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NORTHERN DUBUISSON AREA, ABITIBI COUNTY

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PROVINCE OF QUEBEC, CANADA

Department of Mines and Fisheries

Honourable ONÉSIME GAGNON, *Minister* L. A. RICHARD, *Deputy-Minister*

BUREAU OF MINES

A. O. DUFRESNE, *Director*

ANNUAL REPORT

of the

QUEBEC BUREAU OF MINES

for the calendar year

1935

JOHN A. DRESSER, *Directing Geologist*

PART B

QUEBEC

RÉDEMPTI PARADIS

PRINTER TO HIS MAJESTY THE KING

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NORTHERN DUBUISSON AREA
ABITIBI COUNTY

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INTRODUCTION

General Statement

The present report describes a part of what is often termed the *Siscoe Area*, after the first — and to date the leading — gold producer in the district. The map-area to be considered lies immediately south of that mine and embraces, among others, the Sullivan, Greene Stabell, and Shawkey gold mines, all of which are now in production. The object of this report, primarily, is to record new information made available as the result of mining development subsequent to the previous examination which was carried out by this Bureau in 1930 and embodied in the report of J. E. Hawley for that year. The general geology and other features of the area are well described in earlier reports and indicated on maps accompanying them, so, chiefly in order to avoid repetition, it was felt that a summary of that phase of the subject would suffice for present purposes. On the other hand, the deposits actually under development, and more particularly where such development is of recent nature, are rather fully dealt with. Consequently, the main body of this report falls under the section entitled *Description of Properties.*

The work has included the preparation of a map of the area in which the three above-mentioned mines are situated, much more detailed than any hitherto issued. It adjoins on the west, and is essentially a companion map-area to, the Lamaque-Sigma Mines area, which was mapped in detail by the writer during the 1934 field season.

The map-area is occupied by rocks that fall very largely into three main divisions, namely, Keewatin volcanics, Temiscamian fine-grained sediments, and intrusives largely of granitic character but including granite, granodiorite, and diorite, and numerous porphyry dykes. The greater part of the area is underlain by Keewatin volcanics which, in the southern part, are succeeded and overlain by the Temiscamian sediments that form a part of the main belt of such rocks extending easterly from the vicinity of Rouyn. The Keewatin rocks are intruded by granodiorite of the Bourlamaque batholith, the western extremity of which occupies the north-eastern corner of the map-area and constitutes one of its most important features from the standpoint of its relation to the ore deposits. The Keewatin rocks are also intruded by dykes and stocks or other small bodies ranging in composition from granite to hornblendite. Such bodies include the albite granite exposed to the south of the Greene Stabell mine, the quartz diorite in the vicinity of the Crossroads mine, and the hornblendite of the West Shore property (see accompanying map No.342).

The Keewatin and Temiscamian rocks have been thrust up into a nearly vertical, or steeply north-dipping, attitude; their general strike is,

for the most part, somewhat south of east. The structure is inferred to be such that all of the beds form a part of one limb of a fold, *i.e.*, their structure is isoclinal, only the southern limb of an anticline, or the northern limb of a syncline, being represented within the map-area. The tops of both flows and beds are believed invariably to face to the south.

The area is one of low relief, much of the bedrock being obscured by clays that were deposited in a post-Glacial lake. The northern part lies largely within Montigny lake-bed, a shallow lake with clay bottom and banks.

The mineral deposits are broadly of two types: (1) gold-bearing quartz-tourmaline veins in granodiorite, a type rather characteristic of deposits associated with the Bourlamaque batholith elsewhere; and (2) gold-bearing veins in Keewatin volcanics, commonly in close association with porphyry dykes. The principal example of the first class is the Sullivan deposit. The deposit of the Crossroads mine is in a quartz diorite that forms a small stock separate from, but probably related to, the main granodiorite. The West Shore veins, also, are in an intrusive that may represent still another stock with similar affiliations. These last two deposits are not, however, mineralogically similar to those typical of the main granodiorite batholith or of other, smaller intrusives that are more definitely related to it. The Shawkey, Greene Stabell, Gale, and Parker Island deposits are examples of the second type, consisting of gold-bearing veins in Keewatin volcanics.

The Greene Stabell mine was brought into production in the fall of 1933, the Sullivan early in the following summer, and the Shawkey only during the present winter (1935-36). Figures of aggregate gold output, therefore, as yet mean little, production having so recently been inaugurated.

At the Sullivan mine, a programme of development is being carried on, designed to establish the importance of a number of deposits that occur under favourable structural conditions, with the reasonable expectation that several of these will provide important sources of ore additional to the shoot already established in what is known as *A* vein.

Known ore in the Greene Stabell mine is rapidly nearing exhaustion, after having provided feed for a period of over two years' milling operations. Such development as has been carried out in the mine proper has not materially added to the known reserves as computed in early estimates. In addition to gold, values in copper are recovered; the ore is not, however, of the free-milling type, as is that of the other deposits of the district. Recent mining development, comprising chiefly the sinking of a shaft, has been centred on a new section in ground held under option, in which diamond drilling had indicated the occurrence of gold-bearing material in granodiorite, and somewhat different in character from that of the mine proper. Its true significance remains to be established by the underground work in progress.

At the Shawkey mine, a gold-bearing vein has now been developed to a depth of over 450 feet. It is of good length with the ore exhibiting a pronounced southeasterly rake. Although extensively affected by post-

vein faulting, the vein is quite persistent and is understood to be uniform in its grade of ore. Only a limited measure of success has as yet attended efforts to establish ore in occurrences other than that of the main, No. 1, vein.

On the Gale property, underground exploration is in progress to test several very narrow veins and veinlets, in which visible gold is not uncommon. Properties on which but little work has been carried out subsequent to the 1930 report of the Bureau, or which are still in the early stages of development, include the Crossroads, Parker Island (Kee claims), and West Shore.

Location of Area and Transportation Facilities

The map-area is thirty miles south, and a short distance east, of Amos, which town is situated where the Quebec-Cochrane branch of the Canadian National railways crosses the northerly-flowing Harricana river. Summer transportation into the area is as yet mainly by boat up the Harricana river and its connecting lakes to various wharfs on the shores of Montigny lake. Since this route is navigable for scows, a cheap method of summer transportation is thereby provided from rail-head. With the exception of the Greene Stabell mine, which is on the highway leading easterly from the Sullivan, the principal mining properties are on or near the shores of Montigny lake or of Piché (Thompson) river and are thus readily accessible. It is understood that the highway leading south from Amos to connect with the Sullivan and other mines will be available for all classes of transportation during the summer of 1936, only a short section immediately north of the Sullivan mine now remaining to be gravelled. It is assumed that the Shawkey mine will eventually be connected by a short road leading north to it from the Rouyn-Louvicourt highway now in the course of construction, and adjacent to which the Crossroads mine is situated. Winter transportation is chiefly by horse-drawn sleigh, tractor, and ' snow-mobile ' over the Amos road. Aerial communication during both winter and summer is maintained by a number of commercial companies operating from flying bases at Rouyn, Amos, and Senneterre.

