

# RG 034(A)

NORMETAL MINE AREA, ABITIBI-WEST COUNTY

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**GEOLOGICAL REPORT 34**

**NORMETAL MINE AREA  
ABITIBI-WEST COUNTY**

by

Carl Tolman



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NORMETAL MINE AREA

Abitibi-West County

by Carl Tolman

INTRODUCTION

The Normetal area, examined by the writer during the summer of 1941, comprises about 20 square miles centered at the mine of the Normetal Mining Corporation Limited and includes the eastern halves of ranges IX and X, Desmeloizes township, and of ranges I and II, Perron township. The area lies 10 miles north of the Quebec-Cochrane line of the Canadian National Railways and 5 miles east of the Ontario-Quebec boundary. The Normetal mine, within the area, is at present the northernmost operating mine in Quebec, its closest neighbour being the Beattie mine about 34 miles to the south. Thus the area is north of and separate from the main mineralized belt in western Quebec.

The area has the topographic features characteristic of the Precambrian shield of western Quebec. Relief is slight and the terrain generally consists of low ridges or hills of various sizes, on which rock is more or less obscured by morainal material, rising above relatively flat areas of sand, glacial lake clays and swamp. The largest and most prominent ridge has a length of 1 1/2 miles and a width of 2/3 of a mile. It extends N.60°W. from the centre of lot 43, range X, Desmeloizes township. It rises to heights of between 200 and 300 feet above the flat land to the east, which has an average elevation of 950 feet. Another ridge comparable in size and with similar trend rises in the northwest corner of the area and extends beyond its boundaries. Other highlands are smaller and extend down in size to the small rock exposures or morainal accumulations rising slightly above surrounding sand plains or glacial clays. The southeastern quarter of the area is especially flat, with very few or no outcrops. Desmeloizes river, flowing southward through the central part of the area, provides, with its branches, drainage for most of the area.

The flat country of the eastern part of the area is drained by some of the branches of Turgeon river, while the extreme western part is in the drainage basin of La Reine river. There are two small lakes in the area. The largest, Desmeloizes lake, is at the eastern end (lot 61) of ranges IX and X, Desmeloizes township; it is about 3/4 of a mile long, and is shallow with grassy shores.

The area is readily accessible from the south by roads through a region that has been settled and in which a variable amount of farming is carried on. An all-weather gravelled road extends from the Normetal mine south 12 miles to Dupuy on the Canadian National railway where connections are made with main roads leading east to Amos and Senneterre and south to Noranda and beyond. The mine is also served by a branch railway line from Dupuy.

The southern half of the area is included in the Desme-loizes area<sup>1</sup> (1) and its northern half is within the Perron-Rousseau sheet<sup>2</sup>. The Normetal mine, previously known as the Abana mine, has been the site of geophysical studies in which a number of geophysical exploration companies co-operated with the Geological Survey of Canada<sup>3</sup>.

In the present work the surface geology was mapped on the scale of one inch equals 400 feet, by plane table in most parts of the area, but supplemented by compass and tape in the wooded eastern sections. A base map showing the surveyed lines in the area was furnished by the draughting and cartography branch of the Québec Bureau of Mines. Aeroplane photographs covering the area were available and they were of assistance in indicating the location of outcrops and in furnishing details of drainage. The western half of the area has been thoroughly burnt over so that, with few exceptions, rock outcrops could be mapped by plane table methods. The eastern part, which contains few outcrops, is for the most part wooded. No outcrops whatever were found in the southeastern part. Logging operations are being carried on there and some of the land has been cleared by settlers.

Newton W. Buerger and Josaphat Gilbert ably assisted the writer in the field. The Normetal Mining Corporation kindly made available mine plans and geological data. The friendly co-operation of J.A. Little, mine manager, and his staff, greatly facilitated the work and it is a real pleasure to thank these gentlemen. W. Brown, company geologist, was especially helpful in generously contributing information.

#### GENERAL GEOLOGY

The dominant rocks of the area are volcanic rocks of Keewatin type. They are intruded by dykes and other masses of diorite, granite and late Precambrian diabase.

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(1) References are at the end of the report.

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Table of Formations

Cenozoic	Recent and Pleistocene	Clay, sand, gravel and swamp deposits
Proterozoic (Late Precambrian)	Intrusive rocks	Diabase dykes
		Granites
		Granite porphyry dykes
		Rhyolite, irregular and sill-like bodies
Archaean (Early Precambrian)	Intrusive rocks	Diorites and more basic masses
		Iron formation
		Dacite
	Volcanic rocks (Keewatin type)	Normetal schist
		Banded tuffaceous sediments
		Rhyolite
		Andesite

Volcanic Rocks

The volcanic rocks are steeply dipping to vertical, with a regional trend somewhat north of west. As far as could be determined they are monoclinal, facing southwest. The rocks show considerable range in composition from acidic to basic types. Although the varieties are to an extent intimately interbedded, belts large enough to map consisting dominantly of one type or another are distinguishable. These are andesite, rhyolite, banded tuffaceous sediment, Normetal schist, dacite or "grey lava" and some narrow but distinctive bands of iron formation within the dacitic lavas.

Andesite

The andesites are grey-green to rusty-green rocks which show considerable range in texture. The coarser varieties, which make up the centres of some thick flows, approach in granularity the intrusive diorites and, in isolated outcrops, are difficult to distinguish from them. Some very fine grained varieties, showing no primary structure but with a fair development of schistosity, may be tuffs. The bulk of the andesites, however, are intermediate in texture. Microscopically they are feldspathic rocks showing a relatively high content of chlorite. Epidote-zoisite is commonly a prominent constituent, especially in the coarser varieties, which also show shreds of hornblende. In none of the thin sections examined was it possible to conclude what the composition of the original plagioclase may have been, for everywhere it has broken down with the production of epidote-zoisite, albite and small amounts of other secondary minerals.

Only imperfectly developed pillow structure was observed and most of the flows show none at all. Some flow banding and amygdaloidal structure has also been developed. A few flow contacts were noted in which the upper parts of flows are distinguished by imperfect pillows and in other cases by very fine grained somewhat tuff-like material.

Andesites are dominant in the lavas of the northern part of the area and a number of the flows there are amygdaloidal. Within these rocks in the northwestern corner of the area there are some quartz porphyry bodies which probably represent sill-like intrusions. If the interpretation of a simple monoclinal structure throughout, with beds facing south, is correct, this belt of andesite would occupy the base of the volcanic section but, because of the scanty evidence, this can only be tentatively assumed. Adjoining this band to the southwest are interbedded dacites and rhyolites which give way yet farther southwest to a distinctive belt of rhyolite.

Two belts of andesite large enough to map occur within the dacitic rocks of the southwestern part of the area. The northernmost belt is at least 300 feet wide and consists largely of massive andesite with visible grains. It occupies the northern part of a conspicuous outcrop in the middle of range IX, Desmeloizes township, on lots 44 and 45. The same belt can be distinguished along the regional strike in scattered outcrops on lots 43, 42, 41 and 40. The other band is about 600 feet wide and consists largely of finer grained and more schistose rock, which may in large part represent tuffaceous material. It cuts diagonally across range IX and is exposed on lots 32 and 33 and farther southeast along the strike on lots 35 and 36.

Rhyolite

A conspicuous belt about 2,000 feet wide, consisting largely of acidic volcanic rock, trends diagonally across the central part of the area. It is the most conspicuous and distinctive unit of the volcanic series. Outcrops begin about the centre of range X, Desmeloizes township in lot 44 and occur at intervals northwestward to the northwestern corner of the area in lot 32, range II, Perron township. In its southeastern part the band trends about N. $67^{\circ}$ W. but to the northwest it veers more to the north. Some large conspicuous outcrops occur, separated by low lying areas of glacial materials.

The exposed rocks give the impression of a high degree of homogeneity. Generally it is not possible to distinguish individual flows, which suggests that the rock may not be volcanic. But a uniformly very fine grained or aphanitic texture and the presence of small amounts of agglomerate support the hypothesis of a volcanic origin. Doubtless the uniformity of intense alteration (largely sericitization) has heightened the appearance of homogeneity. The rocks are distinctive in that they weather white or light grey and commonly have a waxy lustre.

In composition the rhyolite consist almost entirely of feldspar, generally considerably sericitized, and a variable but never great amount of quartz. Quartz eyes, in places opalescent, are found in much of the rock. The microscope shows the quartz eyes to be more general than would appear from megascopic examination, since many of them are only a little larger in grain size than the groundmass. In a few of the specimens examined some potassium feldspar phenocrysts which tend to show patchy extinction are also present. Most of the quartz phenocrysts and, to a much lesser degree, the feldspar phenocrysts are strikingly embayed by the groundmass. The dominant mineral of the groundmass is potassium feldspar. A little albite is recognizable, and a variable amount of quartz is generally present. In some instances, the quartz is a product of late silicification. Sericite is developed throughout, usually in tiny flakes showing an alignment that gives rise to schistosity in the rock. In some less schistose varieties the sericite shows more random orientation both between and within the original minerals of the groundmass. Most of the rocks could be classified as having been rhyolites but no doubt those with essentially no quartz belong within the trachyte division. From the purely petrographic standpoint they are now sericite schists. One agglomeratic variety, somewhat darker in colour than the usual rock, and not characterized by a marked waxy lustre, was shown by the microscope to have considerable epidote-zoisite developed within it and to contain a

higher percentage of plagioclase feldspar. This type may be considered transitional toward the groups considered dacites or "grey lavas" in this report.

No attitude of any primary structure could be determined in these rocks. The schistosity generally parallels the trend of the band and dips steeply to the north. The rhyolites are bounded on the northeast by dacites with a minor amount of interbedded rhyolite which gives way to the more extensive andesites occupying the northern part of the area.

