VI.—Recent Developments with the Calyx Drill in the Nictaux Iron Field.—By D'Arcy Weatherbe, C. E., *Minss Dept. of N. S., A. M. Can. Soc. C. E.*

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Introductory: Geological and Historical.

It would be as well perhaps for the benefit of those unacquainted with this district to preface the following account with a few descriptive remarks on its general geology. The measures which accompany the ferriferous deposits here are generally considered to be of Lower Devonian age. The area with which the operations herein to be described deal, may be said to be bounded as follows:—On the north by the Triassic red sandstones which underlie the contemporaneous trap diorites of the North Mountain range; on the west by a band of granite extending northerly, partly across the valley between the North and South Mountain, and lying about a mile west of the Nictaux River. This latter is not strictly speaking a geological boundary, as the same veins of ore have been followed west of the granite, and are possibly overlain by it. On the south along the summit ridge of the South Mountain begins that enormous mass of granite which extends half way to the Atlantic Ocean, and effectually prevents prospecting in that direction. Towards the east, the boundary, as far as these veins are concerned, may be said at present to be indefinite, though they can be traced several miles east of the Nictaux River.

Until 1891 little practical attention had been devoted to the prospecting of the region, and with the exception of the early attempts at mining and smelting, no development of any importance had been undertaken. In that year (1891), the Torbrook Iron Co. commenced operations on a vein of red hematite

averaging about 9 feet in thickness and showing from various tests the following analyses: *

Metallic Iron.	Silica.	Phosphorus.	Sulphur.	Lime, Mang. and Alumina.
52.44	11.00	1.66	none	8.64
60.72	10.28	.17	trace	.....
59.00	12.86	trace	trace	trace
61.38	26.50	.....	.....	.....
47.00	10.12	1.08	trace	5.30
55.74	14.97	trace	trace	.....
74.59	17.21	.18	.23	.....
11.57	5.93	.17	.08	.....
57.93	.....	.16	.09	.....
59.86	.....	none	.36	.....

From which it will be seen that though rather a silicious ore, it is low in sulphur and phosphorus, and high in metallic iron.

The vein dips at an angle of about 80° to the south at the surface, and flattens to 45° at a depth of 350 feet (as proved by the workings of the Torbrook Iron Co.), and the general strike throughout the district is about N. 62 E.

This company in 1896 completed their contracts, and no immediate market offering elsewhere, they closed their mine, after having shfpped in the five years 135,000 tons of ore to the Londonderry and Ferrona furnaces. When closed down, the mine showed large quantities of good ore in sight, and a vein from 6 ft. to 12 ft. in thickness.

About 65 feet to the south of this vein lies another deposit of red hematite, called from its fossiliferous character the "Shell ore vein," which from several analyses runs about 54% metallic iron. This vein measures about 6 to 9 feet in width. The fossil shells occuring in this bed consist of varieties of *Spirifer, Strophomena, Atrypa, Avicula, Bellerophon*, etc., etc.

North of the vein worked by the above company, and about a mile west of their mines, another vein five feet in width has been found, which at this point presents in common with most of the iron deposits in the district, different characteristics, as it is

*These analyses are from a paper on the Iron Ores of Nictaux, by Dr. E. Gilpin, Nova Scotian Institute Science—session 1894-95.

found further to the west. The most marked of these changes is the magnetic property probably imposed by the metamorphism nduced by the proximity of the granite. On the abandonment of the mines, the district remained for some years undisturbed, a state from which it was aroused early in 1900 by the energetic prospecting operations of a syndicate of Halifax gentlemen, who it is understood control practically all of the ground described above, which may now under the light of recent developments be fairly termed the Torbrook or Nictaux "synclinal."

Description of Drill.

A few words may not be amiss as to the parts and working of this drill. It cuts a 4 or 5 inch core as desired, and the satisfactory results attained may be judged by the fact that the writer recently saw several complete unbroken cores 5 inches in diameter and measuring nearly 7 feet in length. An idea of the valuable record secured by such a core is gathered from the fact that they contained slate, quartzite, and magnetite with crystallized geodes of quartz and stringers of calcspar, all dipping obliquely across the vertical axis of the core.

