over troughs lined with blankets which retain the pyrites, which are washed out by hand into a tub of water at regular intervals.

The quartz is hauled into the mill, weighed, and thrown on an iron grating with openings two inches square, which allows the fine stuff to fall into a bin, capable of holding about seven tons. The coarse quartz is drawn by hand to the mouth of a Phelps' breaker also discharging into bins. From them the quartz passes by means of self-feeders of simple construction into the batteries.

The motive power is furnished by a thirty inch Leffell turbine, the fall of water being twenty-one feet, which would allow of the mill being enlarged to double its present capacity.

The fineness to which the quartz is crushed varies in different mills, from a size passing through a mesh of 150 holes to the square inch, down to one of 400 holes.

The following estimate of the cost of crushing is from actual performance, and a mill of ten stamps driven by steam power which is also utilised for driving a small pump :—

QUARTZ CRUSHED TO PASS THROUGH FINEST TWILLED WIRE CLOTH.

	Dollars.
Wood 2⅛ cords at ·75 dollar	1·57
One man by day, to fire and feed batteries at	1·50
One man by night at	1·50
One man by night at	1·25
Chemicals and oil	·50
Wear and tear	·75
Total	7·07
Quartz crushed in 24 hours, 8 tons.	
Cost per ton	·88⅜

The above is for quartz alone; when, as is frequently the case, slate is crushed with the quartz the cost per ton would be materially reduced. At the Ophir Mill, at Renfrew, some years ago, the cost per ton for quartz was 60 cents, when crushing at the rate of 600 tons per month.

In some mills the use of plates in the "batteries" is not adopted, but mercury is added at regular intervals to the ore undergoing pulverisation; the resulting amalgam accumulates around the circular dies on which the stamps fall, and is taken out at the week end. The use of mercury traps and blankets is not as general as it might be. As the gold is generally coarse much of it is retained in the batteries, and the loss is in the fine gold not caught by the plates. Excluding the gold found in a state of minute subdivision in the sulphurets, the mills as a rule do not extract over 75 per cent. of the gold.

The causes of this are the casing of the gold by grease from lamps, dynamite, etc., and the powdered silicates of alumina which form an unctuous slime, as well as the vibratory motion of the stamps inducing a crystalline condition of the gold unfavourable to amalgamation, in addition to the flouring of the gold by the stamping, so that it floats too rapidly over the plates to permit of its being caught by the mercury. No process has yet been found equal to the task of recovering the gold thus lost.

As already stated, considerable quantities of arsenical pyrites and sulphurets of iron, lead, and copper are found in the veins usually in close connection with the gold. The percentage present of these minerals varies very much. Some veins and the encasing rocks are heavily loaded with them up to a proportion as high as 60 per cent.; while in other veins, equally auriferous, the quantity will not exceed one per cent. The average amount may be estimated at not less than 5 per cent.

They are presented as scattered crystals, as films in the bands of the veins, and as irregular masses or pockets frequently connected by threads.

As an almost universal rule they contain gold. A marked exception has been noted at Mount Uniacke where a number of small veins containing large amounts of mispickel yielded but mere traces of gold and silver. Beautiful specimens of gold are frequently secured by treating nodules of pyrites with acid, which presents the metal in curiously interlaced plates and films, when by a previous examination no gold could be detected. As yet the treatment of these pyrites has been of the most superficial character, they are passed through the mills together with the quartz and allowed to run away with the tailings.

The following assay of these ores, freed from quartz, will show their value:—

Locality.	Area.	Ore.	Yield per Ton of 2,000 Lbs.	
			Gold.	Silver.
			Oz. Dwt. Gr.	Oz. Dwt Gr.
Wine Harbour...	Provincial Co....	Arsenical pyrites ...	11 8 16	...
Sherbrooke ...	Boulder Area ...	Arsenical pyrites and galena	4 1 16	8 19 10
Do. ...	Coburg Area ...	Arsenical pyrites ...	1 12 15	6 10 16
Do. ...	Canada Co. ...	Mispickel and iron pyrites	45 0 0	...
Do. ...	Meridian Co. ...	Mispickel and iron pyrites	1 12 16	9 0 0
Montagu ...	O'Connor Area...	Mispickel and iron pyrites	12 12 22	1 0 0
Do. ...	Belt Lode ...	Mispickel	100 0 0	...
Ovens	McCulloehlot ...	Mispickel and iron pyrites	242 16 0	16 5 0

These results are confirmed by the assays of the same ores from various districts made by the writer, who on several occasions, has found nickel and cobalt present up to 2 per cent. The following assays of pyrites which have been concentrated from tailings, show the inadequacy of the ordinary process of stamping to extract the gold from them.

District.	Area of Vein.	Ore.	Yield per Ton of 2,000 Lbs.	
			Gold.	Silver.
			Oz. Dwt. Gr.	Oz. Dwt. Gr.
Tangier ...	New York Co.	Concent. arsen. and sulphides	6 5 0	2 4 0
Do. ...	Leary Lode...	Do. do. do.	4 14 4	...
Waverley ...	...	Do. do. do.	6 14 1	0 10 0
Sherbrooke ..	Average lots..	Do. do. do.	2 10 0	...

The following table shows the assay values of several samples of tailings and pyrites taken from waste heaps not concentrated, showing that much free gold is lost in addition to that carried away by the various pyrites, as already alluded to.