#### Banded Tuffaceous Sediment

Bordering the rhyolites on the southwest is a band of laminated sediment, probably of tuffaceous origin. It shows a maximum thickness of about 150 feet just north of the Normetal mine in lot 44, range X, Desmeloizes township. This is also the southeasternmost exposure of these rocks. They extend N.65°W. and were observed to persist for about 6,000 feet to the region of lot post 37-38 on the Desmeloizes-Perron township line. The rock is heavily sericitized and originally it probably had the composition of feldspathic sandstone, tuff or silt. Lamination and bedding, which has not been wholly obscured by the sericitization and the production of schistosity, ranges from fine to coarse and has a general strike of N.65°W., and a steep dip to the north. Microscopic examination brings out the fine texture, feldspathic composition and intimate sericitization of these rocks. They show a close similarity in composition to the adjacent rhyolites, which suggests the probability of a genetic relation. To the southwest of these rocks there are most schistose varieties which include agglomerates and minor amounts of other rocks that together constitute the country rock of the Normetal ore body. Farther to the southwest these rocks give way to dacites.

#### Normetal Schist

A belt about 700 feet wide consisting largely of schist extends about N.65°W. from the mine and constitutes the country rock of the Normetal ore body. A narrow band of siliceous agglomerate was the locus of mineral deposition. Most of the remaining rocks of the belt were probably tuffaceous although their original character is largely obscured by the schistosity. Rock exposures are confined to range X, Desmeloizes township and extend from the north end of lot 36 diagonally through intervening lots to the south end of lot 45.

The rocks are now essentially fine grained sericite and chlorite schists. The sericite variety is the most representative but chlorite bearing schists are most prevalent in the northeastern part of the belt. These may indicate a tuff of less siliceous composition. The agglomerate is more or less schistose but fragments, most of which differ from the matrix only by appearing more siliceous, can be distinguished. These fragments have dimensions ranging up to a foot or more but usually only a few inches. A puzzling feature is the presence of a round boulder of grey granite 6 or 8 inches in diameter, within these rocks in an exposure just west of the mine.

A distinctive variety of sericite schist contains porphyroblasts of ottrelite, which shows up conspicuously as green spots on the relatively light coloured weathered surface. On the freshly broken surface the mineral is much less conspicuous. These chloritoid-sericite schists were noted throughout the length of the schist belt as well as underground. The microscope indicates the chloritoid to be present in prisms, commonly as much as one centimeter in length, of random orientation. Pleochroism in green is fairly strong. One of the striking features of the mineral is the presence of inclusions of the groundmass consisting largely of quartz, sericite, chlorite and calcite. These minerals are strewn in the chloritoid parallel to the schistosity of the rock so that, although the chloritoid is oriented with no regard to the schistosity, the structure is carried across it by the inclusions. Commonly, on the weathered surface of the mineral, the distribution of these inclusions can be distinguished by a hand lens. A feature of the mineral shown in every thin section examined is the prevalence of lamellar twinning parallel to the base, in accordance with the biotite law.

Garnetiferous sericite schist is another variety noted, but it is much less common than chloritoid bearing schist. When noted on the surface, the garnet occurs as small inconspicuous porphyroblasts in a normal sericite schist. It was also noted underground in one instance in coarse aggregates associated with vein mineralization. The production of this coarse garnet was undoubtedly related to the mineralizing solutions. Since the garnet is penetrated by the sulphides and variously attacked along fractures by a carbonate and a chloritic alteration product, the sulphide mineralization must have occurred after the formation of the garnets.

The presence of cyanite as porphyroblasts characterizes another variety of sericite schist. Since this rock was observed only underground, it may have been formed by the mineralizing solutions. However, it may occur more generally and failure to observe it elsewhere may be due to less detailed observation than that carried out at the mine. The thin sections examined were of cyanite bearing rock adjacent to the ore. They showed cyanite laths oriented at random in the

manner of porphyroblasts. Products of mineralization had wholly replaced the groundmass and had also attacked the cyanite to a considerable degree. Some large crystals have been noted by Wilson<sup>4</sup> and they, like the garnet noted above, may have resulted from the action of mineralizing solutions.

The schists are intruded by a variety of intrusive rocks, including a dyke of (Normetal) quartz diorite, some irregular rhyolite masses and some small, obscure, highly altered, fine grained intermediate to basic bodies. In the westernmost exposures of the belt of schists some granite porphyry dykes are also present. The Normetal schist is bounded on the southwest by an extensive area of dacite.

Dacite

Rocks mapped as dacite occur over the greater part of the area. Except for two relatively thin bands of andesite, a little rhyolite, and some iron formation, they constitute the volcanic rocks in the southern part of the area southwest of the Normetal schists described in the preceding paragraphs. Northeast of the prominent rhyolite band also there is some dacite but it is characterized by some narrow interbeds of rhyolite. A distinctive coarse agglomeratic band is exposed in the southern part of the large outcrop southwest of the mine on lot 43, range X, Desmeloizes township and similar rocks are exposed along the strike in the northern part of lots 36 and 37 in the same range. A well defined fragmental band about 100 feet wide is exposed near the centre of range IX, Desmeloizes township, on lots 40 and 41. An exposure to the southeast on lot 43 just northeast of the sand pit may be of the same horizon. Two other narrow bands of fragmental dacitic material were noted, both in range IX, Desmeloizes township, one near the centre of lots 32 and 33 and the other at their north end. The distribution of zones of fragmental rocks is indicated on the accompanying map.

The dacites range from tuffaceous and agglomeratic types to thick and massive flows. Rarely some quartz is visible to the naked eye. In characteristics they are intermediate between the sericitized rhyolites, in which dark mineral is absent or nearly so, and andesites relatively rich in dark mineral which is generally chloritized. The term "grey lavas" adequately describes their field and hand specimen appearance which contrasts with the light coloured rhyolites on one hand and the green andesites on the other.

A few specimens of these rocks were examined microscopically. They are very fine grained to aphanitic in texture and are composed dominantly of alkalic feldspar, both albite and orthoclase being

usually recognizable. In most types sericite and chlorite are developed in tiny flakes interstitially to the feldspar as well as within it. A small amount of quartz was noted in some of the sections. Carbonate is present in variable amounts, usually in irregular patches. No original ferromagnesium mineral was noted. The sericite and chlorite are generally intimately distributed throughout the rocks and a close correlation between the relative development of these minerals and the colour of the rocks was noted. As the amount of chlorite relative to sericite increases, the colour passes from light grey through greyish green to light green.

#### Iron Formation

Two series of bands of iron formation were mapped in the southwestern part of the area. The individual bands are never more than a few feet thick and are intercalated with dacitic volcanic rocks. One series is in the northern part of range IX, Desmeloizes township and is exposed striking about N.70°W. on lots 32, 33, 36, and 37; the other, with similar strike, is in the central part of range X, lots 32 to 34.

The two occurrences are similar in character and each consists of a series of bands of interlaminated fine grained quartz and fine granular magnetite with quartz. These bands have widths up to 5 feet and their constituent lamina range from 1/8 inch or less up to 1 inch or more in thickness. As many as 5 such bands were noted interbedded with dacitic material across a width of less than 100 feet. Commonly the bands are considerably contorted (See Plate I, B). The microscope brings out the fine grained equigranular character of the quartz and magnetite and shows quartz lamina of great purity alternating sharply with lamina composed dominately of magnetite and minor amounts of quartz. The fine grained equigranular character of the material suggests that it represents the recrystallization of a laminated ferruginous chert.

A few pits have been sunk in the western part of lot 37, range IX, Desmeloizes township, where the iron formation is sparingly mineralized with iron sulphide and quartz.

#### Intrusive Rocks

The oldest intrusive rocks are represented among dioritic masses, small rhyolitic bodies and narrow basic or lamprophyric sills or dykes. There may be considerable diversity in age among them. Granite and associated dykes are regarded to be younger; late Pre-cambrian diabase dykes are youngest of all.

Diorite, Quartz Diorite

Rocks of dioritic composition and texture are found within the lavas in various parts of the area but only in a few places are the occurrences sufficiently large and well defined to be distinguished on the map. They generally exhibit the same alteration in kind and degree as the associated andesitic lavas, and are sometimes difficult to distinguish from them. In the central part of range IX, Desmeloizes township, at the western border of the area, outcrops indicate a diorite body 250 feet wide. Another body, with a width of at least 150 feet, is exposed in the northern part of the same range, on lots 40 and 41. Other bodies less than 100 feet in width are also found in this range. In range X, no outcrops of diorite greater than 100 feet in width were encountered. Of especial interest is a quartz diorite dyke or sill paralleling, about 40 feet to the south, the Normetal ore body; it is here called the Normetal quartz diorite. Massive rock of dioritic appearance is exposed on lots 55, 56 and 57, range II, Perron township. This is in the region of the granite contact and the rocks may in part represent andesite metamorphosed by the intrusion of the granite.

The diorites throughout show considerable uniformity in their microscopic characteristics. In every thin section examined the plagioclase is represented by albite with much associated epidote-zoisite. Hornblende, or its alteration product, is an important constituent in all cases and is present either as shreds or large individuals with a shred-like development at their borders, — a textural development that is usually regarded to result from metamorphism or other alteration. Chlorite is generally developed but usually in small flakes throughout the rock. Nowhere except in the Normetal quartz diorite at the Normetal mine does it strongly attack the hornblende. A variable amount of carbonate, usually in irregular areas, is present. Titanite was found in most of the rocks, commonly intimately associated with an opaque mineral regarded to be ilmenite or titaniferous magnetite. In some bodies quartz occurs in amounts that place the rock in the category of quartz diorite. Usually the quartz is present as granular aggregates with irregular lens-like outline.

The textural and compositional similarity of these rocks to some of the thick andesite flows, as well as their similar alteration, suggests that they may come from a common magmatic source. However, the possibility of more than one age of intrusion cannot be eliminated; some of the diorites may be an expression of an epoch of igneous activity later than that represented by the andesite flows.