The Accompanying Map

The area covered in the accompanying map No. 342 has an east-west length of eight miles and a width of four and a half miles, and thus comprises 36 square miles. It is bounded on the east by the Dubuisson-Bourlamaque boundary line, which also forms the western limit of the Lamaque-Sigma Mines area mapped during the 1934 field season. The southern boundary of the sheet is the line separating ranges V and VI.

Throughout the greater part of the area, mapping was carried out by means of pace-and-compass traverses, such traversing being done at much closer intervals and in greater detail where rock was actually exposed or known to occur than elsewhere. Range lines and the lot posts along them provided the principal reference or tie points. More detailed geological maps were made of the mining properties, and data from these and from

plans kindly furnished by the various mining companies were compiled in the general map.

ACKNOWLEDGMENTS

The writer is indebted to officials of the several mining companies for their hospitality and many courtesies, and for the manner in which they co-operated by furnishing such essential information as mine plans and other records. Acknowledgment is due particularly to the staffs of the several mines in the area, including Colin Johnson, manager of the Greene Stabell; J. C. R. MacPherson, formerly manager of the Sullivan, and W. G. Barrett, the mine geologist; Vincent M. Ryan, manager, and F. J. Leaman, engineer, of the Shawkey; and J. B. Mosso, director, and John Manion, manager, of the Gale mine. Space does not permit of mentioning others who, in one way or another, were very kind and helpful to the writer and his party.

P. E. Auger and K. G. Honeyman, with J. P. Lecavalier as the junior member, acted in the capacity of student assistants. Much credit is due them for the conscientious and satisfactory manner in which they carried out their work.

Most of the determinations of feldspars given in this report were made by members of the laboratory staff of the Bureau.

PREVIOUS WORK AND SELECTED REFERENCES

The most important of the earlier reconnaissance surveys of the general region in which the area under discussion is situated is that of M. E. Wilson (1), of the Geological Survey of Canada, carried out during 1910 and in several subsequent years.

Early geological work more directly concerned with the mineral deposits of the map-area includes that of Bancroft (2), Tanton (3), Mailhiot (4), and Bain (5). The surveys of Bancroft and Mailhiot were carried out during the field seasons of 1912 and 1919, respectively, for the Quebec Bureau of Mines. Tanton visited the area for a short period during the fall of 1915, and Bain worked in the region during the summer of 1924, both under the auspices of the Geological Survey of Canada.

More recent and somewhat more systematic work in the district has been carried out chiefly by Cooke, James, and Mawdsley (6) and (7), and, lastly, by Hawley (8). Cooke reported on most of the mining properties in the present map-area following his field work for the Geological Survey of Canada during 1923, and in 1926, James and Mawdsley, also of the Geological Survey, prepared the first systematic, geological map that includes the area under discussion, namely, the *Dubuisson Sheet.* Hawley's work was carried out for the Quebec Bureau of Mines during the summer of 1930, when he reviewed the results of mining development to that date and prepared a geological map, No. 147, that is largely a revision of the *Dubuisson Sheet.*

For details of this earlier work, reference may be made to the following reports:

SELECTED REFERENCES

(1) Wilson, M. E., *Timiskaming County, Quebec*; Geol. Surv. Can., Memoir 103, 1918 (Also map No. 145A).

(2) Bancroft, J. A., *Report on the Geology and Natural Resources of an Area Embracing the Headwaters of the Harricanaw River, Northwestern Quebec*; Que. Bur. Mines, Ann. Rept., 1912, pp. 199-230.

(3) Tanton, T. L., *Kienawisik Gold District*; Geol. Surv. Can., Appendix to Memoir 109, 1919, pp. 60-72.

(4) Mailhiot, A., *Gold Deposits at Lake Demontigny, Abitibi, P.Q.*; Que. Bur. Mines, Ann. Rept., 1919, pp. 125-158 (Reprinted 1922).

(5) Bain, G. W., *The Geology and Mineral Deposits of the Harricanaw and Bell River Basins*; Can. Inst. Min. & Met., Bull. No. 178, Feb., 1927, pp. 201-247.

(6) Cooke, H. C., James, W. F., and Mawdsley, J. B., *Geology and Ore Deposits of Rouyn-Harricanaw Region, Quebec*; Geol. Surv. Can., Memoir 166, 1931.

(7) James, W. F., and Mawdsley, J. B., *Dubuisson Sheet*; Geol. Surv. Can., Map No. 224A, 1929.

(8) Hawley, J. E., *Gold and Copper Deposits of Dubuisson and Bourlamaque Townships, Abitibi County*; Que. Bur. Mines, Ann. Rept., Part C, 1930, pp. 3-95.

GENERAL GEOLOGY

The broader features of the district, including its physiography, topography, and more particularly its geology, have been described in the reports referred to above. There is, therefore, no need to deal with this phase of the subject further than to sketch the geological relationships and to record such new information as has been gained from a more detailed study and mapping of the rocks, particularly as revealed by recent mining development. It is chiefly this latter phase of the subject, therefore, that is treated in this report, although, since a good part of this information concerns the rocks of the mines themselves, it is necessarily recorded under that section entitled *Description of Properties* and, in order to avoid repetition, is not included in the present chapter except as concerns the general, or broader, relationships of such rocks.

TABLE OF FORMATIONS

PLEISTOCENE AND RECENT		Superficial deposits	Lake clays, sand, gravel, boulders
PRECAMBRIAN	KEWEENAWAN (?)	Intrusives	Olivine diabase dykes (later gabbro)
	PRE-HURONIAN	Intrusives—essentially of granitic character	Andesite porphyry, quartz-albite and albitite porphyries Syenite and granodiorite porphyries, intrusive breccia Albite granite, diorite, hornblendite Granodiorite Hornblendite; diorite and quartz diorite; diorite porphyry, quartz-diorite and feldspar porphyries, hornblende diabase
			'Older' hornblende diabase
	TEMISCAMIAN	Sediments	Greywacke with some slate
	KEEWATIN	Chiefly volcanics, but including some basic intrusives	Serpentine and peridotite, talcose schist Tuff and agglomerate or volcanic breccia Acidic flows; trachyte with altered derivatives, including sericite schists Basic and intermediate flows: pillow and amygdaloidal lavas, andesite and basalt with altered derivatives, including chlorite schists

KEEWATIN

Rocks of Keewatin age have a far wider distribution within the area than any others. They consist very largely of volcanic flows, most of which are of intermediate composition, or andesites, but which range on the one hand to more basic lavas, or basalts, and on the other to more acidic types with a composition about equivalent to that of trachyte. As is common with Keewatin rocks elsewhere, the extent to which they have been altered makes difficult any very precise determination of their original character. The lavas exhibit the usual volcanic structures or textures, such as flow, pillows, and amygdules. Although such structures are perhaps more common in the intermediate and basic types, pillow structure is in some places well developed in lavas of trachytic, or even more acid, composition. These latter are characteristically light-weathering, fine-grained rocks, often sericitic. Although nowhere very abundant, they are to be found at a number of localities within the area, but more particularly as a fairly well marked east-west-striking horizon or lenticular band in the northern half of range VII.