District.	Area.	Ore.	Yield per Ton of 2,000 Lbs.	
			Gold.	Silver.
			Oz. Dwt. Gr.	Oz. Dwt. Gr.
Waverley ...	...	Tailings	0 oz. 7 dwt. 4 gr.	
Do. ...	Barrel quartz	Do.	15 0	...
Montagu ...	Belt mill ...	Do.	16 13	...
Do. ...	...	Tailings natural concentration	3 0 0	..

It would seem that no regular system of assays of the values of the ore and pyrites before and after milling has ever been carried out here. A few such experiments would afford valuable data to replace the empirical and haphazard method of heating the ores too frequently seen among our miners.

At Montagu a Frome concentrator has been erected to heat the tailings of that district, which are said to yield pyrites averaging 60 dollars to the ton. It is yet too soon to speak of its practical working, but should it equal the expectations of the builder there is a good field for this work, as about 412,700 tons have been crushed since gold mining began here.

The amalgam of gold and mercury is squeezed in canvas and leather bags to get rid of as much mercury as possible, and heated in a crucible, having a close lid fitted with condensing appliances. The resulting gold sponge is smelted with oxidising re-agents, poured into oblong moulds and forwarded to the United States, where it is sold on the Mint assays.

Nova Scotia gold, like that of other countries, is an alloy of which silver forms the chief impurity. As a rule it is of a high degree of fineness. The following analyses were made some years ago, but represent its character at the present time:—

Locality.	Authority.	Composition.						
		Gold.	Silver.	Iron.	Copper	Lead.	Zinc.	Total.
Mooseland	O. C. Marsh ...	98·13	1·76	trace	·05	...	...	99·94
Tangier Field Lode.	B. Silliman ...	97·25	2·75	...	...	...	...	100·00
Do. Leary do.	U. S. Assay Office ..	96·60	...	...	..	...	...	...
Waverley	H. How	94·69	4·74	...	·39	...	·16	99·98
Ovens	A. Gesner	93·06	6·60	...	·09	...	...	99·75

This fineness is much influenced by the presence of galena, as the gold from certain lodes carrying large quantities of this mineral sometimes runs as low as 800 parts in 1,000. From numerous assays the average fineness of gold from different countries is about:—

	Parts in 1,000.
Victoria	958
Nova Scotia	955
California	880
Russia	891
British Columbia	875

The foregoing remarks touch briefly on the chief points of interest to the geologist and miner presented by the Nova Scotia gold fields, and it is feared that clearness of detail has to some extent been sacrificed to a fear of trespassing on the patience of the members.

Doubtless the chief attention of the miners here, who, as a rule, possess little capital, will continue to be directed to the small rich veins yielding quick returns, and it is to be regretted that as a rule their operations are confined to working out the more accessible parts of the pay streaks, and no systematic scheme of work is attempted. It is anticipated, however, that in the future the greatest reliance will be placed on the low grade ores. There are numerous belts known to contain many thousands of tons of quartz and slate, yielding by mill tests up to seven pennyweights (6·70 dollars) of gold to the ton. From the costs of extraction and milling already given it will be seen that in many cases these ores would yield good returns if worked on a fairly large and careful system. This experiment is now being practically tested in the Sherbrooke district by parties who purpose adopting the usual treatment in stamp mills to secure the coarse gold, and a systematic concentration of the tailings which will yield considerable quantities of arsenical and other pyrites. These would find a ready sale at the reduction works of the Eastern States, and form an important item in the returns.

The gold is held by the Provincial Government who grant areas of 250 by 150 feet for a term of twenty-one years, with option of renewal, for a fee of two dollars, and a royalty of two per cent. on the gross value of the smelted gold produced, which is valued at nineteen dollars an ounce (from 20 to 60 cents less than its market value). The royalty is collected from the mill owners, who are obliged to give bonds, and make sworn returns of the quartz crushed and the yield of gold.

The following tables show the total yield of gold since 1862, in which year systematic statistics were first collected.

NOVA SCOTIA GOLD FIELDS.—GENERAL ANNUAL SUMMARY.

Year.	Total Ounces of Gold Extracted.	Stuff Crushed.	Yield per Ton of 2,000 Lbs.	Total Days Labour.	Average Earnings per Man per Day and Year of 300 days at 18 dollars per Oz.	
	Oz. Dwt. Gr.	Tons.	Oz. Dwt. Gr.		Dollars.	Dollars.
1862	7,275 0 0	6,473	1 2 11	156,000	83	249
1863	14,001 14 17	17,002	16 11	273,624	92	276
1864	20,022 18 13	21,434	18 16	252,720	1·42	426
1865	25 [illegible]54 [illegible] 8	24,423	1 0 20	212,966	2·15	645
1866	25 [illegible]04 .3 2	32,161	15 2	211,796	2·14	642
1867	27,314 11 11	31,386	17 9	218,894	2·24	672
1868	20.541 6 10	32,262	12 17	241,162	1·53	459
1869	17,868 0 19	35,147	10 4	210,938	1·52	456
1870	19,866 5 5	30.829	12 21	173,680	2·05	615
1871	19.227 7 4	30,791	12 11	162,994	2·12	636
1872	13,094 17 6	17,093	15 7	112,476	2·09	627
1873	11,852 7 19	17,708	13 9	93,470	2·28	684
1874	9.140 13 9	13,844	13 5	77,246	2·12	636
1875	11,208 14 19	14,810	15 4	91,698	2·20	660
1876	12,038 13 18	15,490	15 13	111,304	1·94	582
1877	16,882 6 1	17,369	19 10	123,565	2·46	738
1878	12,577 1 22	17,990	13 23	110,422	2·05	615
1879	13,801 8 10	15,936	17 8	92,002	2·34	702
1880	13,234 0 4	14,037	18 20	103,826	2·18	654
1881	10,756 13 2	16,556	12 20	126,308	1·52	456
Total	321,362 18 7	422,741	.....	3,157,391	...	...