Of those diorites examined in detail, the Normetal quartz diorite dyke, paralleling the Normetal ore body about 40 feet to the south, is the most likely to be younger. This rock is exposed on the

surface with thicknesses ranging from a few feet up to 60 feet. It can be picked up by intermittent outcrops for over a mile and it is intrusive into the Normetal schist and an intrusive rhyolite. The rock has been referred to as a granite, but to the writer its megascopic and microscopic character suggests a quartz diorite and its character is confirmed by chemical analysis (Table 2, page 15). The microscope brings out the rock's highly altered condition, which in the thin section examined is actually more intense than is normal for the diorite. Chlorite, epidote-zoisite and carbonate are conspicuous constituents. The original feldspar is rather thoroughly gone to these constituents and albite; only in places can a suggestion of twinning be distinguished. Doubtless the original feldspar was more calcic in composition than the albite now present. The quartz, for the most part, occurs as fine granular aggregates interstitial to the feldspar. Technically there is hardly sufficient quartz to warrant calling the rock quartz diorite rather than diorite. Much chlorite is developed between quartz particles. A considerable amount of magnetite is present, some of it in skeleton forms associated with chlorite in such a way as to suggest that they were both secondary after some original ferromagnesian minerals.

The contact of this dyke with the enclosing rocks is interesting. In places it is quite sharp, especially against the rhyolite. Elsewhere in parts of the contact with the Normetal schist it is indefinite and somewhat gradational. In places, adjacent to the contact, rather conspicuous crystals of plagioclase are distributed at random throughout the schist, suggesting an origin through feldspathization by emanations from the quartz diorite magma. It is exceptional to have such feldspathization or granitization adjacent to such a small intrusive body. The condition may indicate that the dyke represents a conduit through which considerable volumes of magma passed to feed flows on a surface above or to provide magma for a large overlying intrusive mass.

#### Intrusive Rhyolite

Intrusive bodies of rhyolite were recognized in three localities in the area: one in the northwestern corner on lot 32, range II, Perron township, where irregular and sill-like bodies of rhyolite porphyry intrude andesite lavas; another in the region of the Normetal mine on lots 42 and 43, range X, Desmeloizes township, where rhyolite, in large part porphyritic, is exposed both on the surface and underground; and the third on lots 32 and 34, range X, Desmeloizes township.

The relations of the rhyolite porphyry in the northeastern part of the area are not simple. There is some brecciation of the rhyolite and adjacent andesite and there is a suggestion in the field in places that at least part of the rhyolite porphyry is a product of the granitization of the andesite. The rock has quartz phenocrysts, for the most part conspicuously opalescent, in a fine grained to aphanitic groundmass of quartz and feldspar. Some of the thin sections examined contain a few phenocrysts of feldspar. As far as could be determined, the feldspar throughout is orthoclase. It is considerably sericitized. A feature of much of the rock is the presence throughout the groundmass of tiny flakes of biotite which are of late magmatic if not metamorphic generation. The opalescent nature of the quartz phenocrysts is a suggestion of a possible genetic relation of this rock to the granite in the northern part of the area which also has opalescent quartz. However, the granite is plagioclase-rich and its satellitic dykes, in so far as observed, also have this character, whereas the feldspar of the rhyolite porphyry is predominantly orthoclase. This would lend some support to a lack of relationship but would not be conclusive evidence. However, the rhyolite porphyry generally, through its megascopic appearance and alteration, gives the impression that it is older than the granite. If so it could be related to the rhyolitic flows by having come from the same source.

The rhyolite porphyry in the region of the Normetal mine is exposed on the surface and has been encountered underground where the mass shows considerable irregularity in outline. It is intrusive into the Normetal schist and the dacite, and is intruded by the Normetal quartz diorite dyke lying just southwest of the ore body. In most hand specimens of this rock quartz phenocrysts can be seen and these sections show a sparse distribution of highly altered potassium feldspar phenocrysts. The groundmass consists essentially of fine granular quartz and feldspar. Much sericite and carbonate have been developed throughout. The general characteristics of this rock and the fact that it is intruded by the quartz diorite dyke suggest a considerable age for the intrusion. It may be an intrusive product of the same igneous activity that gave rise to the rhyolitic volcanic rocks. Wilson<sup>4</sup> cites the massive character of this rock, compared to that of the adjacent Normetal schist, which also contains lenses of vein quartz, as evidence that the rhyolite porphyry was intruded after the regional folding and metamorphism of the volcanic rocks which now represent the Normetal schist. The writer believes that the contrast in character is more probably the result of greater strength and resistance to metamorphism of the rhyolite porphyry compared to the relatively weak volcanic rocks and is not indicative of age relative to the regional folding.

The rhyolite in lots 32 and 34, range X, Desmeloizes township, is in contact with diorite, adjacent to a diabase dyke.

Granite

Granite occupies the northeastern part of the area and the same rock probably extends broadly to the north. It is grey in colour, of relatively fresh appearance, high in quartz and low in dark mineral. The quartz shows a tendency to be opalescent.

The mineral composition of a typical specimen (No. 15) determined by Rosiwal analysis is shown in Table 1 and its chemical analyses in Table 2. Quartz generally shows strained extinction and much of the quartz in the rock in the north part of lot 43, range II, Perron township, is somewhat fractured. The plagioclase is everywhere riddled with epidote-zoisite particles and sericite flakes. Its refractive index is now noticeably below balsam and probably it represents a saussuritized product of a more calcic plagioclase. The microcline is relatively unaltered. Rarely it contains a little perthitically intergrown albite. The biotite is brown in colour and is altered to chlorite to a variable extent; the biotite of the rock in the northern part of lot 43, range II, Perron township, is rather thoroughly chloritized but that of the rock in lot 45 shows relatively little chlorite. The common accessories are zircon, titanite and apatite. The zircon is surrounded by pleochroic haloes where it is included in the biotite or chlorite. Titanite is present only in small particles and some have cores of black iron oxide - probably ilmenite or titaniferous magnetite.

A number of dykes of porphyritic albite granite with maximum widths of 4 feet intrude the dacitic rocks along a zone just south of the Normetal mine. They are grey rocks with plentiful phenocrysts of quartz and feldspar in a fine grained groundmass. In one dyke small particles of biotite were noted but in others dark minerals are absent. The phenocrysts appear to be largely albite, but include orthoclase as well. Under the microscope the groundmass is seen to be a granular aggregate of quartz and alkalic feldspar. These dykes could be genetically related to the granite exposed in the northern part of the area. Their colour and general appearance suggest it and nothing can be observed microscopically that would disprove such an assumption. Their chemical character also lends support (See Table 2).

Miscellaneous Basic Intrusive Rocks

Small basic dykes, never more than 3 feet wide, collectively referred to in the field as lamprophyry, were noted in various places within the volcanic rocks. Usually they occur in swarms and are generally parallel to the structure of the enclosing rocks. They are most prevalent in the southwestern quarter of the area in the dacites

of ranges IX and X, Desmeloizes township. These rocks now consist essentially of hornblende, and range in texture from medium to coarse. A great amount of recrystallization, probably resulting in complete mineralogical reconstitution, is characteristic of these rocks. In none of those examined microscopically could the feldspar be determined. The most persistent of the dykes is traceable across lots 32, 33 and halfway across 34, range X, Desmeloizes township.

Small fine grained bodies, generally irregular in outline and greatly altered, are found on the surface and underground in the vicinity of the Normetal ore body. They are intermediate to basic in composition and because of their great alteration and irregularity in outline they are difficult to distinguish from the other rock units constituting the country rock. They consist of little else than carbonate, chlorite and sericite.

Table 1

ROSIWAL ANALYSES

Number .....	15	53	230	19
Quartz .....	38.3	--	2.2	--
Plagioclase ...	40.8	51.6	55.1	68.7
K-Feldspar ....	12.7	--	--	--
Biotite .....	8.3	trace	trace	trace
Hornblende ....	--	7.5	trace	--
Augite .....	--	38.6	39.1	18.0
Olivine .....	--	--	--	10.2
Magnetite .....	--	2.3	3.6	3.1
Apatite .....	--	trace	--	trace

15 - Granite in northeastern part of the area. Sample from outcrop 75 feet south of range line, lot 43, range II, Perron township.

53 - Diabase, large dyke in range II, Perron township.

230 - Abana diabase dyke. Sample from near centre of dyke in drift on 300-foot level Normetal mine.

19 - Olivine diabase, large east-west dyke, range I, Perron township.

Table 2  
CHEMICAL ANALYSES

	<u>229</u>	<u>15</u>	<u>14</u>	<u>230</u>
SiO <sub>2</sub> .....	47.39	71.69	68.93	49.88
Al <sub>2</sub> O <sub>3</sub> .....	13.94	14.03	16.61	13.88
Fe <sub>2</sub> O <sub>3</sub> .....	4.74	0.98	0.69	2.55
FeO .....	8.81	1.94	0.81	11.84
MgO .....	4.95	0.83	0.70	6.17
CaO .....	7.24	2.20	2.67	10.19
Na <sub>2</sub> O .....	3.43	4.36	5.73	2.36
K <sub>2</sub> O .....	0.03	2.17	1.27	0.41
H <sub>2</sub> O- .....	0.00	0.02	0.03	0.02
H <sub>2</sub> O+ .....	3.12	0.96	1.08	1.46
TiO <sub>2</sub> .....	1.78	0.28	0.26	1.02
CO <sub>2</sub> .....	3.96	0.28	1.20	0.13
P <sub>2</sub> O <sub>5</sub> .....	0.36	0.14	0.13	0.13
S .....	0.05	0.04	0.01	0.15
Cr <sub>2</sub> O <sub>3</sub> .....	0.00	0.00	0.00	0.00
MnO .....	0.33	0.42	0.21	0.29
NiO .....	<u>0.00</u>	<u>0.00</u>	<u>0.00</u>	<u>0.00</u>
Total .....	100.13	100.34	100.33	100.48

(x) By loss on ignition with corrections for CO<sub>2</sub>, FeO and S.  
Analyst Henri Boileau, Province of Quebec, Bureau of Mines  
Laboratories.