At their southern limit, the Keewatin lavas pass transitionally into tuffs of intermediate to moderately acid composition with which are interbanded minor amounts of agglomerate or volcanic breccia. The tuff band attains a thickness of about 2,000 feet and is exposed mainly in that portion of the map-area in range VI to the east of the ' narrows ' separating

Montigny and Lemoine lakes. Elsewhere along the presumed continuation of this band the country is very generally drift-covered. Apart from this main band, there are, in several places, narrow bands of agglomerate interbedded with the lavas; they provide useful criteria for structural determinations. The relatively small amount of volcanic breccia or agglomerate in the present map-area is in striking contrast to the quite extensive occurrence of breccia in the lavas to the east, presumably in the same band, directly along their line of strike, in the adjoining Lamaque-Sigma Mines area (1). The significance of this peculiar distribution, and the inferences to be drawn from it, from the standpoint of structure, are discussed on a later page, under the heading of *Structural Geology*. That the lavas of the present map-sheet pass into tuffs by transition is indicated by interbedding of the two in the zone of contact between them. Since the tops of the beds face to the south, it follows that, in this area at least, the closing phase of Keewatin volcanic activity consisted in the extrusion of fragmental material, now represented by beds of tuff. Upon these were deposited the Temiscamian sediments. The actual contact with the true sediments is, however, nowhere exposed in this area, but is marked, to the east of the lake-narrows, by a drift-filled stream valley or depression, and, to the west of the narrows, most probably by the valley of the Piché (Thompson) river, which is believed to coincide closely with the line of contact, although rock exposures here are insufficient to establish definitely the validity of this assumption. These topographic features are believed to be an expression of the underlying rock structure represented in contact, and together with the fact that the vicinity of the contact is followed for an appreciable distance by a dyke or sill of diabase, they are suggestive of a 'break' or fault along the line of contact between the Keewatin and the Temiscamian. Opposed to this, however, we have the contrary evidence, cited above, that there is a transition from Keewatin lavas to tuffs, which, in turn, appear to be structurally conformable with the overlying Temiscamian sediments.

The flows and tuffaceous beds strike somewhat south of east, paralleling the strike both of the Keewatin-Temiscamian contact and of the Temiscamian beds themselves. Their dip is invariably steep, and somewhat more commonly to the north than to the south, in which case they are overturned, since all structural indications—of which there are a considerable number in various places within the map-area—support the view that the tops of the flows and beds invariably face toward the south. Further reference to this matter is made in the section of the report devoted to *Structural Geology*.

Included in the Keewatin, in addition to lavas, tuffs, and agglomerates, are certain occurrences of rock now largely altered to serpentine, and, in more extreme cases, to talc or soapstone. Relatively small exposures of such rocks are to be seen in a number of places in the area, but they are probably most abundant in the bed of Montigny lake, west of the Sullivan mine and of the western margin of the granodiorite batholith in which the deposits of that mine occur. Exposures on the two principal islands in the lake, and the rock of the cores of two diamond-drill holes bored from

(1) Que. Bur. Mines, Ann. Rept., Part. B, 1934.

the lake ice in Sullivan property, indicate the possibility that such rock may extend for more than a mile and a half west of the assumed granodiorite contact. Such indications are not, of course, sufficient to establish that the rock actually forms a continuous body between its known occurrences as outlined. In this occurrence at least, there is a suggestion that the serpentine or talc owes its origin, in some way, to the main granodiorite, possibly representing an alteration phase of the lavas in certain more or less restricted places along the borders of the batholith. Elsewhere, there is little to indicate how the serpentine has originated, although Hawley (1) found evidence for its intrusive origin in at least one place in the map-area. On the other hand, the fact that the serpentine bodies are commonly more or less conformable with the Keewatin flows is of interest as pointing at least to a close relationship with the latter. The most reasonable assumption would appear to be that such rock has been derived by alteration both of lavas and of bodies of basic rock (peridotite) intrusive into them.

Temiscamian

Temiscamian sediments occupy the southern and southwestern portions of the map-area and, for the most part, are poorly exposed. They represent the unbroken easterly continuation of the main belt of Temiscamian rocks from the vicinity of Rouyn. In the present area, only the fine-grained members of the series, chiefly greywackes, are exposed. Their bedded or banded character is commonly very obvious. With the exception of the western end of a large outcrop on the east side of the lake-narrows, near the boundary between ranges V and VI, where the beds are somewhat contorted by drag-folding and related, probably minor, faulting, the strike and dip of both bedding and schistosity, which appear invariably to correspond to one another, are remarkably uniform. The strike averages N.70°W., which also is the strike of the Temiscamian-Keewatin contact and of the Keewatin rocks to the north. The dip varies from vertical to steeply north.

Pre-Huronian Intrusives

'Older' Hornblende Diabase:

At two places in the map-area, occurrences of the so-called 'older diabase' were noted. One is in the southern half of range VI, to the east of the lake-narrows, where the diabase follows along the south side of a ridge in which Keewatin tuffs are exposed. Here, in intermittent outcrops, the diabase may be traced in a direction slightly south of east for more than a mile and a half and across a maximum width of about 450 feet. It thus follows closely, and is assumed to have been injected along, the zone of contact between the Keewatin tuffs and the overlying Temiscamian sediments. Although massive in places, the diabase is in large part so highly sheared as to suggest strongly that it was involved in much of the folding and movement by which the Keewatin and Temiscamian rocks were affected, and, consequently, that it is older than other intrusives in the area. Similar reasoning would suggest that the diabase was injected

(1) *Op. cit.*, pp. 15-16.

as a sill closely following the plane of contact between the two series of earlier rocks. It would appear to correspond very well to diabase or amphibolite, which also takes the form of sills and is intrusive into lava flows, near Malartic lake, as described by Cooke (1), and which, he notes, resembles the amphibolite occurring as horizontal sills at Opasatica lake, in the Rouyn district.

In the other occurrence of what is regarded as 'older diabase', the rock is more uniformly massive and somewhat finer in grain than the foregoing, but is rather similar petrographically. It is to be found in the north half of lots 46 and 47, range VII, where it intrudes fine-grained trachyte, both as a body forming the southern part of the main outcrop and other small exposures to the south, and as narrow dykes.

The massive phases of the rock in both occurrences have a diabasic texture. The principal primary constituents are andesine (Ab55) — as determined in the rock of the southern occurrence — and hornblende, with quartz in varying amount. There are also the usual secondary minerals, including chlorite, epidote, zoisite, and magnetite, these being especially abundant in the highly sheared phases of the rock. From its mineralogical composition and texture, the rock may be termed a hornblende diabase.

