

NOTES ON THE ORE DEPOSITS OF SOUTH CHETICAMP, CAPE
BRETON ISLAND, N. S.—BY M. V. GRANDIN, Cheticamp.

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One of the most interesting and instructive mining districts of Nova Scotia, especially for the study of certain peculiar structural features of ore deposits, is that of Cheticamp.

PHYSICAL GEOGRAPHY.

The district lies in Inverness county, on the north-west side of the Island of Cape Breton, about 110 miles north-east of Pictou, from which place it may be reached by steamer during the season of open navigation. During the winter, however, the most direct route is by mail-coach from Inverness—the terminus of the Inverness railway—a distance of about forty miles.

It comprises a tract of country about 13 miles in breadth, extending along the Gulf of St. Lawrence in a north-easterly direction from Factory river to George's brook—a distance of 16 miles; its area being about 200 square miles. The most trenchant and conspicuous natural division of the district is into a narrow seaboard plain and a plateau lying to the east and north-east of the plain. But for the purpose of this description the great gorge of the Cheticamp river, which traverses the district from south-east to north-west is taken as the dividing line between North and South Cheticamp. The principal metalliferous deposits are located in the southern division which embraces almost the whole of the plain and more than half the plateau area included within the district. The barite and other deposits of the northern division have been made the subject of investigation by Dr. H. S. Poole, so they will not be described in this paper.*

* See bulletin to be shortly issued by Geological Survey of Canada.

The plain, which embraces the island of Cheticamp, covers but one-tenth of the area of the district. It stretches along the shore between Factory and Cheticamp rivers—a distance of nine miles, and rarely exceeds two miles in breadth. Its surface is traversed in a north-east and south-west direction by long low undulations, which towards the east and north, along the foot of the grand escarpment of the plateau, break up into hummocks and high ridges.

The harbor, which was originally a narrow strait running parallel to the undulations and severing the island from the mainland, but now silted up at the southern end, is about $3\frac{1}{2}$ miles long and a little over a quarter of a mile wide. It is the only well sheltered harbor on the western coast of Cape Breton and requires but little dredging to keep it open. Ice, however, commences to form during the latter part of December and lasts from then until the latter part of April or early part of May, during which time navigation is entirely suspended. From this cause and the absence of railway communication with other parts of the province, the development of the resources of the district has been much retarded.

The plateau, with its almost severed stumps, comprises the remaining nine-tenths of the district. It is a portion of that great dismembered branch of the grand Appalachian group which embraces the larger part of northern Cape Breton. The front line of the tableland runs approximately parallel to the coast-line, except at a little south of the middle where it is broken by an embayment into which extends a tongue of the plain traversed by the Cheticamp river. North of Jerome brook, the plateau and its stumps rise precipitously out of the sea or from narrow level terraces; south of this brook it rises almost equally as abruptly from the plain. The average height of the plateau is about 1100 feet. Its surface, especially along the edge, is frequently deeply trenched by huge gorges and ravines cut by innumerable brooks and streams in their descent to the sea.

The drainage system of the district corresponds in its principal lines with the general slopes of the surface, which are from south-east to north-west. The main artery is the Cheticamp river, which enters it from the east a few miles north of the middle, runs south-westerly towards the centre for about $2\frac{1}{2}$ miles and thence north-westerly for nine miles through a deep, dangerous and almost impassable canyon to its beautiful salmon pools where the gorge widens. From thence it continues approximately the same course for three miles, when after cutting through Black mountains it debouches on the Cheticamp plain and flows northerly to the Gulf of St. Lawrence. The river is, like mountain streams, rapid and shallow, and is nowhere navigable, except for small boats near its mouth. It receives many large brooks from the north and south. One of its most important southern tributaries is the L'Abîme brook, in the drainage basin of which the principal metalliferous deposits of the district are situated. This brook has its origin in some ponds and swamps about five miles in a south-easterly direction from its junction with the Cheticamp river. For $2\frac{1}{2}$ miles from its source it flows quietly across the plateau, after which it descends wildly through a deep ravine for the remainder of its course. One of the principal feeders of the L'Abîme is the McLeod, which joins it from the west, a mile above its mouth. About three-quarters of a mile above its junction with the L'Abîme and shortly after commencing to deeply trench the plateau, the McLeod brook receives the Grandin brook from the south and then descends in a north-easterly direction in a series of cascades through a deep wide gorge. The Grandin brook is a very small stream and flows northerly through a narrow ravine.