229 - Normetal quartz diorite. Sample taken from massive outcrop 100 feet south of Normetal mine office.

15 - Granite in northeastern part of area. Sample from outcrop 75 feet south of range line, lot 43, range II, Perron township.

14 - Albite granite porphyry. Sample from dyke 3 feet wide, 1,000 feet southwest of No.3 shaft Normetal mine.

230 - Abana diabase dyke. Sample from near centre of dyke in drift on 300-foot level, Normetal mine.

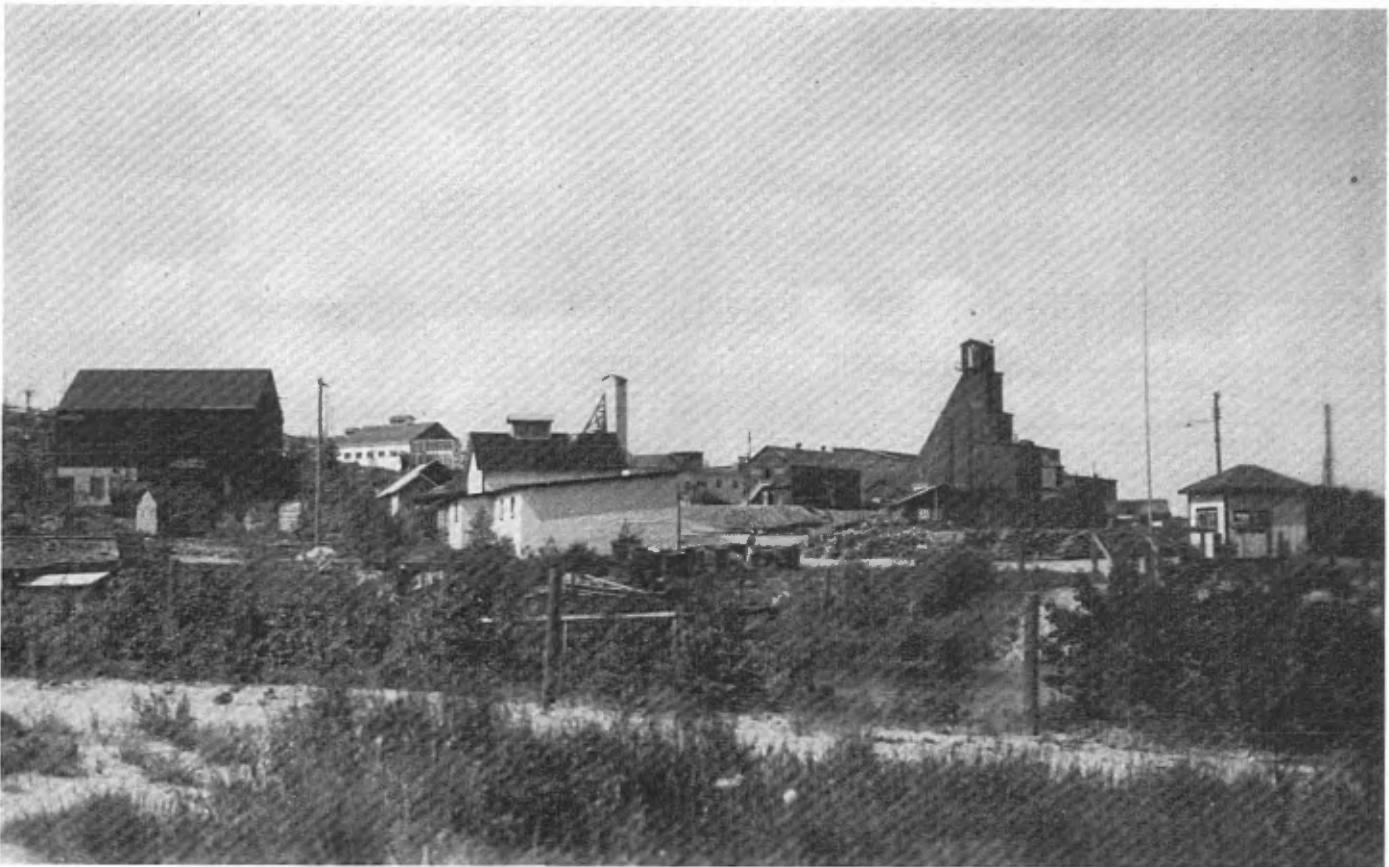
Late Precambrian Basic Dyke

Basic dykes, of the general types regionally distributed in this part of Quebec, occur in different parts of the area. They are gabbroic in composition, show generally a good development of diabasic texture and are relatively little altered. They cut all other rocks. It is possible that more than one age of intrusion is represented among

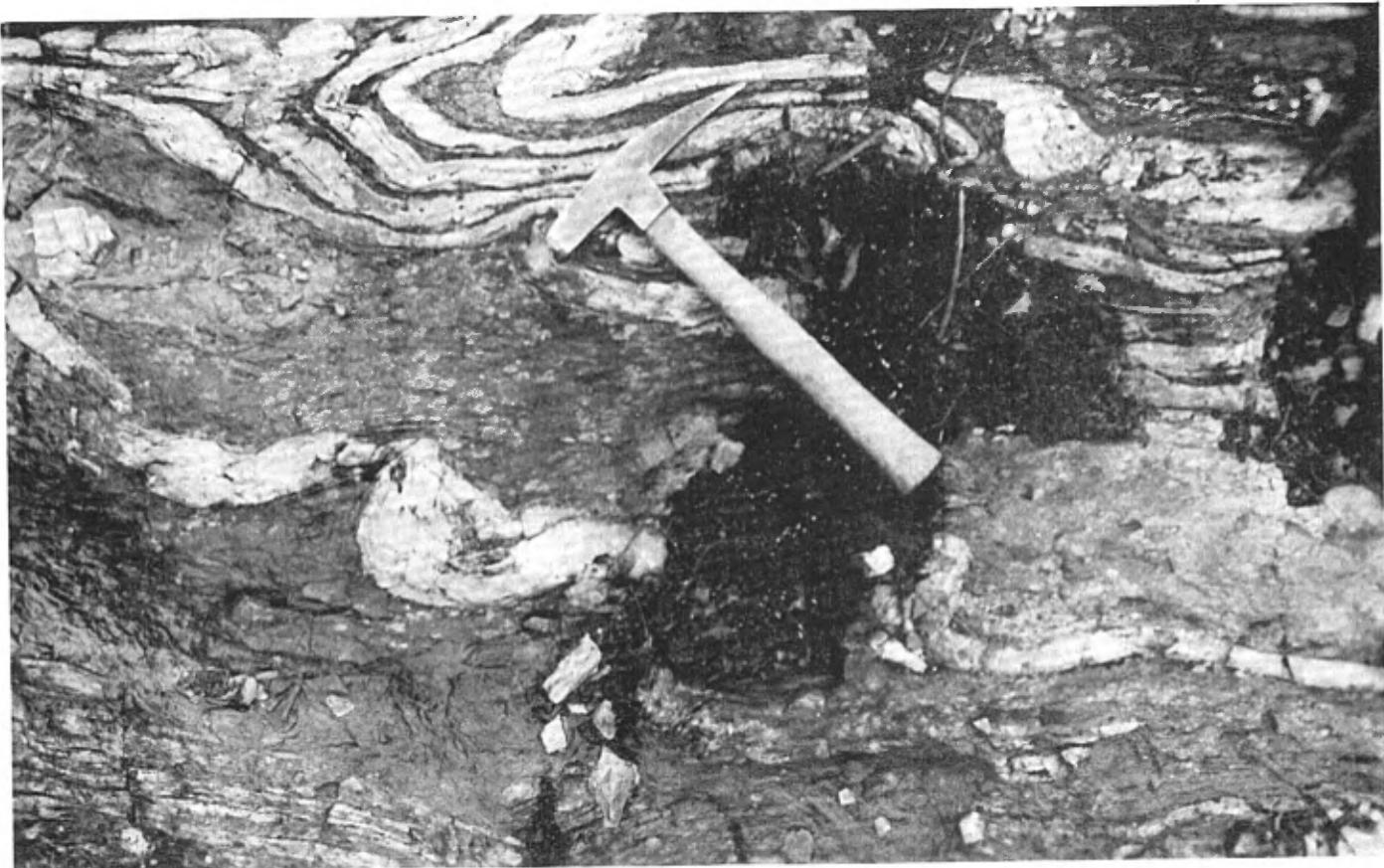
them, but no definite data bearing on the matter were obtained. Their strike is distinctive, being confined to the northeast quadrant, with most of the very thin dykes — not shown on the map — tending to strike almost due north. Three petrographic types may be distinguished: diabase, quartz diabase and olivine diabase.

The simple diabase is best represented in a prominent dyke trending about N.65°E. in the northwestern quarter of the area. Its exposures are largely confined to a series of hills of various sizes that stand up above the general lowland of this part of the area. Outcrops are found at intervals from the northern part of lot 36, range I, Perron township, to the northern border of the area on lot 46, range II, Perron township. It is in intrusive contact with volcanic rocks (largely andesite) and granite. The rock is medium to coarse grained with well developed diabasic structure. The mineral composition of a typical specimen (No. 53) is shown in Table 1. The feldspar is labradorite ( $Ab_{40}An_{60}$ ) and it occurs in well formed laths, relatively unaltered. They penetrate, and are molded around by, augite. Most particles of augite have been partly transformed around their borders to hornblende. Magnetite is a prominent minor constituent and commonly associated with it is a small amount of biotite. A few crystals of apatite can be seen.