HORBLENDITE; DIORITE AND QUARTZ-DIORITE; DIORITE PORPHYRY, QUARTZ-DIORITE AND FELDSPAR PORPHYRIES; HORNBLENDE DIABASE:

These several intrusives have been grouped together, partly for convenience in describing them, but chiefly because it is considered probable that they are related genetically. While it is thought likely that they are related also to the main granodiorite body in the northern part of the map-sheet, they are found chiefly in the area of Keewatin rocks, forming a zone with a width of about a mile and a half adjacent to the contact of the latter with the Temiscamian sedimentaries. They occur both as stocks and as dykes; if in the form of the latter, the texture is commonly porphyritic.

Hornblendite.—On the West Shore property, in lot 16, range X, is a body of hornblendite, running east and west, which is exposed for a length of 1,000 feet. It intrudes Keewatin lavas that outcrop to the south. The rock is granitic in texture, contains abundant hornblende, and occasionally exhibits bluish 'eyes' of quartz. A few dykes of altered diorite porphyry, also rich in hornblende, intrude the Keewatin lavas near the southern margin of the hornblendite, and probably represent a porphyritic phase of that intrusive. As noted on page 57, a strong shear-zone in the hornblendite is occupied in part by gold-bearing vein material. The writer favours the view that the hornblendite is allied to the granodiorite of the Bourlamaque batholith, although, on the other hand, as pointed out by Hawley (2), it may represent a basic phase of certain granites which are exposed a short distance to the west.

(1) Geol. Surv. Can., Summ. Rept., Part C, 1923, pp. 102-103.

(2) *Op. cit.*, pp. 31-32.

Diorite and Quartz Diorite.—A rock varying in composition from diorite to quartz diorite encloses the principal vein of the Crossroads mine and extends to the southeast of that property for a known distance of three-quarters of a mile, being exposed in that direction principally as two prominent knolls on the Godon claims. In the vicinity of the Godon showings, it is seen to intrude irregularly Keewatin agglomerate and related volcanics. Although the diorite is generally much altered, primary constituents are still prominent and include hornblende that may constitute as much as 60 per cent of the rock, oligoclase feldspar, and, in the more acidic phases, quartz. These latter contain a higher proportion of feldspar than the diorite proper. Quartz may occur as bluish 'eyes' such as are typical of much of the rock of the Bourlamaque batholith and of smaller, related masses. Secondary minerals of the diorite include epidote, chlorite, albite, and kaolin. The fact that quartz vein material, with abundant tourmaline, is associated with the diorite of the Godon claims, and that the Crossroads vein also carries tourmaline, is rather suggestive of a relationship between the diorite and granodiorite of the Bourlamaque batholith, the deposits of which are characteristically rich in tourmaline.

Diorite Porphyry, Quartz-Diorite and Feldspar Porphyries, Hornblende Diabase.—The rocks grouped under this heading occur as dykes cutting the Keewatin and are restricted mainly to the area adjacent to the narrows connecting Montigny and Lemoine lakes, in range VII and the northern half of range VI, where they are found as far east as lot 51. They are best exposed in the south half of range VII, in lots 42 and 43, and also in lots 47 to 51. The several rock types of the group are believed to be closely related to one another from a genetic standpoint.

The most abundantly represented, and probably also the oldest, of this group of intrusives is diorite porphyry. It occurs characteristically as dykes up to fifty feet in width, a number of which are exposed in lot 42, range VII. Although clearly intrusive into the Keewatin, such dykes, as a rule, are not readily distinguishable from the latter, owing to similarity in appearance of weathered surfaces. It is likewise difficult to distinguish the diorite porphyry from certain highly altered, granular, but apparently intrusive, material that occurs typically as very narrow dykes or bodies conformable with the Keewatin rocks and thus with a general east-west strike. The diorite porphyry, on the other hand, shows a tendency to cut across the schistosity and other structures of the Keewatin rocks, a feature which affords the best practical means of distinguishing it from the other rock. The general features of the diorite porphyry, including the texture and mineralogical composition, are such as to suggest a relationship to the diorite porphyry 'type *C*' of the Lamaque and Sigma mines (1), which occurs chiefly as an irregular body or bodies, but also as offshoots taking the form of dykes. Most probably, these dykes are to be regarded as representing somewhat more acidic differentiates of the diorite body of the Crossroads and Godon claims. They occur only a short distance east of that intrusive and show definite similarities to it in mineralogical composition, differing mainly in their texture and in that they generally carry less

(1) Que. Bur. Mines, Ann. Rept., Part B, 1934, pp. 11-12.

hornblende. As already noted, the Crossroads-Godon diorite is thought to be related to the Bourlamaque batholith.

The texture of these diorite porphyry dykes is commonly porphyritic, but, in general, not very obviously so. Plagioclase is by far the most abundant constituent of the rock, and all determinations indicate a composition near albite. It appears to be secondary, however, replacing a more calcic plagioclase. Minor amounts of orthoclase are present in some of the thin sections examined. Chlorite, probably derived from hornblende, is abundant, and hornblende itself may constitute as much as 15 per cent of the rock. Common secondary minerals include epidote, zoisite, carbonate, biotite, sericite, and, in some sections, quartz. Rock assumed to be the same type, but carrying some primary quartz which may occur as phenocrysts, forms a dyke fifty feet wide in lot 50, where it is apparently the earliest of a differentiation series which includes other diorite porphyries and also diabase.

Occurring chiefly in the north half of range VII, lots 47 to 51, is a series of dykes which are obviously closely related but of somewhat different ages, as shown by their mutual intersections. Although not definitely established in all cases, the sequence appears to be: (1) diorite porphyry carrying primary quartz; (2) diorite porphyry with phenocrysts of both plagioclase and hornblende; (3) diorite porphyry with plagioclase phenocrysts and with more biotite than hornblende; (4) feldspar (oligoclase-albite) porphyry; (5) quartz-diorite porphyry in which hornblende occurs as long, slender phenocrysts; (6) hornblende diabase. The series is believed to represent, both in composition and time of intrusion, different phases of injection connected with the differentiation of a common magma. Characteristics common to all members of the series include rather abundant hornblende and soda plagioclase (perhaps largely secondary), and, also, iron sulphide in the form of pyrrhotite. Apart from Nos. 1, 4, and 6 of the series, the dykes are small and of interest only insofar as they indicate the sequence of intrusion. Dykes of No. 1 group are prominent, and apart from the fact that they carry primary quartz are similar to the diorite porphyry dykes already described. Those of No. 4 group, consisting of feldspar porphyry, are by far the most abundant dykes in this vicinity. They exhibit beautifully zoned plagioclase (oligoclase-albite) phenocrysts and contain a certain amount of orthoclase, in addition to hornblende and some biotite. The hornblende, constituting up to 15 per cent of the rock, also may take the form of phenocrysts. No. 6 group, presumably the youngest of the series, is represented by two dykes of hornblende diabase, in which hornblende makes up about 65 per cent of the rock. Primary quartz was noted in one of these dykes. Generally speaking, the dykes of this series (in lots 47 to 51) are less altered than are those of the diorite porphyry (in lot 42) first described. The feldspar porphyry and hornblende diabase dykes, in particular, are quite massive and of fresh appearance.