The plain is mostly cleared and under-cultivation. The slopes of the gorges and ravines of the plateau are clothed with many kinds of woods, conspicuous among which are the birch, maple, beech, spruce and fir; but on the higher and more level surfaces of the tableland the prevailing vegetation is stunted.

spruce and fruit-bearing bushes interspersed with the rank herbage which flourishes in the great wastes of marshland.

The district possesses a most remarkable diversity of scenery. Its most striking feature is the grand escarpment of the plateau, rising from sea and plain in lofty mural and castellated cliffs, majestic talus-slopes and precipitous and craggy acclivities. Its coast-line scalloped into long and grateful curves, presents, especially the northern part, a succession of bold headlands and picturesque bays and coves. Along its shores may be seen an endless array of strange, fantastic and beautiful forms carved by the sea out of its many-hued rocks. From the higher summits of the region, glorious panoramic views are unfolded of plain and plateau. Looking towards the former, spread out like a map at our feet, we see sparkling streams winding across it to the sea, and over its surface dark copses of fir alternating with bright green patches of cleared land. Turning towards the plateau, stretching as far as the eye can reach we see a great wilderness of pristine forest, moreland and rock. Here and there its surface is seen cut into labyrinths of gorges and chasms with foaming torrents, tumbling cascades and deep secluded salmon and trout pools.

GENERAL GEOLOGY.

The relationship of the rocks to the forms of the surface can only be briefly referred to in this paper.

The trend of the coast-line and that of the undulations of the plain, the course of the escarpment, the position, size and shape of the harbor and the island, have all been largely determined by the strike and the nature of the underlying rocks. The law of the survival of the strongest and fittest holds good in physiography as in biology. The softer rocks have suffered the most from erosive agents and left the harder as the salient features of the district. The granitic rocks which constitute the front of the plateau have acted as protecting barriers to the softer schists which lie beyond them, and have determined the trend and retarded the recession of the escarpment.

The courses of the principal streams appear to have been mainly determined by the original slopes of the surface; but those of the smaller brooks and torrents have been influenced chiefly by fault lines, the disposition and lie of the schists and the relative resistant power of the rocks.

Two great systems of rocks are represented in the district—the pre-Cambrian and the Carboniferous. The classification of the former into series has not yet, on account of the complexity of the problem, been attempted. The Carboniferous are divided into two series:—the Lower and the Middle. Broadly viewed, it may be said that the pre-Cambrian rocks occupy the plateau, and the Lower Carboniferous the fringe of hummocks and ridges along the foot of the escarpment, and the plain. The rocks of the Cheticamp Island are regarded by Mr. Hugh Fletcher as Middle Carboniferous.

The pre-Cambrian formation consists mainly of granites, syenites, felsites, gneisses and schists. Granitic rocks, cut by dikes of trap, predominate along the edge of the plateau. These give place towards the interior of the district to patches and belts of schistose rocks alternating with or surrounded by massive igneous rocks. The whole formation has been much plicated, sliced horizontally and vertically by shear and thrust planes, and in consequence of these mechanical movements and the chemical action thereby set up, most of its rocks have been converted into varieties of gneisses, schists and other foliated rocks.

The massive igneous rocks are frequently metalliferous, but it is the schists that have so far proved the principal ore-bearing rocks of the district and in them the important deposits have been located.