The apparatus consists of an upright boiler and compound engine (about 12 h. p.), drum, chain and sprocket wheels, driving shaft and bevel wheel, rotating device, drill head and hoisting derrick.

The drill proper consists of the "cutter," a hollow steel cylinder with peculiarly shaped teeth at the bottom, set alternately at approaching and diverging angles with its axis. This is screwed to the bottom of the core barrel which is simply an iron tube of the same diameter into which the core passes when cut

In hard rock, instead of the cutter and core-barrel, the shot bit and barrel, a fifteen foot steel cylinder of the same diameter is used, and under its edges are fed chilled steel shot, and the friction caused cuts the core.

The drill rods are of 3 in. hollow steel, and are screwed by means of a "reducing plug" into the upper end of the core-barrel.

The "calyx," or as it has been aptly termed the "chip barrel," is also a tube of the same diameter as the core-barrel, and surrounds the lower drill rod. It rests on the reducing plug, and is open at the upper end. Water being fed down the drill rods, passes out at the bottom of the hole, and is forced up between the rock wall and the core-barrel and calyx. This water naturally carries with it the sand and rock chips formed during the process of cutting the core, until when the top of the calyx is reached, the pressure is lessened by the space being increased, and the chips fall into the calyx, thus forming a perfect, though inverted record of the formation passed through. To the top of the pulley-head is screwed the feed pipe, and to the bottom a square rotating rod which is screwed to the highest drill rod, and fitting through the rotating device is held by a clutch, and thus the motion is given to the drill.

Method of Operation.

After setting up the drill, the first operation is to insert the pipe-casing—an iron tube slightly larger in diameter than the outside of the core-barrel—through the loose surface material, and a short distance into the bed rock.

This is done by placing on top of the pipe-casing a wooden block (about 12″ thick), and using a pounder worked with the hoisting gear. A heavy, flanged iron pipe, weighing probably 400 lbs. has been used for this purpose with success. Great care must be taken to keep the piping plumb, as mistakes at this stage will probably necessitate abandoning the hole.

Another error that is sometimes made, and which by experience has been corrected here, is the digging of a shaft in which to sink the casing. Even with the greatest care being exercised, it is found that though the shaft outside the pipe may be filled and thoroughly tamped, there is great liability of the hole being blocked, and of the top of the calyx catching on withdrawal of the drill.

Having successfully placed in position the casing, the cutter, and core-barrel, or if the rock is very hard, the shot bit is intro-

duced, and the engine set going. When a sufficient depth is reached the calyx chip-cup is coupled on and the rods successively placed between the chip-cup rod and the square rotating rod.

It occasionally happens that a rod-coupling breaks at a depth below the surface. The portion of the drill above the break is withdrawn, and a threaded cone called a "tap" is inserted on the end of a rod, and screwed into the broken coupling and the bottom portion is withdrawn.

When the core breaks accidentally it immediately becomes known by the riding motion of the drill, and the drill runner should be on the alert at such a time to prevent much weight being placed on the drill head, as the couplings at once become endangered.

When it is desired to withdraw or break a core, the motion is stopped, and a heavy flush of water is forced down the drill rods, coarse gravel being at the same time fed with it. The gravel becomes jammed between the core and core barrel, thus holding the former firmly; the pipe wrenches are now placed on the square rotating rod at the top, and with the aid of the engine a sharp twist is given to the drill, and the core breaks.

In the event of a piece of the core splitting off below, and it being found impossible to re-insert the cutter or shot-bit, the chopping-bit, a steel head like a blunt chisel is placed on the end of a rod, and repeatedly dropped into the hole, breaking up the offending piece of rock.

As little water as possible is used with the shot, as it tends to waste by depositing it in the chip cup, or bringing it up to the surface. On the other hand, with the cutter in softer rock all the water possible is used.

Records of Boring.

Boring was commenced on October 13th, 1900, on the "Berteaux" Farm, at Torbrook, the drill being under the charge of Mr. Burnett, the drill company's expert.

A position was chosen for the first hole at a point about 12 feet south of the hanging wall of the "Shell Ore" vein. This vein, as mentioned, has been proved for a long distance east and west, and the dip at this point was supposed to be about 85° to to the south. Thus the vein should have been tapped at a depth of about 137 feet from the surface; but this, as will be shown by the records given below, did not prove to be the case.