It is computed that about 8,000 ounces were produced before that date, which would make the total amount to the present date about 330,000 ounces.

In addition to the amount legitimately mined and crushed, there is reason to believe that in every district a very considerable quantity is stolen by the miners, theft being assisted by the common occurrence of the gold in small nuggets or "sights" in the quartz. Much of the richest quartz from numerous veins worked by two or three men is known to be reduced in hand mortars, and the resulting gold is surreptitiously sold, so that the returns made to the Department of Mines may be considered as by no means fully representing the amount of gold extracted.

The tables also show the number of mills, which it may be remarked work only at intervals, also the number of days' labour performed at mining, prospecting, and surface work, from which it will appear that the business although small is fairly remunerative.

NOVA SCOTIA GOLD FIELDS.—GENERAL STATEMENT FOR THE YEAR 1881.

Districts.	Number of Mines.	Days' Labour.	Mills Employed.	Steam Mills.	Water Mills.	Quartz, etc., Crushed.	Yield per Ton.	Maximum Yield per Ton.	Total Yield of Gold.	Average Yield per Man per Day for 12 Months at 18 dollars per Oz.
							Oz. Dwt. Gr.	Oz. Dwt. Gr.	Oz. Dwt. Gr.	Dollars.
Carribou ...	3	15,426	3	2	1	1,661	13 14	6 3 16	1,129 18 13	1·31
Gays River ...	1	274	...	...	...	...	...	...	12 14 7	·78
Montagu ...	2	17,982	2	2	...	1,165	15 10	3 1 15	900 6 16	·90
Oldham ...	1	2,471	2	1	1	604	10 21	1 7 9	329 10 4	·98
Renfrew ...	2	5,038	1	...	1	583	9 "	1 5 19	269 8 13	·96
Stormont ...	1	4,332	...	...	...	80	9 18	5 3 0	173 10 0	1·58
Tangier ...	3	11,721	3	1	2	716	2 3 9	2 3 9	399 9 16	·73
Uniacke ...	3	10,003	4	3	1	3,094	11 3	2 5 7	1,355 8 21	·61
Waverley ...	2	5,517	3	1	2	535	8 23	2 0 0	374 0 0	2·28
Sherbrooke ...	10	29,285	6	4	2	5,279	14 0	1 18 6	2,580 2 20	1·32
Wine Harbor	1	5,098	1	...	1	552	1 8 20	3 3 0	795 14 0	2·80
Unproclaimed..	4	19,161	5	1	4	2,287	1 1 7	2 11 9	2,436 9 12	2·20
	33	126,308	30	15	15	16,556	12 20	6 3 16	10,756 13 2	1·52

From the foregoing remarks it will be seen that the area containing gold is very large, and that the little work that has hitherto been performed has shown that there are numerous lodes that have yielded good returns. The district as yet has not shown the extensive alluvial deposits characterising those countries which have become famous for their production of gold, and the future development will, so far as can be judged at present, be due to more extensive working of the veins.

The district affords good openings for men having capital and mining experience, and as a rule such men have done well here. Companies have done equally well whenever their operations have been controlled by competent agents, who have learned to work on the systems experience has shown to be best adapted to the country, and have not maintained the rules of mining learned in wide lodes, etc.

When the cheapness of labour, the abundance of water power, a favourable climate, and the accessibility of the district are considered, it may be fairly anticipated that gradually the attention of miners and capitalists will be turned to the Nova Scotia gold fields, and that with improved methods of treatment, and the accumulation of experience in detecting and following the richer deposits this industry will become a leading one in the province.