A powerful fault, traversing the district from north-east to south-west and following the course of the escarpment, separates the pre-Cambrian from the Carboniferous. The latter is represented by conglomerates, sandstones, shales, gypsum and lime-

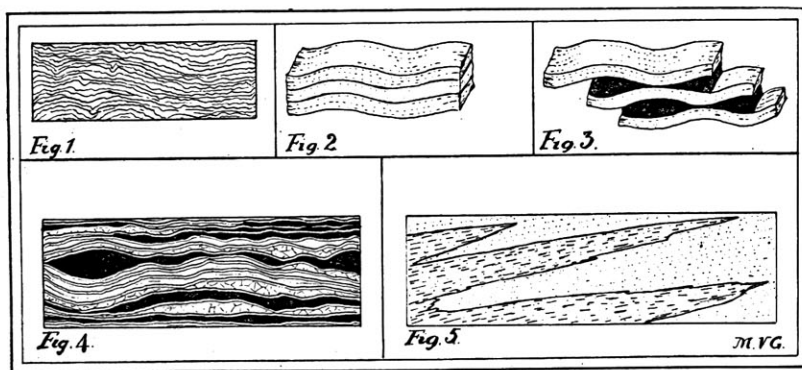
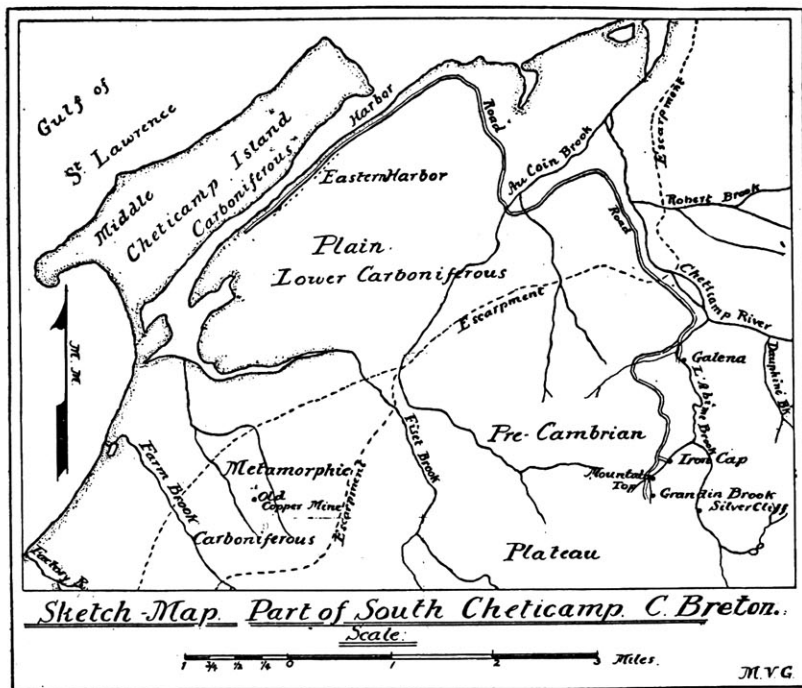
stones. Conglomerates and sandstones, more or less metamorphosed, form the high ridges which run parallel to the edge of the plateau. Along this boundary fault, these rocks are highly tilted, generally dipping seaward, but sometimes bent back upon themselves. They are also frequently faulted, crushed and cut by trap dikes. In places they give promise of workable deposits of copper, but elsewhere in the district the Carboniferous rocks are apparently barren. These metamorphosed sandstones are succeeded by thick beds of gypsum and limestone which form the hummocky land. The geological features of the plain and island are comparatively simple. The rocks of these tracts are principally sandstones and shales. Those flooring the plain, dip seaward, while those of the island have a general dip towards the mainland.

THE L'ABIME ORE-BEARING SCHISTS.

The principal metalliferous deposits of the district are located in a belt of schists occupying the drainage basin of the L'Abime brook. They are easily accessible from Eastern harbor by road. (See map.)

The belt consists mainly of sericite, chlorite and hornblende schists, which appear to have been produced by the metamorphism of an original stratified series—their planes of foliation being guided by the stratification of the original materials. A definite order of succession can be made out among them and their groups of sericite and other schists traced continuously over long distances.