In this first hole the following section was exhibited:

No. 1 Hole.	
Material.	Feet.
Detritus, clay and loose boulders	12
Reddish shale (soft and friable)	48
Total	60

At this depth, 60 feet from the surface, the hole was abandoned in consequence of its being blocked by boulders getting jammed in it under the metal pipe casing, which it seems had not been properly inserted below the surface of the bed rock. A shaft had been dug for its insertion.

The next hole, 15 feet to the eastward of no. 1, was the same distance from the supposed position of the hanging wall. Owing to a delay in the arrival of piping, it was not commenced until Oct. 26th. From this date it was sunk continuously till Nov. 21st, when a depth of 201 feet was reached.

The following section shows all particulars with regard to the boring:

No. 2 Hole.			
Date.	No. of Hours of Boring.	Material.	Feet.
Oct. 26 ..	1	Red Shales	4
" 27 .	3½	" " and blue slate	17
" 29 ..	4¾	" "	22
" 30 ..	5¼	" "	24
" 31 ..	6½	Blue slate	19
Nov. 1 ..	7½	Hard broken slates with quartz	7
" 2 ..	8	" " " " "	6
" 3 ..	5	Very hard blue slates and spar stringers	6
" 5 ..	10	" " " "	5½
" 6 ..	8¾	" " " "	10
" 7 ..	8	" " " "	7
" 8 ..	9	" " " "	7
" 9 ..	10	" " " "	6
" 10 ..	9½	" " " "	7
" 12 ..	8½	" " " "	6
" 13 ..	8½	" " " "	5½
" 14 ..	9½	" " " "	7
" 15 ..	10	" " " "	6½
" 16 ..	9	" " " "	5½
" 17 ..	9	" " " "	6
" 19 ..	14½	" " " "	13
" 20 ..	6	" " " "	4
Total...	171¾		201

It will be noticed how the rate of boring decreased when the drills left the soft shales, and entered the hard blue slate, and although not shown in the section, bands of quartzite were also met with. As seen by the record the cores would seem to show that the vein had feathered out into the shales or that the angle of dip was much more nearly vertical than at first assumed. In support of this latter theory it must be stated that the cores showed the dip of the rock to be practically vertical throughout.

The drill was now moved over to a position 12 feet to the north or actually on the hanging wall of the vein, and No. 3 hole was commenced on Nov. 26th. It should be mentioned that Mr. Burnett (the Drill Company's expert) left towards the end of October, and Mr. Phinney took charge of the drill on

behalf of the Government. The drill was finally drawn from this hole on Dec. 27th, after operating about 396 hours.

No. 3 Hole.

Material.	Feet.
Surface clay and boulders	10
Slate ond soft shales	3
Red shales with spots of spar and hematite	13
Blue slate and spar (very hard)	3
Red shale (hematite in spots)	13
Blue and red shale (hematite in streaks)	14
Soft red shale (hematite)	30
Slate and brownish ore	37
(Hematite with red shale)	27½
Brown ore, shsle with spar (very hard)	11
" " blue and red shale (hard)	19½
Red and brownish ores	3
" " " and slate	28
Brown ore and slate	15½
Softish shales showing spar stringers	102
Total	330

Ou examining the record above, it will be seen that the drill encountered ore from a depth of 13 feet at intervals down to 228 feet. At the same time it is a fact that no solid vein of any thickness was passed through in this hole, though the ore actually brought up iu the core-barrel appeared to be of good quality, and to run high in metallic iron.

Unfortunately it is a disadvantage of the large sizes of this drill that with its present arrangement of high top gear, it cannot be manipulated successfully at an inclination to the vertical, and the results of this hole leave one in considerable doubt as to whether anything of value has been proven here.

Owing to a peculiarity of the strike of the measures in this part of the district, it appears that they are subjected to a series of twists, or that short faults occur at intervals, throwing the portions affected to the south, when followed in a westerly direction. It may be therefore, that this hole has been sunk

exactly at one of these points where the strata would probably be much distorted and broken. However, be that as it may, it will be admitted that the following attempts on the part of the operators have proved eminently successful, not only in establishing the fact that large bodies of ore exist; but in assisting to prove that the formation here is a true synclinal basin.