The dyke encountered in the underground workings of the Normetal mine may be classified as a quartz diabase, although the percentage of quartz is small. This intrusion has long been referred to as the Abana dyke and is of special interest because it separates the Normetal ore body into two parts. A small exposure near the line between lots 45 and 46, southern part of range I, Perron township, is probably the same dyke. If such is the case its general strike is N.15°E. Southward along the projected strike from its occurrence in the mine workings no exposures are found within the area, but, beyond, a similar dyke with a like trend is exposed. The dyke is about 190 feet wide where encountered underground and appears to dip steeply to the east. In the exposure in range I, Perron township, its full width is not exposed. The rock is dark brown on the weathered surface and slightly greenish dark grey or black when freshly broken. Texturally the quartz diabase resembles the diabase described in the previous paragraph. The mineral composition, determined by Rosiwal measurements of a type thin section (No.230), is shown in Table 1 and its chemical composition in Table 2. The feldspar is practically unaltered and is determined to be labradorite with the percentage composition  $Ab_{40}An_{60}$ . Very little hornblende has developed by attack on the edges of the augite. A few very small flakes of biotite are present. The quartz is strikingly interstitial to the other constituents. Some of it is in worm-like intergrowths with feldspar. A small amount of magnetite and yet smaller amounts of apatite are present.

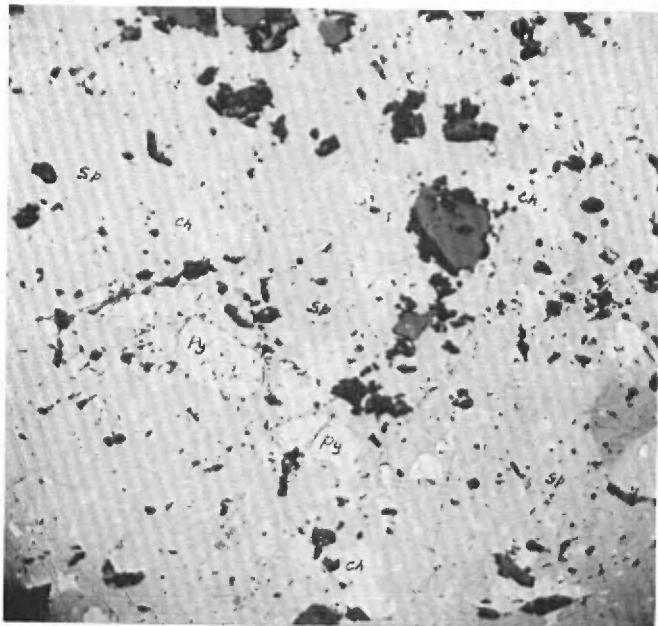


Surface plant of the Normetal Mine. Note the headframe of shaft No 2 (flying flag) with mill adjacent. The headframe of shaft No 3, partially enclosed, is to the left. The headframe of shaft No 1 has been taken down.



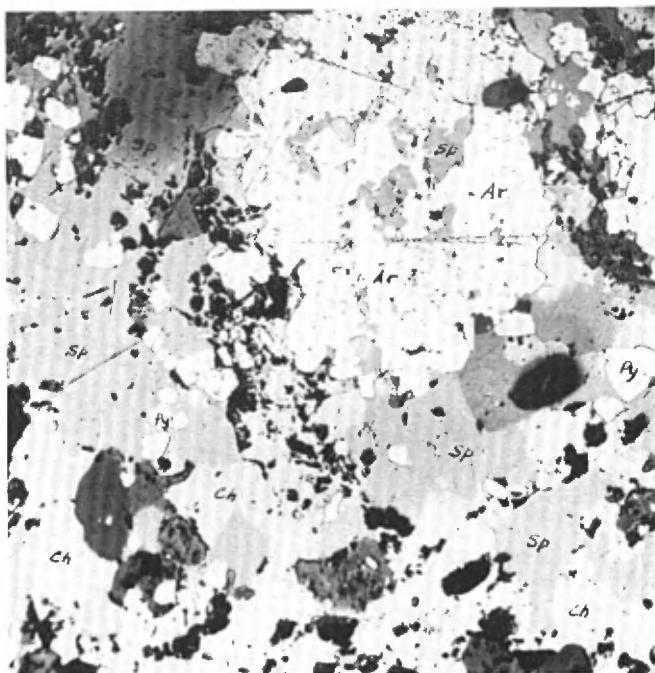
Banded and laminated iron formation in dacite. The contortions are noteworthy.

PLATE III



Sphalerite (grey) showing included chalcopyrite (white low relief).  
Pyrite, white with high relief. X 65.

PLATE IV



Large area of arsenopyrite (Ar) invaded by sphalerite (Sp). Scattered crystals of pyrite (Py). Large areas of chalcopyrite (Ch). X 65

The olivine diabase is best represented in a dyke about 125 feet wide trending just north of east in the southern part of lots 43, 44 and 45 in range I, Perron township. About 1 1/2 miles to the west, along the strike, an identical dyke trends across lots 32, 33 and 34, range X, Desmeloizes township. This rock is a conspicuous light reddish brown on weathered outcrops and dark grey when freshly broken. Its mineral composition is shown in Table 1. Diabase structure is strikingly developed. In thin section the olivine is conspicuous and shows the characteristic fractures of this mineral with a small amount of serpentine along them. Some olivine is enclosed in augite. No hornblende can be seen, but there is a scanty development of brown biotite, usually in close association with magnetite. Apatite is also present as an accessory and it is much more prominent than it is in the other varieties of diabase.

#### STRUCTURAL GEOLOGY

The rocks of the area dip steeply, generally about 80° to the northeast. The general strike is about N.65°W. but becomes more nearly northwest in the northwestern part of the area. Available data indicate that the structure is a monocline throughout with tops to the south. The best structural determinations were obtained in pillows in dacitic flows in the southern part of lots 43 and 44, range I, Perron township, and in the southern part of lot 51, range IX, Desmeloizes township. These observations are supported by some generally distributed but less definite determinations on pillows, gradation in grain relations and flow cleavage bedding relations. Preliminary observations of aeroplane photographs suggested, by the distribution of outcrops, the presence of a large drag fold in the region of the Normetal mine. However, careful mapping of the rock units did not substantiate the assumption; the simple monoclinal structure appeared to persist.

Most of the faults or shear zones are parallel to the regional strike. Movement of this kind was no doubt initiated at the time of the close folding of the volcanic rocks and would in part at least represent the adjustment necessary between different flows and other rock units involved consequent on the folding of such a thick sequence. Such movement would be concentrated at weak horizons or at contacts in the case of a sequence of strong flows or other rocks. Later stress, or its component, operating in the same direction as that which caused the folding, would also tend to be relieved by movement along the same structures, which would constitute zones of weakness. All the mineralization noted in the area was confined to such strike faults or shears. In the case of the Normetal deposit the strike shear was confined to a weak bed of volcanic fragmental rocks termed the Normetal schist in this report.

Cross faults in the area are of later generation. The most obvious pattern of fracturing is indicated by the distribution of the late Precambrian basic dykes which presumably occupy fractures along which there may or may not have been movement. Their trend is notably in the northeast quadrant. In addition, small faults offsetting dykes and contacts a few feet can be seen in many places, but no evidence of large displacements is found on the surface. Underground at the Normetal mine, the ore body is seen to be offset about 150 feet to the left by faulting along the site of the Normetal late Precambrian basic dyke. The available evidence, though contradictory, supports the assumption that the dyke is later than the mineralization. Faulting within the dyke, indicated by a sheared and brecciated zone 20 to 30 feet wide near its east side, has occurred; it is not clear to what extent the offset of the ore body is due to movement along the site of the dyke before emplacement and consolidation of the dyke material or to movement afterwards which resulted in the shearing and brecciation. The movement was doubtless recurrent, the initial movement producing the fracture up which the dyke material came and later movements producing the sheared and brecciated zone in the dyke. An even later movement may be represented in the fracturing of No.3 ore zone, adjacent to the dyke, which has resulted in a considerable flow of surface waters in the upper levels. Other cross faults of relatively small displacement which offset the ore body are encountered underground and these are, with few exceptions, of the right hand variety. The distribution of the outcrops of the prominent diabase dyke in the northwestern part of the area suggests that the dyke has been offset by faulting or that it is quite sinuous in trend. Detailed mapping of the outcrops shows that the latter is more probable.

#### ECONOMIC GEOLOGY

The prevailing type of mineralization in the area is represented by replacement deposits, essentially of pyrite, with in places variable amounts of chalcopyrite and sphalerite, along shear zones generally roughly parallel to the regional structural trend. Gold and silver have been found in some of these shear zones, but at no place have they alone been great enough to warrant development. So far only at the mine of the Normetal Mining Corporation has sufficient concentration of chalcopyrite and sphalerite been encountered to permit their economic exploitation.

Normetal Mine

Discovery and Development

The property of the Normetal Mining Corporation Ltd. comprises 21 mineral claims as follows: Desmeloizes township, range IX, north half-lots 41, 42, 46 and 47; range X, south half-lots 38 to 45 and north half-lots 36, 37, 38, 44 and 45; Perron township, range I, south half-lots 34 to 37. The mine is located in lots 43 and 44, range X, Desmeloizes township, 12 miles north of Dupuy on the Canadian National Railway from which it is reached by a standard gauge tramway and a gravelled motor road.

Following its discovery in the spring of 1925, the property was optioned by Canadian Exploration Limited. In the same year, it was transferred to Abana Mines Limited, who, in the course of the next 5 years, developed the mine to the 500-foot level; but in 1930 operations were suspended because of prevailing low metal prices. The property was taken over by the Normetal Mining Corporation Limited in 1931. A mill with a capacity of 250 tons, partially installed by the former owners, was completed and milling was started in September, 1937. From time to time the milling capacity has been increased, reaching about 650 tons per day in 1941, with plans for a further increase to 775 tons early in 1942. The standard gauge tramway from the mine to the Canadian National railway at Dupuy was completed in December, 1937. The mine has been developed by 3 shafts: No. 1 to 300 feet with three levels; No. 2 to 900 feet with 7 levels; and No. 3 to 2000 feet plus sump, with connection to older levels and opening 15 levels in all. Preparations have been made to deepen No. 3 shaft by 750 feet. Power is supplied by LaSarre Power Company, and is supplemented by an auxiliary diesel-driven plant installed in 1937 and since enlarged.