The structure of this area is an extremely complicated one. In the uplifting of granitic masses to the east and west of it, the whole tract was subjected to enormous mechanical movements which not only threw its rocks into wave-like folds but dislocated them by reverse faults and cut them into slices by shear and thrust planes. The longitudinal axis of the folds strike approximately N. N. E. and S. S. W. In the central part of the area they pitch S. S. W. or S., whereas in the



northern part they are, when observed, inclined to the N. N. E. or N. This pitching of the axes may have been caused either by their being broken across the strike or by transverse east and west upheavals. The lines of movement run in certain definite directions and principally along lines of shearing and thrust planes. They may be grouped into two systems at least:—(1) Those running N. N. E. and S. S. W., and (2) those trending E. S. E. and W. N. W. or E. and W. and approximately at right angles to the first system. In a general way it may be said that the vertical lines of shearing or cleavage-foliation run parallel to the strike and the thrust planes coincide with the stratification-foliation planes of the schists.

To still more complicate the structure of this complicated belt of country, cross undulations and contortions have been developed on the flanks of the main folds which cause great irregularities in the lines of outcrop.

These movements appear to have developed considerable volcanic activity and the schists were cut by dikes of felsite and diorite which in places seem to have some genetic association with the ore deposits.

THE PRINCIPAL ORE DEPOSITS.

Grandin brook copper deposit.—The ore deposit in which development work is in the most advanced stage, is that of Grandin brook, which is situated on the edge of the plateau near the junction of the McLeod and Grandin brooks. The work consists of a slope at its most southerly outcrop, several lateral openings made at intervals for about 900 feet along the right bank of the Grandin brook ravine and the stripping of the vegetation and debris from the precipitous cliffs in which it outcrops in the McLeod brook gorge. It consists of several beds, aggregating probably not less than 250 feet in thickness, of sericite and chloritic schists impregnated with copper pyrites. These beds are locally known as the "copper schists," and rest on the schists which outcrop in the McLeod brook and which

are of considerable but undetermined thickness. The McLeod rocks possess somewhat similar lithological characteristics to those of Grandin brook and like the latter carry metallic sulphides disseminated through most of their beds. There is, however, as a rule, a marked difference in the nature of the sulphides carried by the two groups. Arsenopyrite, which is the dominant ore of the McLeod rocks, is conspicuous by its absence in the "copper schists." The nature of the rocks overlying the deposit has not yet been determined, as the hanging wall has not been reached; but the data so far collected indicates they possess characteristics similar to the underlying beds. The "copper schists" at their outcrop in the Grandin brook strike N. N. E. and S. S. W., with an average dip of 45° to the E. S. E.; but owing to the axis of the fold pitching S. S. W. at about an angle of 10° , the deposit is tilted up towards the north at its outcrop in the McLeod cliffs and then it has been ground down by detritive agencies to a thickness of about 40 or 50 feet. The characteristic cross-folds and contortions of the L'Abîme schists are well illustrated at the deposit. Fig. 1 gives some idea of the tumultuous nature of the smaller contortions. The same pressure which produced the cross undulations, not only caused horizontal displacement of the beds, but caused the layers to slide over each other, by which movements cavities were developed. Many of these cavities have no doubt been modified in shape by the corrosive action of circulating fluids, but their original shape has generally been fairly well preserved. Figs. 2 and 3 represent the manner in which the lens-shapes were produced. Fig. 2 represents the corrugated beds before, and Fig. 3 after the sliding movements had taken place. This structure is characteristic of all the L'Abîme deposits; but is not so well illustrated at Grandin brook as at Iron Cap and Galena, as owing to the minuteness and the great abundance of the contortions of the "copper schists" the lenses are usually extremely small. Fig. 4 shows another structure, common to all the deposits, which has been

developed by forces pressing on the end lines of stratification. Both these forms of cavities were no doubt produced in most cases with but comparatively little horizontal displacement of the beds and layers. Below the zone of oxidation they are generally found filled with copper- and iron-pyrites or quartz, but at the outcrops where their metallic contents have been leached out they can usually be more easily studied. The copper-bearing solutions appear to have gained access to the cavities by travelling up and along the planes of jointing, shearing and foliation, as these divisional planes are frequently covered with thin sheets or films of ore. These thin sheets and minute lenses constitute the bulk of the ore at Grandin brook.