The position for this hole was chosen after some deliberation, and it proved to be a happy one. At a point on F. Wheelock's farm, about 2 miles to the west of the above workings, the three veins spoken of in the first part of the paper, were proved on the surface, and the drill was set up 40 feet to the south of the most southerly of the three (the "Shell Ore" vein). (See Plate V.) The crops of the other two were respectively 84 feet, and 124 feet northerly from the drill. The three veins were intersected at the depths shown, and by reference to the sectional view, it will be seen that they are widening and flattening as they descend. Boring commenced here on Jan. 3, 1901, and finished on April, the drill operating for 1560 hours:

No. 4 Hole.			
Dip.	Material Bored Through.	Thickness in Feet.	Total No. of feet from surface.
84°	Surface material	14	14
	Red and blue slates with bands of quartzite (very hard)	98	112
76	Brown hematite ore (showing fossil shells)	38	150
	Slates as above	176½	326½
70°	Brownish hematite ore	38½	365
	Slates and small seams of brown ore	75	440
76°	Brown ore	36	476
	Slates and bands of quartzite	144	620

On the completion of this very satisfactory boring, the drill was moved over on the south side of the valley, formed by the Torbrook or Black River, and boring was commenced well up on the South Mountain ridge. The drill was situated close to a vein of compact magnetite, whose surface measurements gave the writer the following results taken from north to south:

Material.	Feet.	Inches.	Feet.	Inches.
Ore	5	..		
Slate			2	10
Ore	1	..		
Slate			1	1
Ore	1	10		
Total	7	10	3	11

It should be stated that at the time of measurement the width given in the above section shows all the ground then opened, but it is possible that 7 feet 10 inches may not represent the extreme width of ore in the vein.

This and other deposits on the south side of the valley have been traced on the surface for long distances, and analyses of these southern beds show the following results: *

No.	Metallic Iron.	Silica.	Phosphorous.	Sulphur.	Manganese.	Titanic Acid.
1	54.70	11.5	.66	.007	....	1.44
2	42.80	10.39	3.96	.01	.52	....
3	54.84	10.80	1.40	.02	.41	....
4	53.10	14.10	.70	.14	.24	....
5	55.40	20.35	.50	....	.28	....

Thus it appears that their characteristics are practically the same as the beds elsewhere in the district.

No. 5 hole produced a section as follows:

No. 5 Hole.					
Dip.	Hours of Boring.	Material.	Thickness in Feet.	Total Measurement from surface.	Remarks.
Gradually changes from 87° at surface to 83° at bottom of hole.	7	Surface	5	5	Casing put down.
	99½	Dark slate, loose and broken	50	55	
	17	Slate mixed with iron	7	62	Rock generally loose and broken.
	53	Ore	30	92	
	6½	Slate mixed with iron	4	96	
	68	Dark slates	27	123	
	19	Slate mixed witn iron	7	130	
	76	Ore	29	159	
	36	Slate mixed with iron	13	172	
	51	Black slates	20	192	

* See Gilpin, Iron Ores Nictaux, Nova Scotian Institute Science—session 1894-95.

From this it is obvious that two veins were passed through, both of which flatten with depth. (See Plate V.)

Plate VI is a plan showing the surface features of the locality.

A few notes collected by the writer relative to the rate and cost of boring with this drill as proved by practical experience may be found interesting:

In boring the 620 feet hole on the Wheelock Farm 1560 hours were employed, which time included that taken up in the drawing of rods, sharpening bits and cutters, and other minor delays, so that fairly deducting say 25% of this, it would leave 620 feet of core produced in 1170 hours of actual drilling, or an average rate of boring was attained of over 6 inches per hour.