GRANODIORITE:

The southwestern extremity of the Bourlamaque granodiorite batholith occupies the northeastern corner of the map-sheet. It is exposed

chiefly at the Sullivan mine, but is also indicated by diamond drilling at the Greene Stabell. The contact between the batholith and the Keewatin rocks is shown on the accompanying map as indicated by the above diamond drilling and by diamond-drill holes on the Sullivan property, and elsewhere as assumed from the interpretation of dip-needle surveys. The character and significance of the granodiorite of the Bourlamaque batholith are well known from earlier reports and need not be considered here. The most complete discussion of the granodiorite, together with analyses showing its chemical composition, is to be found in Hawley's report (1).

ALBITE GRANITE, DIORITE, HORNBLENDITE:

Massive intrusive rocks, chiefly granite but including also diorite and hornblendite, occupy part of a limited area in lots 52 to 57 in the north half of range VII and the south half of range VIII. The several rock types are believed to be phases of one and the same intrusive. The variation in composition from acid to basic, which is particularly evident near the area of contact between the intrusive body and the Keewatin lava, would appear to be due to the absorption and assimilation of the more basic lava by the intrusive.

Albite granite is regarded as the ' fresh ' or normal phase of the intrusive or intrusives. It is exposed mainly in lots 54 and 55 in the north half of range VII, but again occurs as smaller dyke-or stock-like masses intruding the Keewatin lavas in lots 52 and 53 in the south half of range VIII. The granite outcrops chiefly as a series of low hummocks of massive, grey-weathering rock of medium to moderately coarse texture. Under the microscope, the rock is of fresh appearance, shows a granitic texture, and is seen to consist of an assemblage of minerals including feldspar — making up about 70 per cent of the rock — quartz, biotite, and, in some specimens, minor amounts of hornblende. Secondary products include sericite, epidote, and carbonate. Albite (Ab95) is the predominant feldspar, but both orthoclase and microcline are represented. The rock varies somewhat in mineralogical composition from place to place, increase in biotite being usually accompanied by decrease in the quartz content. There are, in addition to the granite itself, a few dykes of porphyritic texture but somewhat similar composition, apparently related to it as offshoots.

At a point slightly more than a quarter of a mile northeast of the main exposure of granite, diorite is exposed, the intervening area being completely drift-covered. The diorite consists, to the extent of approximately 60 per cent, of hornblende, with biotite, albite, and possibly quartz, as the other primary constituents. About 500 to 700 feet northeast of where the diorite is first exposed, the rock has changed by transition to a hornblendite and is seen to intrude highly altered Keewatin basalt. The hornblende content of the hornblendite may be as high as 95 per cent, the balance being, commonly, albite.

It is assumed that these various rock types all form part of a stock that extends for at least two-thirds of a mile in a northeast-southwest direction, and from which offshoots or apophyses extend northwest for

(1) *Op. cit.*, pp. 23-25.

about the same distance. Drift-covered ground in the vicinity does not permit of any accurate estimate of the dimensions of the stock, nor indeed of verifying the assumption that the granite, diorite, and hornblendite all actually do form a part of the same intrusive mass.

SYENITE AND GRANODIORITE PORPHYRIES, INTRUSIVE BRECCIA:

Although the rocks included under this heading are not present in great volume either individually or collectively, they constitute the most widespread group of intrusives within the map-area. They are to be seen in the vicinity of the Shawkey, Gale, and Greene Stabell mines, and are particularly well exposed in the area lying between these mines, as, for example, in lots 40 to 47, range VIII. For the most part they occur as dykes, but in places they have the form of small bodies more or less surrounded by the Keewatin lavas they intrude. Almost invariably, the rocks have a porphyritic texture.

The syenite porphyry and granodiorite porphyry appear to be closely related, and in composition they more or less grade or pass transitionally from one to the other; or, they may be regarded as being bridged by a third petrographical type, since the group of dykes in lots 40 to 47, range VIII, are in a sense transitional between the syenite porphyry and granodiorite porphyry proper, as will appear from the petrographical descriptions of the several rock types that follow.

Syenite Porphyry.—The term syenite porphyry has been applied by Cooke (1) to the porphyry dykes as exposed at, and in the vicinity of, the Shawkey and Gale mines. Primary constituents of the rock are albite — both as phenocrysts and as fine crystals in the groundmass — orthoclase, a little biotite, and, commonly, varying amounts of quartz and hornblende, which, however, may or may not be present. Thus, the syenite porphyry at the Shawkey property contains no quartz and very little hornblende, whereas both are present in the dykes at the Gale property. The typical syenite porphyry is grey-weathering and massive.

Granodiorite Porphyry.—It was Cooke, also, who applied the term granodiorite porphyry to the dyke that follows the principal vein-fracture of the Greene-Stabell mine and to a series of dykes of more or less similar composition in the vicinity. The reader is referred to his description of the rock (2). It may, however, be noted here that the dominant feldspar is oligoclase-andesine (around Ab60), and that hornblende is generally quite prominent, whereas quartz is sparse or even lacking. There are also in this vicinity certain hornblendic dykes with somewhat more calcic feldspars, which probably represent a more basic facies of the granodiorite porphyry.

Granodiorite porphyry, as dykes in the southern border of the Bourlamaque granodiorite batholith, has been indicated by diamond drilling at the Greene Stabell mine. This serves to show definitely that the granodiorite porphyry dykes of this mine are later than, and intrusive into, the granodiorite of the batholith. This may or may not be true of the dykes of similar composition in other parts of the area.

(1) *Op. cit.*, pp. 243-244.
(2) *Ibid.*, pp. 257-258.

Transitional Type.—A third member of this group of dykes, or, better, one of the phases of the intrusive series that includes syenite porphyry and granodiorite porphyry, remains to be considered. As already noted, this is a rock of composition regarded as transitional between the syenite porphyry and granodiorite porphyry and, like them, it occurs mainly as dykes but also as bodies. It is also to be noted that these dykes and bodies are found in an area lying in between those in which the syenite porphyry and granodiorite porphyry dykes, respectively, occur, or chiefly in lots 40 to 47, range VIII. They are of massive, grey-weathering, and often rather coarsely porphyritic, rock and their strike is commonly N.W.-S.E.

Under the microscope, typical specimens show phenocrysts of plagioclase that may constitute about 50 per cent of the rock. Those that are not zoned are oligoclase-albite (around Ab75), but well-zoned phenocrysts, which are quite abundant, may range to as calcic as andesine-oligoclase (Ab55). In addition, some orthoclase is generally present. Feldspar is also abundant in the groundmass. Other constituents are quartz (sparse in some specimens), hornblende, and biotite. There are also the usual secondary minerals, mainly epidote, sericite, and chlorite. It will be noted that the dominant feldspar, oligoclase-albite, is about intermediate in composition between that of the syenite porphyry (albite) and that of the granodiorite porphyry (andesine-oligoclase) in the vicinity of the Greene Stabell mine. Furthermore, ferromagnesian constituents are somewhat less abundant in this rock than in the typical Greene Stabell granodiorite porphyrics, whereas quartz is generally in greater amount than in the syenite porphyries of the Shawkey and Gale mines.