Copper concentrates are shipped to the smelter of Noranda Mines Limited. Zinc concentrates were shipped formerly to European smelters but after the outbreak of the war they have been sent to the United States. Published data on production since the mill started operating in 1937 are as follows:-

Normetal Mine Production, 1937 to 1949<sup>(\*)</sup>

Year	Tons Milled	Copper Concentrates			Zinc Concentrates		
		Tons	Metal Recovered		Tons	Metal Recovered	
			Copper (pounds)	Gold (ounces)	Silver (ounces)	Zinc (pounds)	
1937	20,843	1,819	724,820	280	34,798	2,900	2,655,677
1938	110,685	11,004	4,700,192	1,998	231,712	18,312	14,110,428
1939	131,037	13,316	6,212,560	2,416	297,590	16,658	18,076,553
1940	167,631	20,624	9,875,846	2,928	378,244	17,925	19,911,059
1941	209,286	23,634	10,936,658	3,412	488,515	28,171	30,506,413
1942	255,676	30,274	14,177,137	3,899	404,461	23,454	24,788,062
1943	205,020	26,826	12,448,168	3,291	268,528	14,745	15,221,966
1944	192,994	25,996	11,777,152	3,623	286,709	16,528	17,623,897
1945	204,067	31,040	13,867,836	4,380	353,543	19,831	20,858,378
1946	186,634	25,337	11,329,423	3,955	327,621	20,508	21,688,067
1947	209,310	28,562	12,877,613	4,158	345,743	21,599	22,515,278
1948	236,844	26,397	11,802,929	3,745	341,070	30,316	31,583,379
1949	292,235	34,500	15,171,668	4,725	434,199	34,562	35,392,216

(\*) Production figures have been completed up to date of publication -  
Editor.

All the production has been from ore zones Nos. 1 and 2, west of the Abana dyke. These are parallel ore zones, about 50 feet apart near the surface, which come together about the 550-foot level and from there down persist as one ore body.

The deeper levels show a progressive improvement with depth. The following data, from the annual report of the company for 1939, illustrate this tendency which continued in yet deeper levels than those indicated, with the result that the 2,000-foot level is the best so far developed.

Average Grade (per cent)

<u>Level</u>	<u>Copper</u>	<u>Zinc</u>	<u>Width</u>	<u>Length</u>
935-foot	1.79	10.18	11.9 ft.	416 ft.
1,085-foot	1.62	6.72	10.4 ft.	521 ft.
1,235-foot	3.24	4.07	10.8 ft.	578 ft.
1,385-foot	3.91	2.41	14.0 ft.	653 ft.

Most of the development work done to date has been in ore zones Nos. 1 and 2, west of the Abana dyke. Development has been carried east of the dyke to the No. 3 ore zone on the 300-, 550-, 800- and 1400-foot levels. No. 3 ore zone is the eastern end of the ore body represented by zone No. 1 and No. 2 that has been offset to the north by faulting along the site of the Abana dyke. The relative position of the three ore zones is shown in the geological plan of the 300-foot level,(Plan No. 682) page 23. Although mineralization of ore grade was encountered in zone No. 3 on the 300- and 550- foot levels, there has been no production, largely because of difficulties in concentrating the ore. The ore is rather intimately fractured, allowing considerable flow of oxygenated surface waters. The small amount of oxidation of the ore adjacent to the fractures may be the cause of the difficulties of concentration. The little exploration done on the 800-foot and 1,400-foot levels disclosed mineralization which was not of ore-grade but which was encouraging in that it showed none of the detrimental features of the ore of the same zone in the higher levels.

#### Geology

The mine is located on the eastern flank of a broad ridge about 2 miles long which trends northwest. The shafts are near the base of the ridge and to the northwest of them the ground rises about 100 feet in a distance of 500 feet to the broad summit; to the southeast it falls off about 45 feet in the same distance. Outcrops are plentiful on the southern and southeastern slope of the ridge. The rock is rarely overlain by any considerable thickness of drift. Areas of thicker drift separate less prevalent outcrops on or near the summit of the ridge. Down the flank southward from the mine shafts the thickness of the overburden increases rapidly and about 450 feet distant it is reported to be of the order of 200 feet. About 1,000 feet southeast of the shafts some rock is exposed in a low hill rising above the relatively flat heavily drift-covered lowland. Rock exposures are plentiful from the mine shafts westward for 800 to 900 feet. The area of exposures extends a few hundred feet to the north, widening to the northwest along the side of the ridge.

The country rock of the Normetal ore body is sericite and chlorite schists which, in large measure at least, represent metamorphosed volcanic fragmental rocks. This belt of rocks has been termed the Normetal schist and has been recognized, in scattered outcrops, to extend from the mine for about 6,500 feet to the northwest before giving way to a large area devoid of outcrop. Southeast of the mine, except for one outcrop 1,500 feet distant, the area seems devoid of outcrop. The general strike of these rocks is N.65°W. The dip is 80° to 85° northeast with the schistosity and shearing generally

parallel to it. Just west of the mine the Normetal schist has a thickness of 700 feet. To the northeast is a band of bedded and laminated siliceous sediments which in turn gives way to sericitized rhyolite. To the southwest there is some intrusive rhyolite and the Normetal quartz diorite dyke and then dacitic volcanic rocks of wide extent. In the dacitic rocks about 900 feet southwest of the mine there is a zone with narrow granite porphyry dykes. These dykes extend 6,500 feet northwest, where some of them have encroached on the Normetal schist.

The dominant rocks of the Normetal schist are fine grained sericite and chlorite schists. The sericite schists are more prevalent in the southwestern part of the band near the Normetal ore body and chlorite schists prevail to the northeast. A bed of more or less schistose siliceous agglomerate about 25 feet wide on the surface was the most favoured rock for replacement by ore-bearing solutions. The ore body occurs in it and in the rock closely adjoining, generally sericite schist which represents most likely a metamorphosed volcanic fragmental rock finer grained than the agglomerate. Among the sericite schists, chloritoid, garnet, and cyanite bearing varieties were distinguished. They have been described in the section on geology. The chloritoid sericite schist is the most extensively developed of the three and is common underground and on the surface throughout the exposed length of the Normetal schist belt.

In places the massive intrusive rhyolite constitutes the footwall of the ore. This relation is seen in the western part of the ore body on almost all the levels. In places the ore cuts across irregular extensions of rhyolite, but at no place was the ore body observed to extend noticeably into the main mass of this rock. In other parts of the mine the footwall as well as the hanging wall is the fine grained sericite schist representing metamorphosed volcanic fragmental rocks.

The Normetal quartz diorite dyke, about 30 feet wide, which is parallel to the ore body on the surface, about 40 feet to the southwest, pinches and swells somewhat with depth but at no place does it become involved in the mineralization. It is close to the footwall on the 1,400-foot level, but at the 2,000-foot level it has decreased greatly in thickness and lies over a hundred feet southwest of the ore body.

Small areas of fine grained highly altered material of somewhat irregular outline can be distinguished within the Normetal schist on the clean outcrops southwest of the mine as well as underground in the mine workings. The material is schistose, but usually not as much so as the Normetal schist, and it weathers a dark brown.

## INTRUSIVES - ROCHES INTRUSIVES

	Abana diabase Diabase de la Mine Abana
	Normetal quartz diorite Diorite quartzifère de la Mine Normetal
	Rhyolite intrusive Intrusion de rhyolite

## VOLCANICS - ROCHES VOLCANIQUES

	Acid tuffs Tufs acides
	Coarse conglomerate Conglomérat à gros grains
	Undifferentiated tuff and agglomerate Tuf et agglomérat non-différenciés

## MASSIVE ORE - MINERAIS MASSIFS

	Copper predominant Cuivre prédominant
	Zinc predominant Zinc prédominant
	Pyrite predominant Pyrite prédominante

No.2 Shaft  
Puits No.2

Geology by Carl Tolman, 1941. — Géologie par Carl Tolman, 1941.

No.1 Shaft  
Puits No.1GEOLOGICAL PLAN  
300' LEVELINFORMATION BY COURTESY OF  
NORMETAL MINING CORPORATION0 40 80 120 160 FEET  
SCALE — ÉCHELLEPLAN GÉOLOGIQUE  
NIVEAU 300'RENSEIGNEMENTS PAR COURTOISIE DE  
NORMETAL MINING CORPORATION

The microscope shows the rock to be highly carbonated and to consist of little else than carbonate, sericite and chlorite. The masses are interpreted to be highly altered intrusives of medium to basic composition. Whatever their origin, they are inhospitable to metallic mineralization and, where encountered by the vein, constitute barren horses or areas of very lean mineralization. Such relations are very well seen on the 1,400-foot level.

A quartz diabase dyke, called the Abana dyke, lies between two parts of the ore body, ore zones Nos. 1 and 2 to the west and ore zone No. 3 to the east. Where exposed by the mine workings the dyke is about 190 feet wide and strikes a few degrees east of north. Faulting has occurred along the site of the dyke with the result that the ore has been offset about 150 feet to the left. This condition is well illustrated in the geological plan of the 300-foot level (map No. 682, page 23). Some movement along the dyke after its consolidation is indicated by a brecciated and sheared zone within it near its eastern margin. It cannot be said whether this wholly accounts for the offset suffered by the ore body.

#### Relation of Abana Dyke to the Mineralization

A significant point is whether the Abana dyke is older or younger than the ore body. Most ore deposits in western Quebec, through their areal distribution and structural and petrographic relations with respect to granitic intrusives, are thought to be genetically related to such intrusive bodies, usually in the sense that the mineralizing solutions were related in depth to the magma that gave rise to the igneous body. The regionally distributed diabase dykes such as the Abana dyke are much younger than any recognized epoch of granite intrusion, so that if the Normetal ore body is younger than the dyke some interesting and very significant possibilities present themselves.