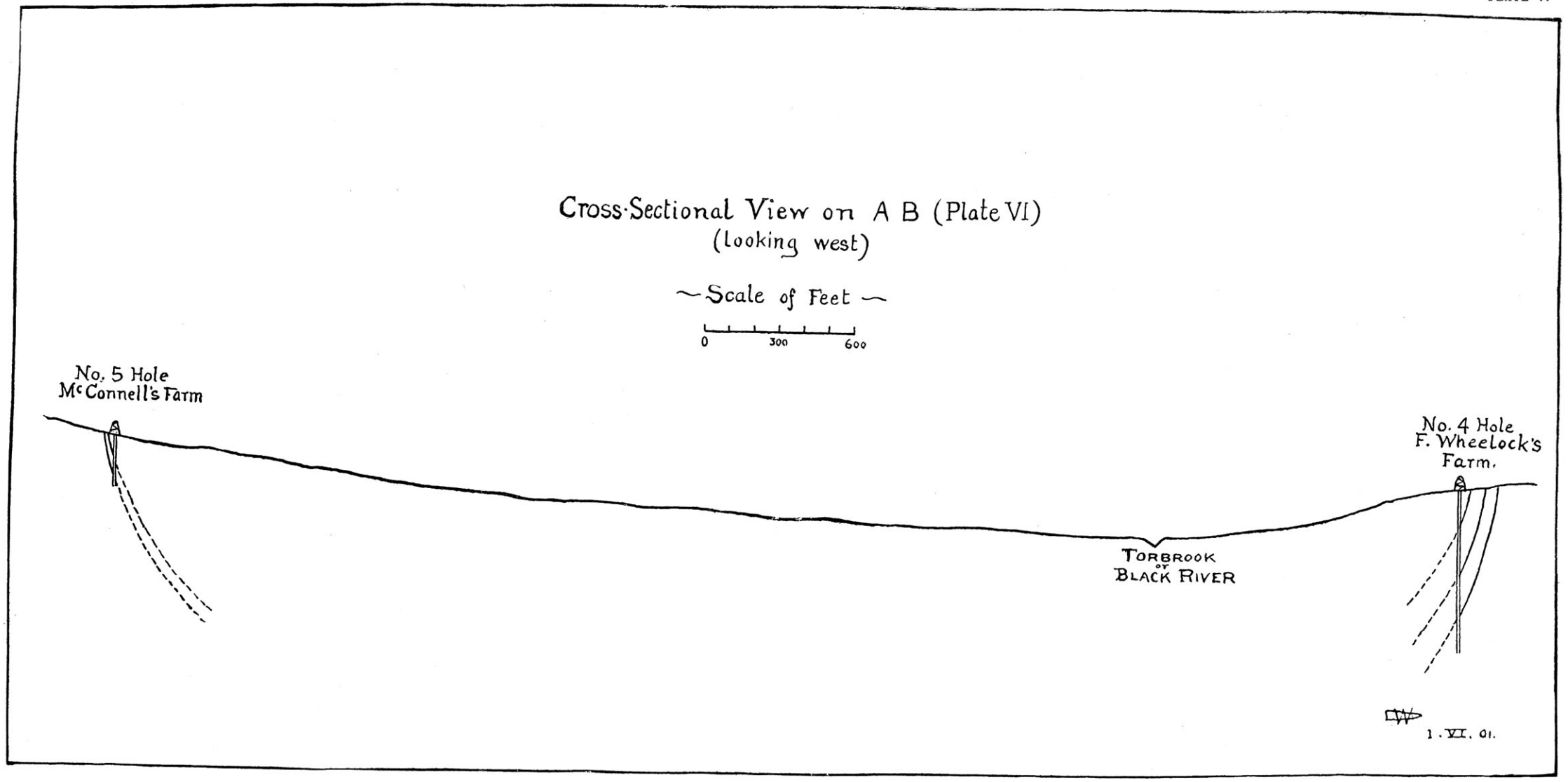
The cost of boring this hole may be very approximately set down at $2.00 per foot, made up as follows:

Labor	$670.00
Management	250.00
Fuel	195.00
Lighting, oil, waste, etc	35.00
Shot	50.00
Wear and tear	50.00
	$1250.00