The surface characteristics and products of copper deposits may be seen at Grandin brook. At and near the surface, to a depth of from 5 to 15 feet, the metallic contents of the schists are often completely leached out leaving the rock in a cellular and porous condition. The schists at the surface are rarely stained, being, although normally of a greyish or greenish color, bleached nearly white. A few inches below the surface, however, they are generally discolored by limonite. This leached zone gradually passes into one in which green carbonates predominate, and this in turn into one containing a mixture of partly decomposed copper pyrites and carbonates which rapidly gives place to an unoxidized copper pyrite zone.

The outcrops of all the L'Abîme deposits are somewhat difficult to follow, as although admirable sections are occasionally laid bare in brooks and cliffs, they are usually covered with superficial deposits, forests, dense thickets, swamps and bays. The tendency of the ores to decompose and become leached out where the rocks are exposed to surface agencies, and the general resemblance of the rocks to each other, also add considerably to the difficulty. The course of the outcrop of the "copper schists," however, has been traced by means of "float" and a few exposed sections for a distance of nearly a mile.

The Grandin brook deposit is owned and is being developed by the Cheticamp Copper Company, Limited, Halifax.

As all the deposits of the L'Abime area resemble one another very closely in the mode of occurrence of their ores only the peculiarities or exceptionally well developed structural features of the following deposits, will be described.

Mountain Top.—The Mountain Top deposit outcrops in the deep gorge of the McLeod brook near the mouth of the Grandin and immediately beneath the "copper schists." It consists of four distinct beds of schist which in descending order are as follows :—

1. Chlorite. Not explored. Thickness not determined.
2. Serecite, 4½ feet thick.
3. Chlorite, 25 " "
4. Serecite, about 50 " "

These rocks outcrop on or in close proximity to an anti-clinal axis which pitches S. S. W. at about 10°. Along the crest and flanks of the fold, undulations have been developed with their axes parallel to the axis of the main fold. No. 1 is harder than normal varieties of chlorite schist and carries auriferous arsenopyrite associated with chalcopyrite in lenses and veins of the compression type (Fig. 4.) The lower chlorite No. 3 is very much softer than No. 1, and is remarkable for its crumpled and contorted folia. It carries arsenopyrite and pyrrhotite in lenses and veins similar to those of No. 1. In No. 2, the ore is also distributed in much the same way, and consists principally of auriferous arsenopyrite. No. 4 is a very hard serecite approaching quartzite in appearance and hardness. The planes of shearing which are here well developed are grooved and fluted in the most beautiful manner so that portions of the rock have some resemblance to prostrate Corinthian columns. Veins of the compression type predominate in this bed. The ore is more concentrated for about 10 feet below its junction with No. 3, and from this zone samples of arsenopyrite

have been taken carrying as high as \$90 in gold per ton. But although these phenomenal values have been shown, the deposit is essentially a big low-grade proposition, as are the other deposits of the L'Abîme.

The outcrop has been traced over a large area, but work has as yet been confined to its outcrop in the McLeod gorge. This property is owned by the Richfield Mining Company, Limited, Halifax.