KETCH MAP,

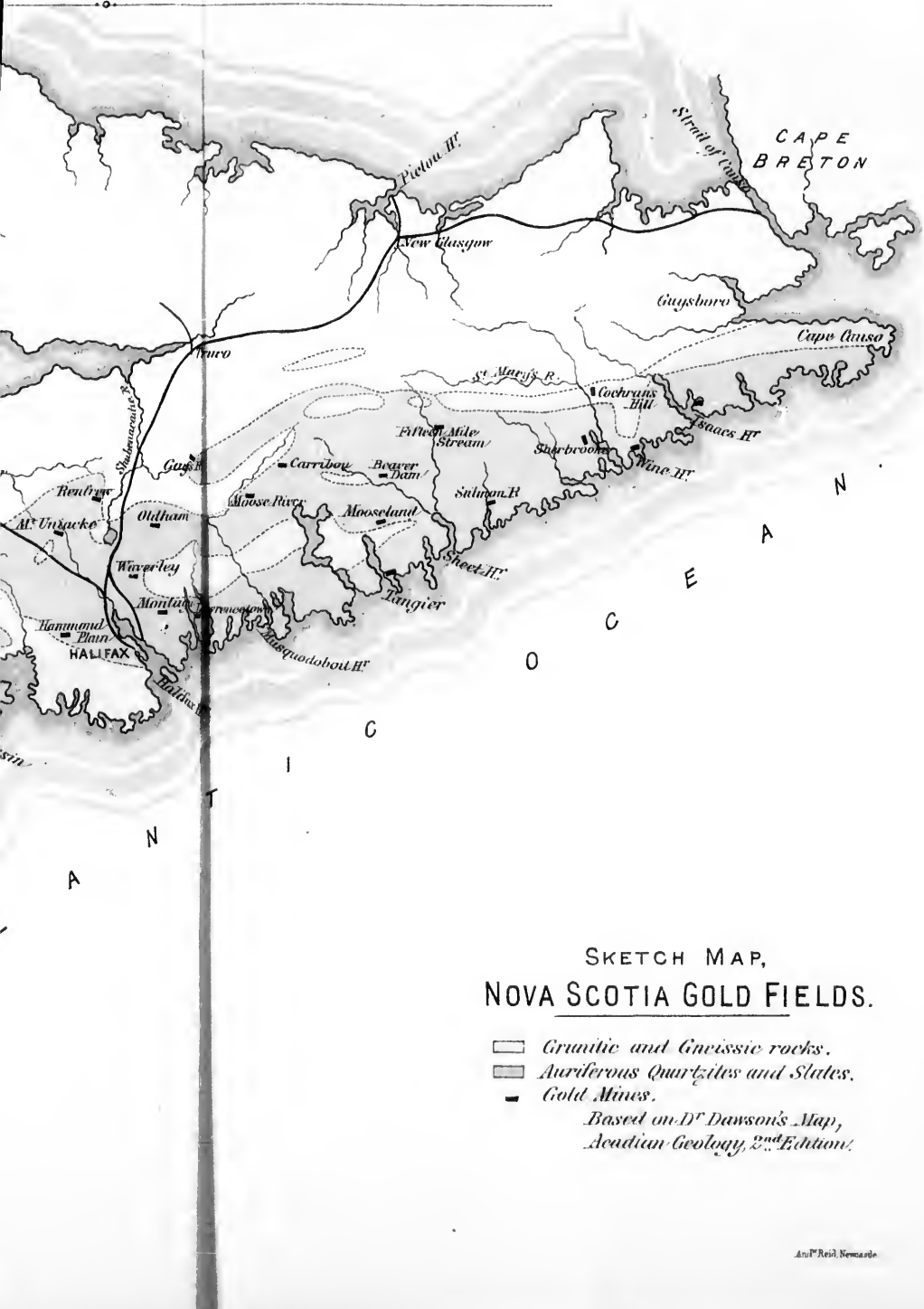
OTIA GOLD FIELDS.

e and Gneissic rocks.
ous Quartzites and Slates.
Mines.
ased on Dr Dawson's Map,
ordian Geology, 2nd Edition.

And.T.Reid. Newcastle


Bay of Fundy
Blomidon
Windsor
Shubenacadie R.
Rentrew
Mt Uniacke
Oldh
Waverley
Mont
Hammond Plain
HALIFAX
Victoria
R. Avon
Digby
Gold R.
Chester Basin
Middlefield
La Have R.
Lunenburg
Owens
Liverpool
Yarmouth
Cape Sable
A T L A N

in's paper "On the Gold Fields of Nova Scotia".



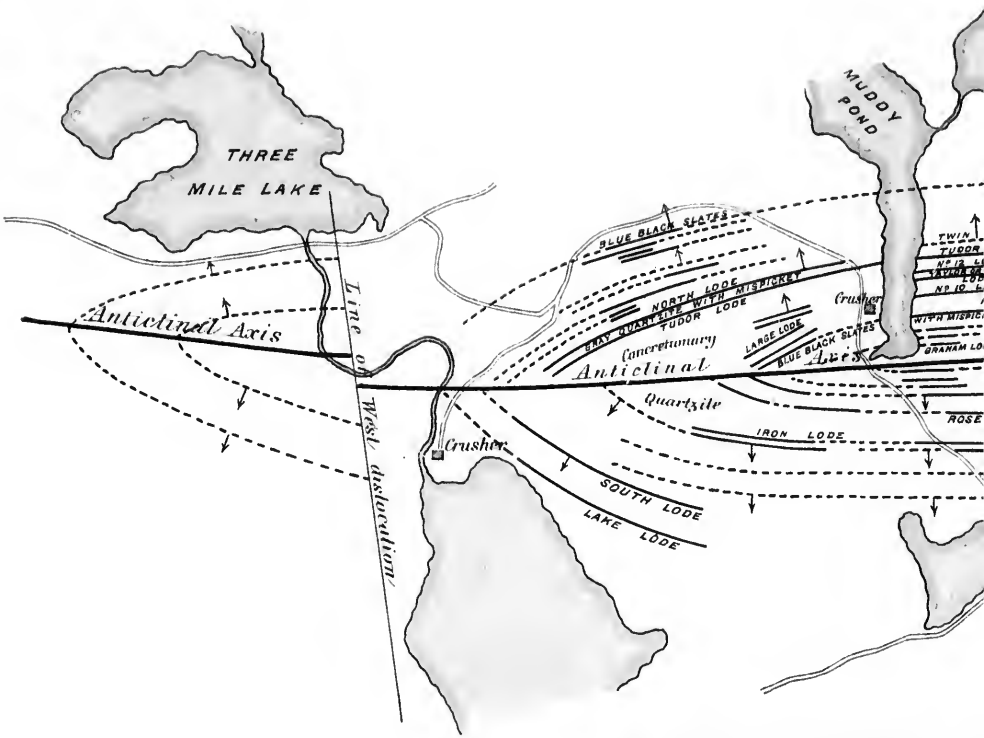
Sketch Map,
Nova Scotia Gold Fields.