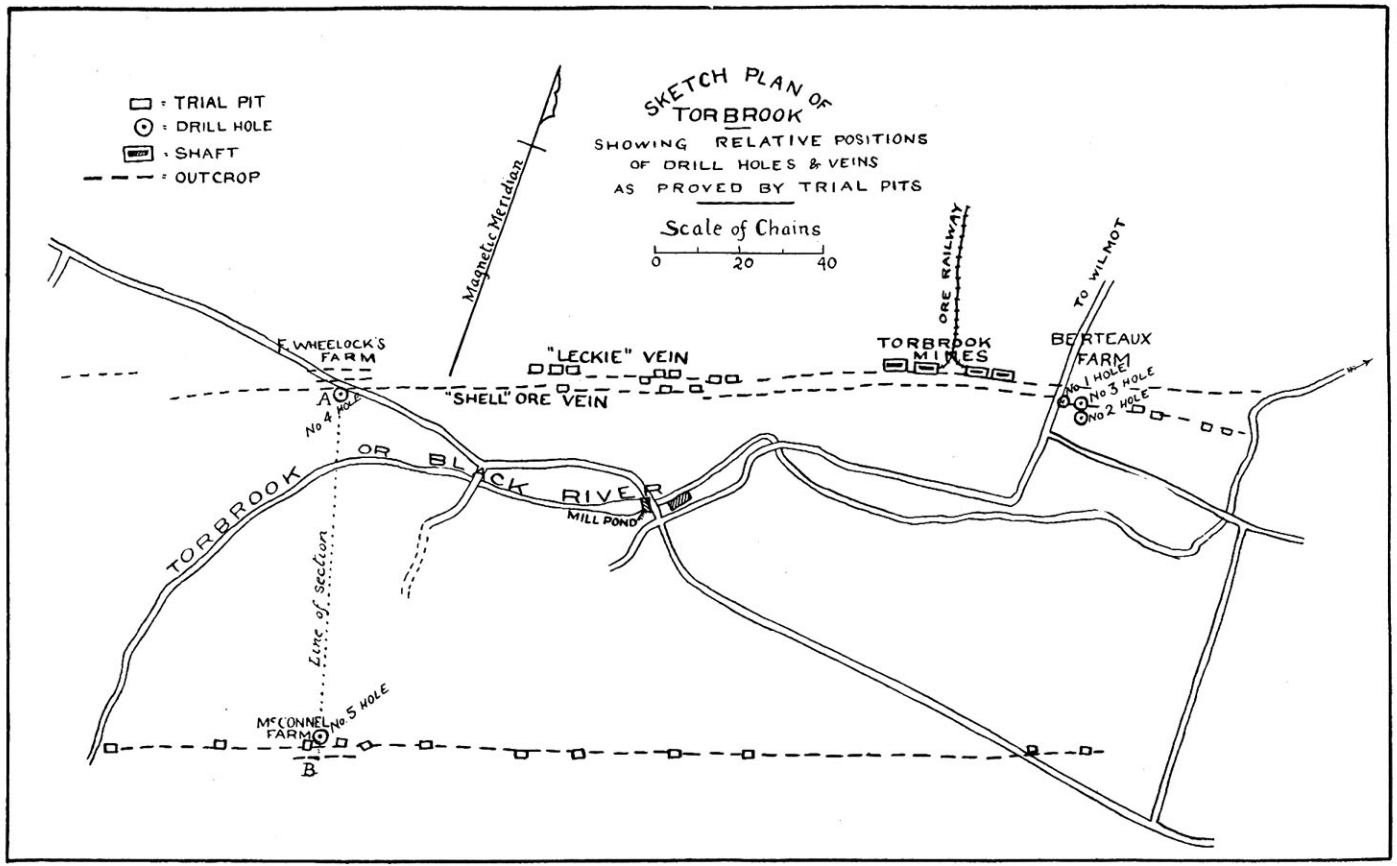
In considering the above, it must be borne in mind that the rock here though composed of slates and shales, is very hard, and often intercalated with quartzite, and highly ferruginous bands; and further, though the drill runner is a competent man, all the conditions at first were new, and consequently both the cost and rate of boring will probably be materially reduced as the operations progress.

In order to show that this hole was a severe test, the record of no. 2 may be taken in comparison, and it will be seen that on the average over 1 foot per hour was bored. while from 4 feet to 6 feet per hour was done in the softer portions of the rock.

The cost of boring in this softer rock is also reduced by the fact that the cutter is used instead of shot, which latter method is not only expensive in the consumption of shot but also of shot barrel, which costs about $2.25 per foot, and wears away at the rate of about 1 foot of barrel in 50 feet of rock.



CROSS-SECTIONAL VIEW, TORBROOK, N. S.
(TO ILLUSTRATE PAPER BY MR. WEATHERBE).



(TO ILLUSTRATE PAPER BY MR. WEATHERBE.)

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