Assuming that the mineralizing solutions which gave rise to the deposit are later than the diabase dyke, they might, either be related to granitic activity later than the dyke or they could be related in depth to the magma that gave rise to the diabase dyke. It does not seem likely that a period of granitic igneous activity and associated mineralization, later than the diabase dyke, could have escaped detection in this part of Quebec. If the ore body is later than the dyke, a genetic relation at depth to the magma giving rise to the dyke would seem more probable. This would imply the mineralizing solutions coming up only shortly after the dyke and during the same epoch of igneous activity. The diabase magma must have been widespread, judging from the presence of dykes in all parts of the region, so that a genetic relation to it would present extensive possibilities for the

occurrence of such ore deposits. Since the dykes are derived from the deeper magma, the general locality of such dykes might be considered favourable for the occurrence of an ore deposit, because the mineralizing solution forming it would also be derived from the same magma reservoir. If the structure were favourable for the emplacement of one it might well be favourable for the other.

A north-south diabase dyke traverses the ore body of the Horne mine at Noranda in a similar manner to the dyke at Normetal. Wilson<sup>4</sup> has recently considered the relation there as well as at Normetal and at other sulphide deposits in western Quebec. He concludes that the evidence, although conflicting, is more favourable to the hypothesis that the ore in each case was deposited after the diabase dykes were intruded. The strongest support at the Horne mine for this conclusion, as pointed out by Wilson<sup>4</sup> and earlier investigators<sup>5</sup>, is that in a number of places tongues of ore 18 inches to 3 feet wide penetrate the dyke for a distance ranging from 4 to 8 feet and in some localities the ore is in contact with coarse diabase. However, on the contrary, generally the dyke displays a chilled edge against the ore, giving an abrupt contact such as would be the case if the dyke were intrusive into the ore. Any veining of the dyke by ore, even on a minute scale, is local and exceptional. It is suggested that a certain amount of penetration of the dyke by sulphides could result from the intrusion of the ore body by the dyke, and that some melting and migration of the ore could be expected to be brought about by the heat of the magma. Such an explanation may not be adequate to account for the sizeable tongues of ore in the dyke that have been described, even though they are very few.

The detailed relations of the diabase dyke to the Normetal ore body have been exposed relatively little in the underground workings. Ore occurs on the two sides of the dyke as zones No. 1 and 2 on the west and zone No. 3 on the east side. Zone No. 3 lies about 150 feet north of the place where the mineralization would be if zones No. 1 and 2 were extended along their strike across the dyke. Offset of the ore body by faulting along the site of the dyke is suggested and receives confirmation by the recognition on the 300-foot level of the quartz diorite dyke closely paralleling the ore on the southwest in the same relative position on both sides of the dyke (See plan No.682, p.23). A narrow zone of shearing exists in the dyke along its eastern border, so it is not clear whether the offset was caused by movement before the emplacement of the dyke or afterwards or at both times. The ore body on the two sides of the dyke, although of the same type, does not match in detail to the extent that would be expected if the offset were brought about solely by horizontal movement. There may well have been considerable vertical component to the movement, so that different

levels of the deposit as it was formed are now in juxtaposition on opposite sides of the dyke. This would effectively explain any discordance in detail of the ore body on the two sides.

In the available exposures the general impression is certainly conveyed that the dyke is later than the ore. This comes principally from the abrupt cross-cutting relations of the dyke and the fact that it displays chilled edges not only against adjoining rocks but also against the ore. Little can be added to the observations of Mawdsley<sup>1</sup> bearing on the chilling of the dyke against the ore, the presence of small off-shoots of the dyke apparently cutting the ore, and the existence of some small tongues and veinlets of pyrite in the margins of the dyke. Mawdsley accounts for the latter by assuming that the pyrite was incorporated by the dyke as it cut through the ore body. If the dyke were earlier than the mineralization, to account for ore bodies on both sides of it would mean, as pointed out by Wilson<sup>4</sup>, that the ore-bearing solution rose from depth independently on either side of the dyke, which formed an effective barrier to replacement. This is not easy to visualize.

The evidence at Normetal, in the opinion of the writer, indicates strongly that the dyke is younger than the mineralization but it does not present positive proof, especially in the light of relations described in similar deposits in western Quebec, such as those at the Horne mine. In any event the occurrence of the Normetal ore body and other ore bodies, in the vicinity of cross-cutting diabase dykes, may be something more than fortuitous. On this rather hypothetical basis, failing controverting evidence, the intersection of a mineralized shear and such a dyke may be considered possibly favourable for the localization of ore, and prospecting operations be governed accordingly. Conceivably the dyke, if it were younger than the ore, may have occupied an early zone of weakness or ancestral fault or other structure that directed the movement of ore-bearing solutions and influenced the deposition of mineral from them. If it were older, the favourable structural intrusion of the dyke may have still obtained after the emplacement of the magma and influenced the localization of the ores, or the presence of the dyke may indicate the availability of mineralizing solutions if they both evolved from the same magma at depth.

#### Structural Features

The dominant structural feature of the deposit is a strike shear zone (strike N.65°W., dip 80° northeast) in which the ore body occurs within the steeply dipping Normetal schists. This has

been interrupted by the late Precambrian Abana diabase dyke along the site of which cross faulting has taken place. Movement along this fault, which offset the ore body about 150 feet to the left, may have taken place along a fracture before the emplacement of the dyke. Movement after emplacement is indicated by a sheared zone in the dyke along its eastern border. Cross faults, at various angles to the ore body, are recognized in the underground workings. Most are the right hand variety. Their displacement in every case appears small. One of the most persistent of these cross faults strikes due north with almost vertical dip and is well exposed at the end of the crosscut from No. 2 shaft on the 800-foot level. It is indicated on the levels immediately above and on the levels below either as a single fault or a series of closely spaced faults. Maximum horizontal offset has been about 15 feet to the right. A vertical component to the movement is definitely indicated. The fault is well exposed on the 1,400-foot level, where it intersects and displaces a minor fault of the left hand variety which strikes due east.

#### Mineralization

The most prevalent metallic minerals of the deposit are sphalerite, chalcopyrite and pyrite. Some streaks of pyrrhotite traverse the massive chalcopyrite and they seem to be more prevalent with depth. Small amounts of galena can be rarely seen. Arsenopyrite is another sparsely disseminated mineral. There is a well marked tendency for each of the major sulphides - sphalerite, chalcopyrite, and pyrite - to occur separately in both massive and disseminated bodies accompanied by relatively minor amounts, if any, of the other sulphides, rather than to occur together as intimate mixtures of important amounts of all three. As a consequence, it is possible to satisfactorily map the ore body throughout in terms of ore in which each of the three major sulphides is dominant. In this connection see the geological plan of the 300-foot level, p.23. No.1 ore zone, which on the surface is parallel to No. 2 ore zone about 40 feet to the northeast, is rich in chalcopyrite, contrasting with No. 2 which is relatively rich in sphalerite. Below the 550-foot level, where the two ore zones come together, the same mineralogical distinction continues in that ore with dominant sphalerite occurs along the footwall and chalcopyrite ore along the hanging wall. A considerable tonnage of massive pyrite as well as disseminated pyrite is indicated in all three ore zones. Although the pyrite bodies do not show as great consistency in their distribution as the chalcopyrite- and sphalerite-rich bodies, statistically they favour the footwall part of the ore body. In ore zone No. 3 the distribution of the different sulphides relative to the walls is not so clear, but the zone has only been opened up on a few levels and exploration has at no place been extensive.

Studies of polished sections supplied additional information on paragenetic relations. Pyrite and arsenopyrite are the earliest of the sulphide minerals. (Plate II-B). In places arsenopyrite shows up in conspicuous elongated crystals, but polished sections showed that it has a wider distribution, although never in more than very minor amounts, than could be suspected from megascopic observations. For instance, a number of different specimens of rich sphalerite ore, which in the hand specimen showed scattered small particles of pyrite, on examination of the polished section showed the presence also of a few scattered particles of arsenopyrite. An exceptional specimen of massive sulphide, collected from a development face on the 1,500-foot level, which in the hand specimen appeared to be pale coloured pyrite, was determined in polished section to consist of rather fine grained pyrite and arsenopyrite in intimate association. The two minerals were distinguished by a colour difference and by the anisotropic character of the arsenopyrite. This was the only instance in which pyrite and arsenopyrite were noted in contact and the contacts were indecisive as far as age relations were concerned. The earliest of the remaining sulphides is sphalerite. Rarely does this mineral occur without at least some included chalcopyrite, usually in very small particles, (Plate II-A) and its relationship with the chalcopyrite suggests that the two were deposited contemporaneously. However, the bulk of the chalcopyrite, such as the massive bodies, was probably deposited after the deposition of the sphalerite had ceased, so that the period of chalcopyrite mineralization was relatively long, its earliest part overlapping the latter part of the sphalerite mineralization. The small size of the chalcopyrite inclusions and their general distribution suggests that their presence may be due to exsolution, but a geometric arrangement of the inclusions such as is common in such cases was not recognized. Pyrrhotite is closely associated with the massive chalcopyrite and its deposition appears to have been late in the chalcopyrite period and shortly following it. Galena is the latest of the sulphides. It was noted by the writer in only a few places. Where observed, it was associated with quartz at the footwall of the zinc ore body. It has been reported that samples from the zinc ore body, in some levels at least, show increased amounts of lead as the footwall is approached. From the writer's observation, however, the impression was gained that the galena was somewhat erratic in distribution. In none of the polished sections of massive zinc ore was galena observed.

Quartz is associated with the sulphide mineralization in places, but the amount is relatively small and altogether it is an inconspicuous component, especially in the massive sulphides. Its deposition was either recurrent or continuous throughout the mineralization period. Some quartz lenses in the schist country rock are earlier than the main sulphide mineralization and some appear to have accompanied the late sulphides.