The dykes under consideration are thus more or less ntermediate in composition between the syenite and granodiorite porphyries; but even between the latter, the differences are such as may well be due to local variation in rocks derived from a common source, and this entire series would, perhaps, best be grouped under a common petrographic designation.

Intrusive Breccia.—In the north half of lots 45 and 46, range VIII, is a small body of granodiorite porphyry more or less surrounded by Keewatin lavas in which there is an abundance of inclusions of rock quite similar in character to the granodiorite porphyry itself. Other, smaller occurrences of similar breccia are to be seen in the vicinity. A remarkable feature of this breccia is that many of the inclusions are well rounded, and on casual inspection might suggest the pebbles or boulders of a conglomerate. In order to explain the origin of this breccia, it would appear necessary to assume two periods of porphyry intrusion, the earlier one being now represented by the inclusions in the breccia. Supporting this assumption is the fact that the, presumably related, dykes in this vicinity represent two or more successive invasions of magma, since intersections may be seen of dykes of somewhat different appearance but which, petrographically, seem much alike.

ANDESITE AND ANDESITE PORPHYRY, QUARTZ-ALBITE AND ALBITITE PORPHYRIES:

Dykes of the type grouped under the above heading occur, insofar as yet revealed, only in the vicinity of the Sullivan mine. They are fully

described in connection with the discussion of that property. In age they are definitely post-granodiorite, and the younger types of the series, the andesites, have a close structural relationship with the vein fractures of the mine. As noted in the writer's report *Lamaque-Sigma Mines and Vicinity* (1934, Part B), there is, in that area, an essentially similar relationship between dykes that have been classed as andesite porphyry and many of the vein deposits. While the dykes of the two occurrences differ somewhat in appearance, they are, in the opinion of the writer, sufficiently alike, both petrographically and in their structural relationships, to permit of correlation between the two groups. It is of interest to note in this connection that the andesite dykes of the Sullivan mine are related to the main Bourlamaque granodiorite batholith, whereas those of the Lamaque and Sigma mines are related to a subsidiary, or satellitic, intrusive of more variable composition.

General Location and Genetic Relationship of the Pre-Huronian Intrusives:

The principal areas of occurrence of the various intrusives described in the foregoing pages have already been indicated. It is, however, an interesting fact that, in contrast to their relative abundance in the Keewatin rocks — and more particularly in those areas slightly removed from the Keewatin-Temiscamian contact — granitic intrusives are lacking in the outcrops of the sediments that were examined. It should be remembered, however, that the sediments are relatively poorly exposed, and that only the northern border of the sedimentary belt is represented in the map-area.

The relative ages and genetic associations of these various groups of intrusive rock-types must remain, to a considerable extent, a matter of conjecture. The probable genetic relationship of those rock types that are grouped together in the *Table of Formations*, and that are discussed under a common heading, has already been outlined. The order in which they are placed in the table may or may not represent correctly their relative ages, but it does indicate the writer's supposition as to a possible age association. In some cases, of course, the age relationships are fairly definitely established.

Excluding the 'older' hornblende diabase, all the pre-Huronian intrusives described have certain features in common. They are all characterized by a preponderance of plagioclase over orthoclase, and no doubt, chemically, by a preponderance of soda over potash, since the plagioclase is commonly of the sodic or albitic variety. In some measure at least, the albite is certainly secondary, replacing an original more calcic plagioclase; but even so, the significant fact remains that one phase of activity connected with the intrusives consisted in the introduction of solutions rich in soda, a process well recognized in connection with mineral deposition in this general area. Although, in the present map-area, there is a definite genetic relationship between the intrusives and the gold deposits, it is not everywhere possible to definitely establish which particular type of intrusive has been responsible for the gold deposition. In the *Table of Formations* and in the foregoing descriptions, these intrusives are subdivided

into five groups. Gold deposits are known to occur in association with rocks belonging to three of these groups, and more especially with the following types of intrusives, one belonging to each group: diorite, granodiorite, and syenite or granodiorite porphyry. As noted later, under the descriptions of the mining properties, wall-rock alteration at the Sullivan and Shawkey mines, for example, is remarkably similar, and is therefore indicative of similar processes in the final phases of intrusive activity, even though the intrusive of the Sullivan is granodiorite and that of the Shawkey dykes of syenite porphyry. It seems reasonable to conclude that, even if they were derived from a common magma, these pre-Huronian intrusives, in their later or closing stages of intrusion, at least, were expressions of much the same type of igneous activity. This would, in turn, suggest a common underlying source.

Keweenawan (?)

Olivine Diabase ('Later Gabbro'):

Exposures of olivine diabase in lots 41 to 43, range VII, and in lots 44 and 45, range VIII, appear to represent two separate but nearly parallel dykes striking in a northeasterly direction. In addition, there are in the vicinity a few very narrow dykes of similar rock, most of which also strike northeast. A small dyke of olivine diabase such as these cuts through the main vein of the Greene Stabell mine and thus clearly post-dates the period of mineralization of that deposit.

For a description of the olivine diabase dykes in this and adjoining areas of the district, the reader is referred to the memoir of Cooke, James, and Mawdsley (1).

STRUCTURAL GEOLOGY

The following outline of the structural relations of the several rock types is applicable not only to the area under discussion, but is thought to provide the key to the structure of the adjoining Lamaque-Sigma Mines area. In his report (2) on the latter area, the writer suggested two possible interpretations of the structural relations, leaving the decision between the two possibilities an open question, to be settled by further investigation. It is now believed that this later work in the adjoining field definitely establishes the broader structure of the Lamaque-Sigma Mines area, as will appear in what follows.

All observations within the present map-area indicate that the tops of the Keewatin flows and tuffaceous beds face to the south. The flows and beds have been folded or thrust up into a nearly vertical attitude, the same being true of the Temiscamian sediments which overlie them to the south. The dip now varies but little from vertical, and, where not actually vertical, the beds commonly dip steeply to the north and in such cases are, of course, overturned. Variations in strike, although nowhere very pronounced, are somewhat greater than changes in dip. In that part of the map-area lying west of the narrows separating Montigny and Lemoine lakes, the beds, in-

(1) *Op. cit.*, pp. 141-144.
(2) *Op. cit.*, pp. 19-20.

cluding the Temiscamian sediments, strike somewhat south of east, or, as an average, S.70°E. To the east of the narrows, the strike becomes more nearly east-west, more particularly in the case of the Keewatin rocks, although the same is, to a large extent, true of the Temiscamian sediments also. The change in strike — which, as already stated, is only to the extent of about 20 degrees — is gradual rather than abrupt, and not only does it affect the constituent members of the Keewatin and Temiscamian, but also the major contact between these two formations, a feature which lends support to the view that they are structurally conformable. Since, as already pointed out, all indications are to the effect that the Keewatin and Temiscamian beds of the map-area face to the south, it may be inferred that only one limb of a steeply-dipping fold is represented in the map-area. The main Temiscamian sedimentary belt is believed to owe its position in the Keewatin rocks to having been deeply infolded in them, and thus a major synclinal structure is implied. Accordingly, the rocks of the present map-area may be regarded as constituting a part of the steeply-dipping, northern limb of a major synclinal fold.