- Granitic and Gneissic rocks.
- Auriferous Quartzites and Slates.
- Gold Mines.

Based on Dr Dawson's Map, Acadian Geology, 2nd Edition.

And.w Reid, Newcastle.

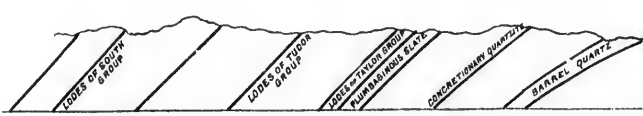
To illustrate Mr. Edwin Gilpin's paper "On the



WAVERLEY GOLD DI

Scale 1200 feet to one i

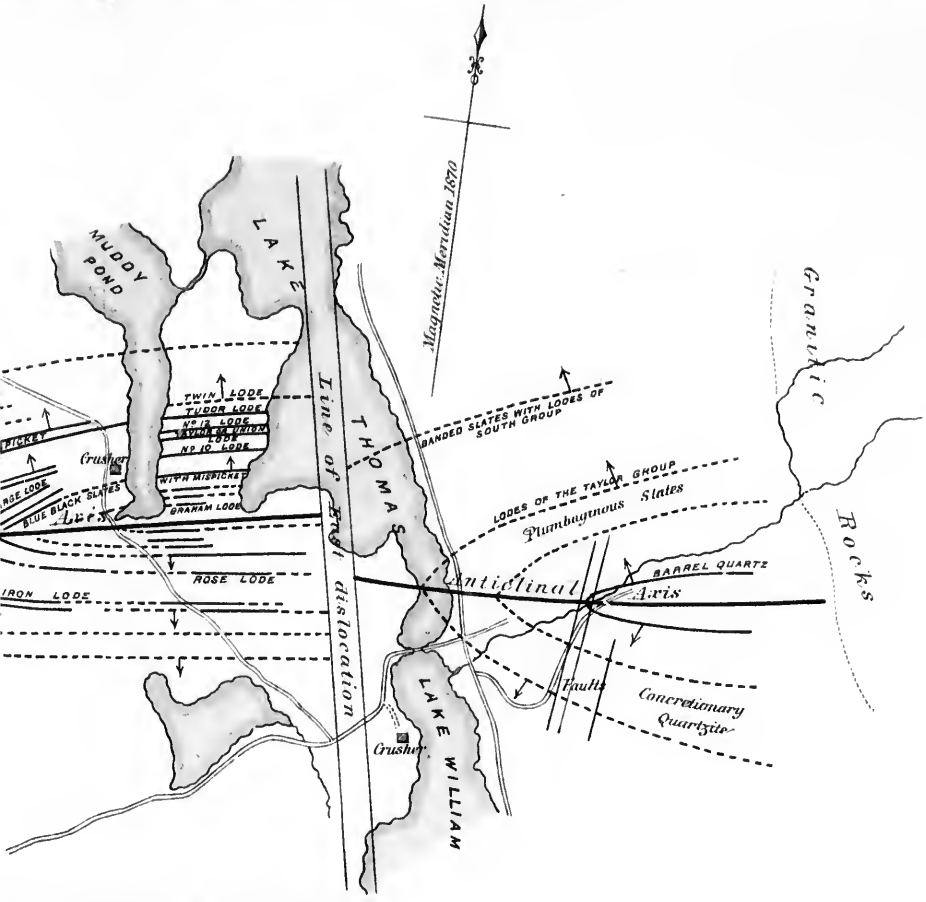
Continuous lines show worke
Arrows show dip of lo



SECTION ACROSS BARREL Q

Scale 600 feet to one i

n's paper "On the Gold Fields of Nova Scotia".



LEY GOLD DISTRICT.

le 1200 feet to one inch.

ous lines show worked lodes,
ows show dip of lodes.

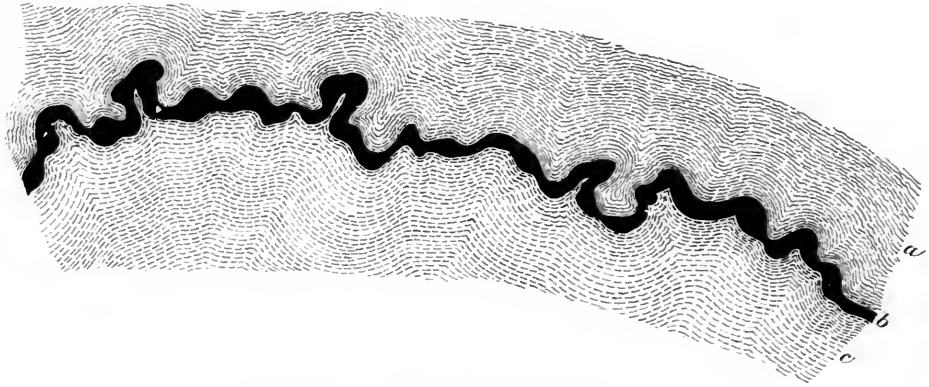
OSS BARREL QUARTZ CROP.

le 600 feet to one inch.