Wall rock alteration is inconspicuous and has taken the form of sericitization, chloritization, and carbonatization. Previously the same general processes, acting on volcanic rocks during regional metamorphism, had produced the country rock, the Normetal sericite-chlorite schist, so that the action of the mineralizing solutions was simply to intensify and carry further toward completion changes already initiated. The most noticeable result is a tendency for the products — sericite, chlorite, and carbonate — to be somewhat coarser in grain. In places some especially coarsely crystallized chlorite was noted associated with massive chalcopyrite. The chlorite is almost black in colour and could off hand be easily mistaken for biotite. The mineral is characterized by extremely low birefringence; anomalous interference colours are common. In this regard it differs from the more generally distributed chlorite resulting from regional metamorphism. Exceptionally the country rock was noted to have been wholly converted to this chlorite and associated carbonate. The result, in places, is more or less segregation of the constituents, with the formation of fairly distinct rounded carbonate-rich areas up to a few inches in diameter surrounded by chlorite-rich material. Sericitization resulting from the action of the mineralizing solutions is even more difficult of recognition. Carbonate is prevalent in the rock adjoining the ore body and is usually present as a dissemination or as irregular patches of various sizes.

Chloritoid, because of its occurrence in the country rock exposed in the mine workings, has been regarded to be a product of the mineralization. However, the present work shows that such is not the case, for the mineral is not limited in its distribution to the vicinity of the ore body. It was found along a horizon extending the full exposed length of the Normetal schist belt, and also in the sericitized rhyolite lying to the north. Furthermore, its occurrence as relatively large crystals, oriented at random with no regard to the schistosity, is the normal one for chloritoid porphyroblasts in a schist resulting from metamorphism of material containing abundant alumina and a sufficiency of iron oxide.

Cyanite, another mineral characteristic of the metamorphism of highly aluminous rocks, was also recognized in a number of specimens of the wall rock, but in all these it had the random orientation and general character of porphyroblasts. However, Wilson<sup>4</sup>, noted crystals of cyanite up to 1 inch long in the east drive along the ore zone on the 675-foot level. It may be that this coarse crystalization was induced by the mineralizing solutions. Probably in the same category is some coarse red garnet observed on the 800-foot level. It is associated with fine grained quartz, sericite, and chlorite. Thin sections show the garnet to be altered to chloritic material along fractures and it is also penetrated by veinlets of chalcopyrite.

Possibilities

The fundamental factors involved in the localization of an ore body are first of all the availability of a solution carrying the mineral matter, then a suitable structural condition, such as a shear, that would allow the passage of the mineralizing solutions, and finally physical and chemical conditions that would cause the precipitation of the mineral matter. The known ore in the Normetal property is confined to replacement deposits in a strike shear within the Normetal schist. This shear, since the requisite conditions for the formation of an ore body are present in it, should serve as a primary guide to future exploration. The increasingly favourable showing of the lower levels of the mine augurs well for yet deeper development. Exploration of the shear along its strike in both directions from the mine presents important possibilities. To the east, ore zone No. 3 has been probed only on a few levels. Southeastward from the dyke, in the light of the improvement in mineralization noted at depth, exploration on the strike of the shear has added attractiveness. Unexplored possibilities also exist along the shear immediately to the northwest of the mine. Beyond the outcrop in the vicinity of the mine and near the northwest corner of the south half lot 42 the horizon of the shear passes into the property of the Central Mining Corporation. The same horizon is distinguishable yet farther along, in the large outcrop on the north halves of lots 36, 37 and 38, where the Normetal Mining Corporation has done some trenching and diamond drilling, apparently without much encouragement.

Parallel ore bodies are likely to occur. A regional stress may be relieved along a number of parallel faults or shears rather than a single one and more than one of them may constitute a suitable passage way for the mineralizing solution and a favourable site for deposition of its mineral. There is no indication of parallel mineralization in the large outcrop in the region of the mine nor in the underground crosscuts. However, the fact remains that the mineralization so far noted throughout the area is related to shears or faults parallel to the structural trend. An interesting possibility exists on Normetal property north of the mine where two mineralized zones have been found on the north half of lot 43. If these zones persist they should intersect the Normetal diabase dyke. There is some question of the relation of the dyke, if any, to the localization of the Normetal ore body, a matter that has already been discussed at some length. Whatever the relation may be, the fact remains that the mineralization at Normetal does occur in the shear near its intersection with the dyke and a similar condition obtains at the Horne mine and elsewhere. This is sufficient to suggest the desirability of investigating other mineralized shears in the vicinity of their intersection with the dyke.

Central Mining Corporation

Central Mining Corporation controls 5 claims adjoining Normetal as follows: North half of lots 39 to 43 inclusive, range X, Desmeloizes township. The northwestern part of the property is underlain by the sericitized rhyolite and southwest of it in turn the laminated tuff, the Normetal schists and dacites can be distinguished. The Normetal quartz diorite, which intrudes the Normetal schist and is parallel to the Normetal ore body a few feet south, is exposed on lots 40 and 41. Two late Precambrian diabase dykes 5 or 6 feet wide, trending slightly east of north, occur in the southern part of the north half of the same lots.

An interesting feature of the property is that the southwestern part lies across the probable northwestern extension of the Normetal shear zone. This horizon in the Normetal schist should enter the property near the southwest corner of the claim comprising the north half of lot 42 and continue diagonally across the property to its western border, a distance of about 3,000 feet. Some outcrops show the presence of the Normetal quartz diorite sill-like body, and sheared and altered Normetal schist adjacent to it on the northeast, in the same relative position as the quartz diorite and the shear zone at the Normetal mine. Although the rock is characteristically altered, appreciable sulphide mineralization has not been exposed.

Two other mineralized zones occur on the property. Both are in the sericitized rhyolite northeast of the Normetal zone. One is about 600 feet north of the southeast corner of the property and is exposed in an outcrop adjacent its eastern boundary as a narrow shear mineralized sparsely by pyrite and traces of chalcopyrite and sphalerite. It is reported to have been intersected by diamond drilling at intervals across lots 42, 43 and part of 41, but with no improvement of mineralization indicated. Most of the holes intersected the mineralized zone at depths of less than 300 feet but one deep hole is reported to have cut it at a depth of over 900 feet. Extension of the zone along its strike to the southeast into the Normetal property is obscured by overburden. If it persists, it would intersect the Normetal late Precambrian diabase dyke, as interpolated between the mine and its exposure in lot 45, range I, Perron township, near the line between lots 44 and 45. The second zone does not outcrop and, according to Paul D'Aragon<sup>6</sup>, it is parallel to the one just described and lies about 500 feet northwest. It is reported to have been intersected by 2 drill holes near their collars and to consist of heavy iron sulphide presumably with little or no copper, zinc or other values. The reported strength of the mineralization affords some justification for exploration of the zone in either direction along its strike. The analogy of the Normetal ore body, where massive iron sulphide bodies

occur distinct from chalcopyrite and sphalerite ore bodies, is pertinent. The extension of the zone on the Normetal property presents possibilities to that company.

Other Mineralization

Range I, Perron Township

On the southern halves of lots 40 to 45, range I, Perron township, shearing with attendant silicification, chloritization and sericitization and sparse metallic mineralization has been noted. Trenching of overburden, and some shallow rock work, had been carried out in years past. The outcrops were mapped in considerable detail in an effort to correlate the rock sequences through the different outcrop areas. The rock units consist of interbedded dacitic and rhyolitic rocks, with smaller amounts of andesite. Part of the sequence in the southern part of lots 43 to 45 is intersected by a late Precambrian diabase dyke about 100 feet wide which trends slightly north of east. Also, near the southeast corner of lot 45, there is an outcrop of diabase interpreted to represent the Abana dyke which has, if the interpretation is correct, a strike slightly east of north. The correlation of this outcrop with the Abana dyke exposed underground is based on its lithological similarity and its position on the indicated line of strike. However, the intervening area, a distance of almost 4,000 feet, is devoid of outcrop and the continuity of the dyke is not proved.

The rocks of this sequence have suffered minor cross faulting and in places the rhyolite has been considerably brecciated. Despite dislocations due to later cross faulting, a fairly well defined zone of mineralization can be distinguished within a sericitized rhyolite band. It shows a little sulphide, erratically distributed. In the eastern part of lot 40, in lot 41 and in the western part of lot 42, the zone traverses the large outcrop occupying the southeastern slope of the prominent ridge trending northwest from the Normetal mine. Along the strike, beyond an area of low ground several hundred feet wide entirely devoid of outcrop, the zone can be distinguished in the southern part of a large outcrop in lot 43. Projecting the zone yet farther southeast through an area with no outcrops, assuming its continuity with the outcrop already mentioned, it would intersect the Abana dyke on lot 45, near the township line. In 1941 some drilling was done by the Inspiration Mining and Development Company Limited to test the zone as it approached the postulated intersection, but presumably the results were not favourable.

Miscellaneous

In the prominent outcrop near the centre of lots 44 and 45, range IX, Desmeloizes township, there are some relatively tight shears, in part sparingly mineralized with iron sulphide. Some trenches and pits have been dug. Near the middle of lot 37, range IX, Desmeloizes township, some sparse iron sulphide mineralization which occurs in iron formations has been exposed by trenching. Also in the middle of lot 41 of the same range a number of tight shears, with spotty pyrite mineralization, have been explored. Some zones sparsely mineralized by pyrite were noted in the large outcrop on lots 36 and 37, range I, Perron township, but they lacked any indication of strength.

CONCLUSIONS

The concluding remarks made with reference to the Normetal mine are in large measure applicable to the area as a whole. It is believed that a zone of some width along the general trend of the Normetal ore body, in both directions from the mine, warrants careful exploration. Included in this zone are the mineral occurrences mentioned in this report. Unfortunately, exploration of the zone to the south east is made difficult by the large area of low ground devoid of outcrop.

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