As noted above, the structure of the present map-area is definitely related to that of the adjoining Lamaque-Sigma Mines area, since it is directly on the line of strike of the Keewatin rocks of that area. It will be noted from map No. 334 (Lamaque-Sigma area), that the Keewatin rocks have the same strike and dip as those in the present map-area, which must mean that they maintain their stucture from one area to the other. As pointed out in the 1934 report, the structure, mainly as inferred from the distribution of the rocks within the Lamaque-Sigma map-area, could be that of a single anticlinal or synclinal fold, but the apparent folding might be due simply to interbedding of similar bands of rock. It now appears that the latter supposition is correct and that the structural relationship of the rocks of the two areas is the same, namely, that only the one, steeply-dipping limb of a fold is represented throughout. The fact that agglomerate or volcanic breccia, so abundantly represented in the Lamaque-Sigma map-area, is very sparse in the present one, is also of interest in connection with the structure, and more particularly so since, here, normal types of lava flows occur directly westward along the line of strike of the agglomerate beds of the adjoining area. This must mean that the agglomerate in the Lamaque-Sigma area occurs in the form of highly lenticular bands or beds which have rapidly lensed-out to the west and thereby failed to extend along their strike to where, in their stead, normal volcanic flows are exposed in the present map-area. It follows that the vicinity of the Lamaque and Sigma mines was the scene of much volcanic activity of explosive type, probably more or less local, the main product of which was volcanic breccia with some associated tuffs.

Most of the Keewatin and Temiscamian rocks of the map-area are in some measure schistose, although in many places schistosity is only locally developed. In general, the strike of the schistosity corresponds fairly closely to that of the beds, and the dip is uniformly steep to the north, or, in places, vertical. Fracturing or faulting, and also jointing, has affected all the rocks of the area. Faults striking in a northeast direction are well exemplified at the Gale and Greene Stabell mines, as, for example, in the

Blouin Lake fault, which is a zone rather than a simple fault, and is, in part at least, post-ore in age. The 'Mine' fault, which is occupied in part by the main vein of the Greene Stabell mine, is an example of a fault with northwesterly (N.60°W.) trend. Other vein-fractures or faults striking northwest (N.40°W.) characterize the vein deposits of the Sullivan and Shawkey mines. There would thus appear to be a tendency for the gold-bearing veins of the area to favour the northwest-striking system of fractures or faults. In addition to the faults of the two sets mentioned, there is a series of minor fractures, or joints, common to all the rocks of the area. They strike, as an average, about N.20°E. and dip steeply. Lastly, there is a series of late (post-ore) faults which are particularly abundant at the Shawkey mine, where they have an average strike of N.70°E. Further data concerning faulting in the area may be obtained from inspection of the accompanying map and from the descriptions of the various mining properties. It would appear that both the earlier structures — namely, folding as exemplified in the Keewatin and Temiscamian rocks — and the later structures — faulting and fracturing in these and in later intrusive rocks — are such as would normally develop under the influence of north-south compression, and would imply that the rocks were affected by stresses acting in essentially the same manner both at an early, and again during a relatively late, period of the Precambrian.

ECONOMIC GEOLOGY

Gold and associated silver, together with a small amount of copper, are the only metals of economic interest as yet known within the map-area. The gold deposits occur mainly as veins of the fracture, or fissure, type. They may be broadly classified as constituting two types:

(1) Veins of quartz with tourmaline, in granodiorite or diorite and related rocks, carrying pyrite and generally some chalcopyrite. The deposit of the Sullivan is typical; somewhat less so are those newly developed in the Greene Stabell and Crossroads mines. Possibly the West Shore deposit, also, is of this type.

(2) Vein deposits in Keewatin volcanics, rather than in the intrusive rocks, that commonly carry little or no tourmaline. Generally, they are closely associated with dykes, including both syenite and granodiorite porphyries. The veins are of quartz, with pyrite, pyrrhotite, and chalcopyrite in varying quantity; some contain also sphalerite and galena. Examples of such deposits may be seen at the Greene Stabell, Shawkey, Gale, and Parker Island properties.

Important in connection with all the deposits is the fact that they are closely associated with intrusive rocks.

DESCRIPTION OF PROPERTIES

The following descriptions, except as concerns the Greene Stabell mine, refer to the mining properties as developed at the close of the field season in October, 1935. Properties described by Hawley in the 1930 report of the Bureau, and upon which there has been no subsequent development of significant nature, are described but briefly or not at all. For

information relating to such properties, reference should be made to the 1930 and earlier reports.

The Greene Stabell mine was re-visited in the spring of 1936 with the object of examining certain deposits opened-up subsequent to the previous examination, and occurring under circumstances quite different from that of the original, productive vein. In the case of this property, therefore, the description includes development up to the spring of 1936.

Greene Stabell Mines, Limited

The property of Greene Stabell Mines, Limited, comprises mining concessions (M.C.) 112, 141 and 151 lying partly in the northern half of range VIII and partly in the southern half of range IX, with an aggregate area of 286 acres. The Company also holds under option from Stabell Lake Gold Mines, Limited, an additional 17 claims adjoining their property, and it is here that more recent developments have largely centred. The claim in which the principal ore-bearing vein occurs (known as the *Stabell* vein) was staked by Joseph F. Stabell in December, 1914. It was purchased in 1922 by W. F. Greene and associates, by whom the property was incorporated as Stabell Gold Mines, Limited. Development prior to 1923 consisted only of surface work, but in the spring of that year diamond drilling was commenced, to be followed in the fall by shaft-sinking and underground exploration. In the fall of 1924, the shaft had attained a depth of 620 feet (its present depth), and shortly afterwards all operations were suspended. In March, 1928, the Company was reorganized as Greene Stabell Mines, Limited, chiefly under the sponsorship of new financial interests. The mine was immediately de-watered to permit of its further exploration, which was continued throughout the greater part of 1929, or until December of that year. The property then lay idle until the spring of 1933, when preparations were made to bring the mine to production.

Milling at the rate of somewhat more than 60 tons per day was commenced in November, 1933. Power for these operations was at first furnished by a 550 h.p. Diesel engine, but in July, 1934, electric power became available through the transmission line newly completed from Rouyn by the Northern Quebec Power Company. To the close of 1934, production was as follows: gold, $197,810; copper, $10,693. For 1935, the figures were: gold, $241,192; copper, $16,425. Thus, gold produced to the end of 1935 had a total value of $439,002. Gold recovery per ton of ore milled during 1935 was approximately $9.50 (gold at present valuation). The mill operated on ore from the Stabell vein until June, 1936, by which time the principal shoot was practically mined out. Following this, some ore from the recently-discovered vein of the Stabell Lake option (which occurs in granodiorite) was put through the mill; but after a short period, milling operations were suspended to permit of the thorough exploration of this and related deposits that had been indicated in the granodiorite area.