Iron Cap.—Next to the Grandin brook deposit, Iron Cap is in the most advanced stage of development. It outcrops 500 yards E. N. E. of Mountain Top in precipitous cliffs along the right bank of the McLeod brook which here flows easterly 600 feet below the general level of the plateau. The deposit consists of a bed of chlorite schist of undetermined thickness carrying auriferous arsenopyrite and pyrrhotite. The bed has been stripped along the brook for a distance of about 200 feet exposing a section of about 25 feet in thickness. The schists are here seen to be bent into an anticlinal fold and to dip east and west of its axis at low angles. A tunnel has been driven into the ore-body for about 100 feet at the end of which the schists make a sudden plunge to the south. The section exposed may be divided into two zones: (1) an upper zone in which pyrrhotite predominates and (2) a lower one in which arsenopyrite is the principal ore mineral. Large lenses which owe their shape to the sliding of corrugated masses of rock over one another and almost horizontal veins filling cavities produced by compression (Figs. 2, 3 and 4) are well developed here. The ore, although it has not shown the phenomenal high values of some of the Mountain Top ore is more abundant and more evenly distributed through the rock-mass. The series of chlorite schists, of which this deposit is a member, has been traced over a wide area and at all its outcrops it is found to contain metalliferous ores. It is owned by the Richfield Mining Company, Limited, Halifax.

Galena.—"Galena," from a structural point of view is one of the most interesting and instructive of the L'Abîme deposits. It is situated in the L'Abîme gorge about 900 feet below the general level of the plateau and a mile N. N. E. of Iron Cap. It consists of a bed of garnetiferous sericite schist (locally called the "grey schist") carrying galena associated with zinc blende and arsenopyrite and outcropping in cliffs on both sides of the L'Abîme brook which here flows north-easterly. The schists are at this deposit bent into a synclinal fold with characteristic longitudinal and transverse undulations well developed. Several openings have been made on the right bank of the brook which facilitate the study of the structural features of the deposit. At these openings the prevailing dip is approximately N. N. W. at about 28° . Overlying the "grey" at the most westerly opening (No. 1) is a hydromica schist of bluish color (locally called the "blue schist") which is seen at the next opening towards the east to impinge upon and intertongue with the "grey" as the outcrop of the latter ascends the bank of the brook. Higher up the bank, but stratigraphically lower than it appears at No. 1 opening, the "grey" is seen intertonguing with the "blue." Lower down the brook in the cliff on the left bank, fragments of the "grey" are seen intercalated among the "blue." This faulted condition of the schists could only have been caused by a lateral thrust which broke and drove the severed beds over their original continuation and forced their jagged ends together. (See fig. 5.)

The ore minerals are found in lenses and veins in the "grey" schist in much the same manner as they occur in the deposits already described; but at Galena they are also found deposited in sheet-like masses along the thrust plane at the contact of the "blue," and "grey" schists. They are also found occupying rents of a somewhat lenticular shape which cut through the planes of foliation and which appear to have been formed at the time the thrusting took place.

The "blue" schist contains very little ore. It is a more compact and close-grained rock than the "grey" and does not appear to have been as much disturbed as the latter and fewer cavities were therefore developed for the reception of ore.

The thickness of the "grey" has not yet been determined as its base is nowhere exposed either by natural sections or the development work. From measurements taken in the slope, however, it would appear to be not less than 25 feet. This deposit is owned by the Cheticamp Gold Mining Company of Halifax.

Silver Cliff.—The most interesting structural feature of Silver Cliff—an argentiferous galena deposit situated on the L'Abîme brook about $1\frac{1}{2}$ miles south of "Galena"—is the development of incipient secondary foliation by shearing—the rock splitting into thin corrugated slabs along planes perpendicular to those of stratification-foliation. The ore-bearing schist is here a chloritic variety which has been violently disturbed and severely plicated. It rests upon a corrugated sheet of white quartz, below which is seen a dark hornblendic rock (probably a diorite) which shows shistose structure but imperfectly developed. This deposit is owned by the Inverness Mining Company, Limited, of Halifax.

From the foregoing facts relating to the mode of occurrence of the L'Abîme ores, there would appear to be no doubt that the deposition of the ores took place *after* the formation had been folded, faulted and sliced, and not prior to, as has been reported, and that the ores were deposited along the lines of movement rather than along the planes of foliation or stratification and, therefore, while the beds of schist are faulted, it by no means follows that the ore bodies have been dislocated to any great extent.