And.r Reid Newcastle.

To illustrate Mr. Edwin Gilpin's paper "On the Gold Fields of Nova Scotia."

FIG. 3.



SKETCH OF CORRUGATED LODE,

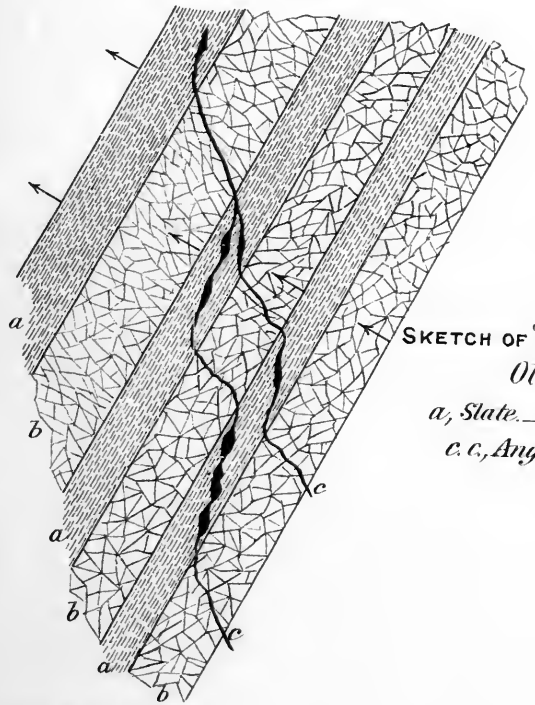
Moose River;

a, Soft slates—b, Lode ¾" to 4" thick;

c, Arenaceous slate,

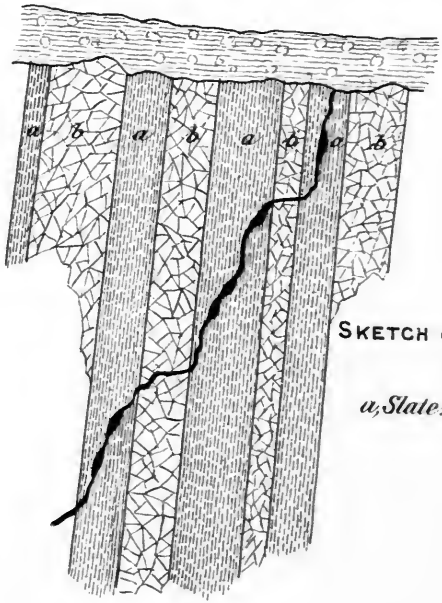
To illustrate Mr. Edwin Gilpin's paper "On the Gold Fields of Nova Scotia".

FIG. 1.



SKETCH OF "ANGLING LODE,
Oldham,
a, Slate. — b, Quartzite,
c. c., Angling lodes.

FIG. 2.



SKETCH OF "ANGLING" LODE,
Oldham.
a, Slate. — b, Quartzite.

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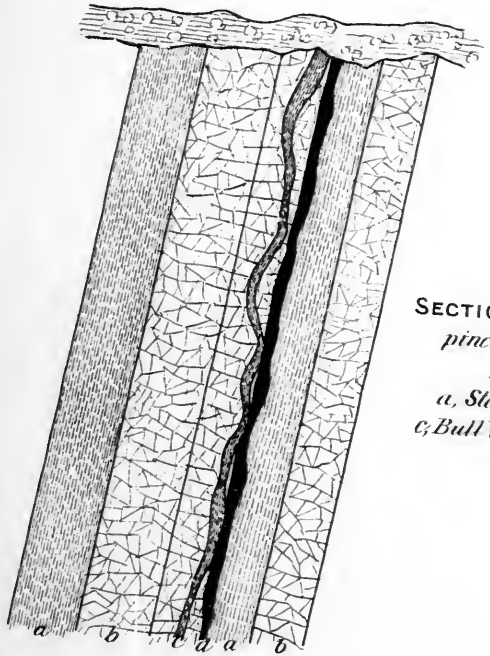
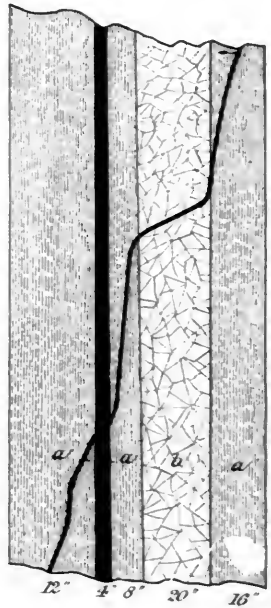
FIG. 1.



SECTION OF "BULL" VEIN,
pinching Nugget lode,
Mr Uniacke.
a, Slates_b, Quartzites,
c, Bull Vein_d, Nugget Vein

FIG. 2.



SECTION OF "BELT" LODE,
showing Cross lode.
a, Slate_b, Quartzite,

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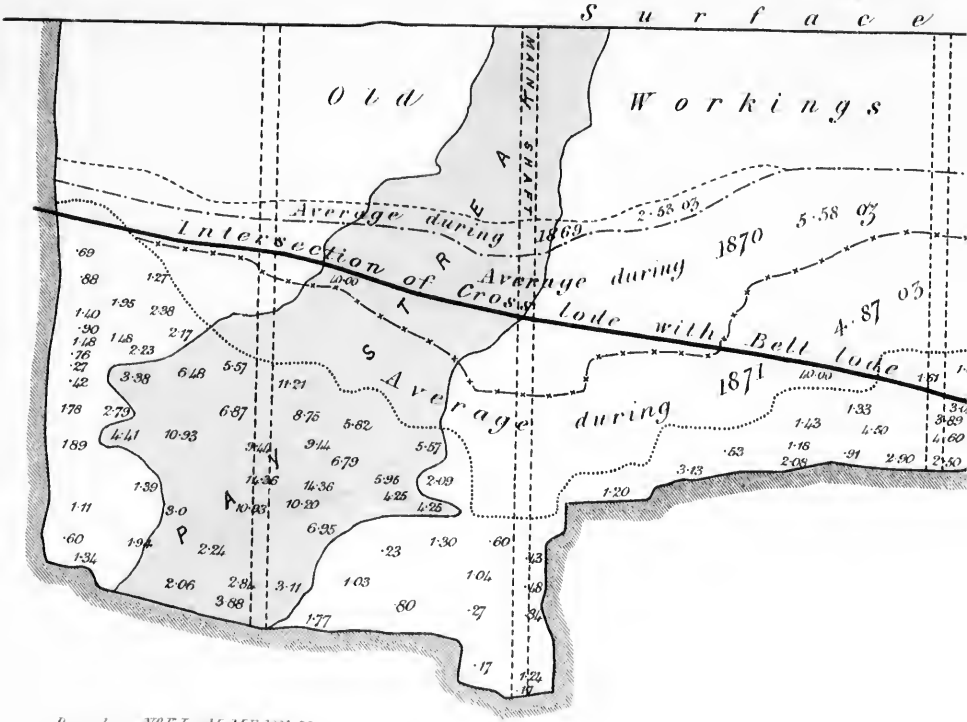

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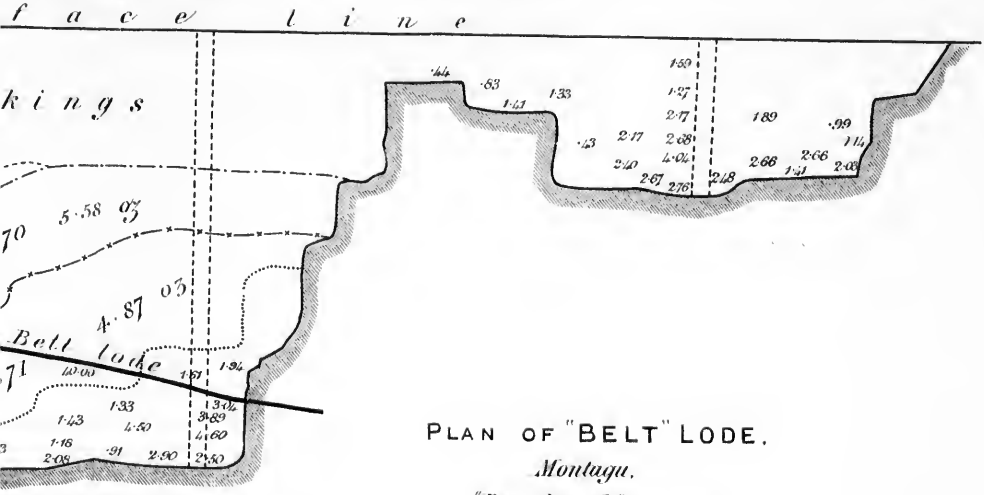
un's paper "On the Gold Fields of Nova Scotia".



PLAN OF "BELT" LODE.

Montagu.

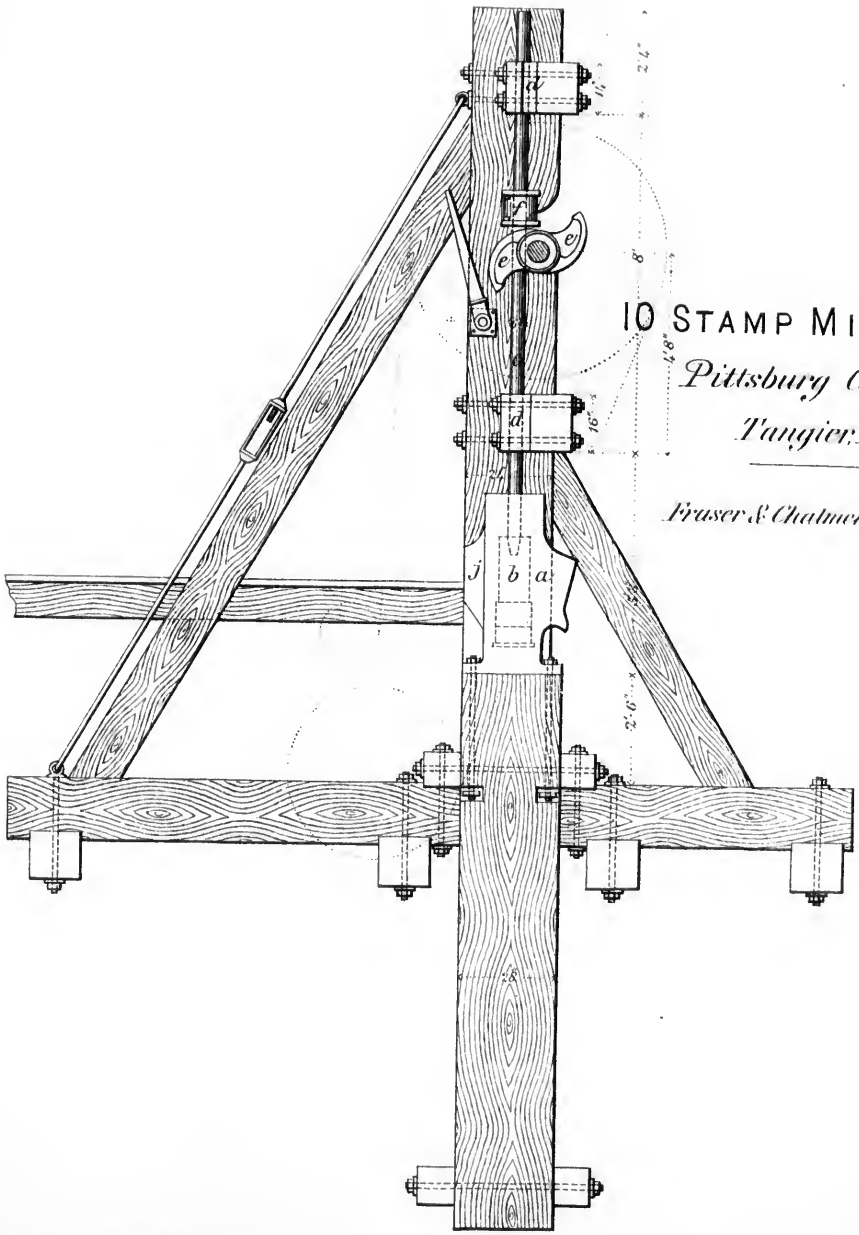
"Pay Streak" shaded.

Scale 80 feet to one inch.

Figures show yield of quartz in ounces per ton.

Andᵉ Reid, Newcastle

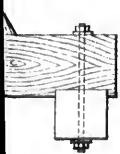
To illustrate Mr. Edwin Gilpin's paper "On the

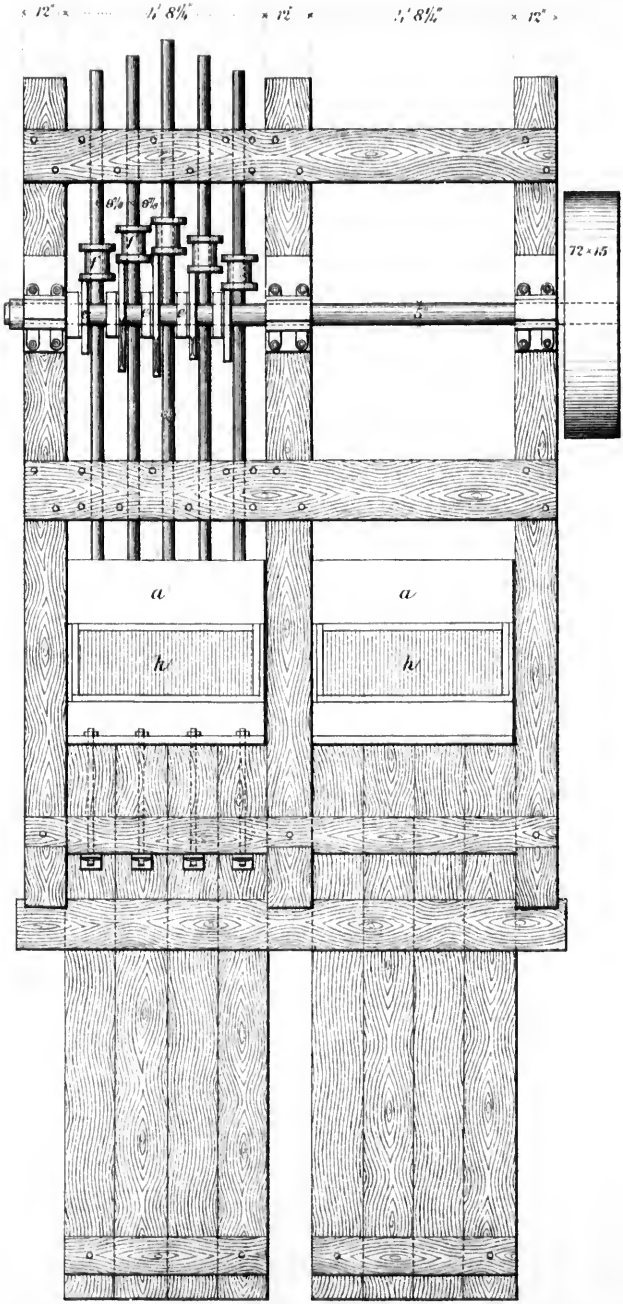


ins paper "On the Gold Fields of Nova Scotia."

MP MILL_750 lbs;,
sbury Gold Co.,
Tangier, N.S.

& Chalmers, Chicago, Ill.





Jn.º Reid Newcastle