The Stabell Vein:

The Stabell vein is in Keewatin lavas, about a quarter of a mile south of the southern margin of the Bourlamaque granodiorite batholith. The

lavas consist chiefly of a succession of flows that are well defined as such and thus provide useful horizon markers for working out structural relations and, more particularly, faulting. Although in places their attitude is modified by faulting, the volcanic beds have a general east-west strike and an average dip of 70° to the south. Indications are that their tops face to the south. In their normal position, a section from north to south across the various members of the Keewatin in the vicinity of the mine is approximately as follows :

(1) Dark coloured, commonly schistose or sheared, serpentinized lavas, extending south from the southern margin of the granodiorite batholith across a width of some 900 feet. This horizon of schistose rocks is not exposed at the surface but is well exhibited in the long cross-cut driven to the vicinity of the granodiorite contact on the 600-foot level of the mine.

(2) Fairly massive serpentine or altered peridotite, forming a band at least 70 feet in width but probably discontinuous along its strike.

(3) Rather massive, trachytic lava of medium grain. The thickness of this flow would average about 65 feet.

(4) Andesite lava, as a ten-foot band bordering the rock of No. 5.

(5) Agglomerate, forming a persistent band ten feet in width. This bed has proved most useful as a horizon marker.

(6) Lava characterized by well developed pillows and making up a flow 55 feet in width.

(7) Rock consisting essentially of coarse, massive andesite, as a band attaining a width of 370 feet. A narrow but not very well defined zone of pillowed andesite occurs within it. Relatively large and rounded or ellipsoidal 'inclusions' in the andesite are prominent and consist of rock remarkably rich in epidote and of a lighter green colour than the andesite proper. These are locally termed 'wash-tubs'. The Stabell vein as developed underground occurs largely in this massive andesite.

(8) Pillow lava, as a 240-foot flow.

(9) Volcanic breccia, forming a 50-foot band.

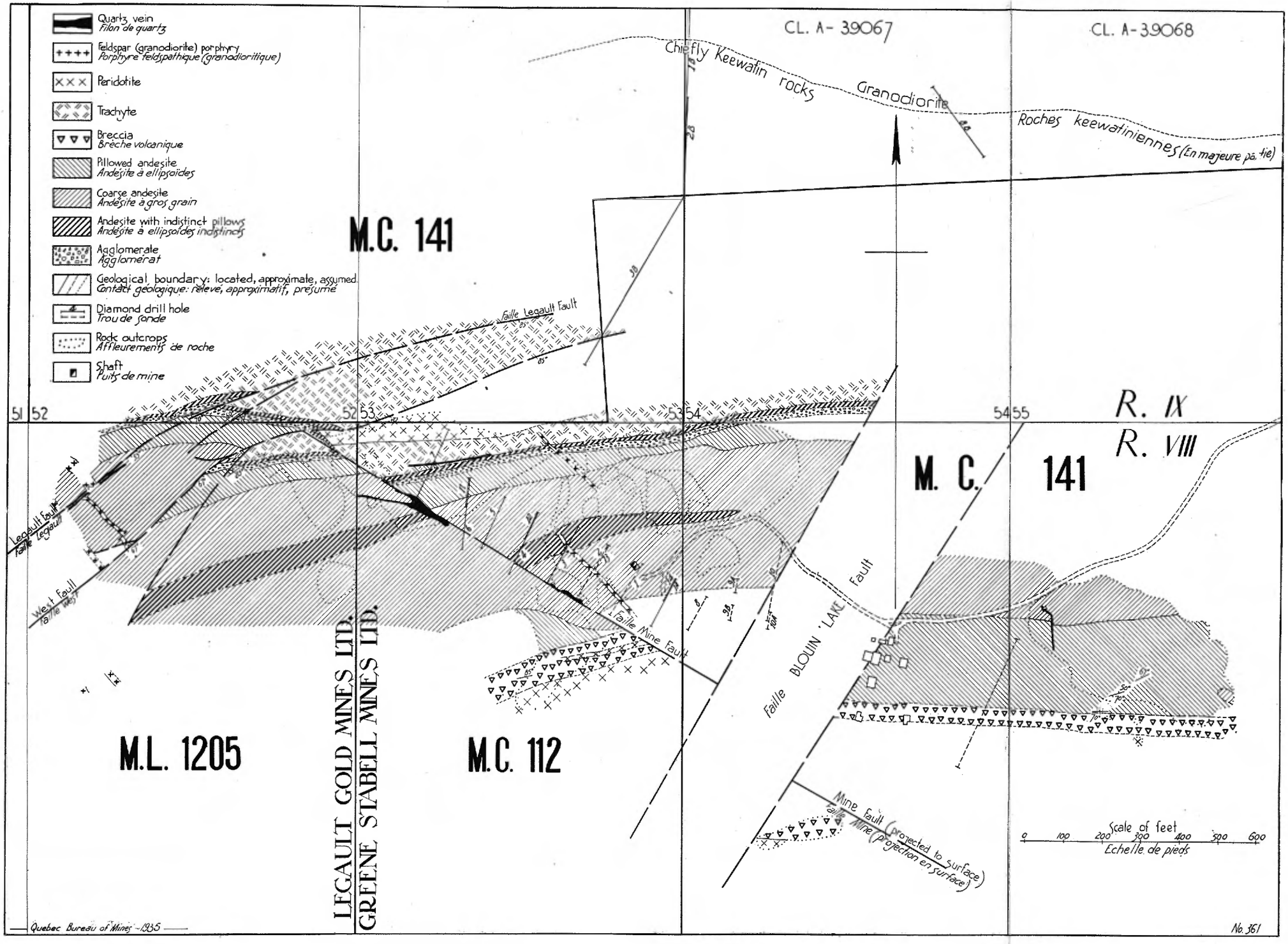
(10) Serpentine; width not known.

The figures for width given above refer to the width of the various formations as exposed at the surface, but since the flows dip steeply, the figures given would approximate the true thickness in each case. More detailed reference to these rocks, particularly as concerns their petrographic character, will be found in earlier reports, and more specifically in those by Cooke (1) and Hawley (2).

A series of faults cut and offset the various flows or bands, and since some of them, at least, are earlier than the porphyritic intrusives, they will be considered before dealing with the intrusive rocks. With the single exception of the Mine fault, which strikes N.60°W., the faults have a general,

(1) *Op. cit.*, pp. 256-261.

(2) *Op. cit.*, pp. 63-70.



Map No. 361. — **Plan showing detailed surface geology in vicinity of mine fault. Greene Stabell Mines, Limited.**

(d'après W. F. James et J. E. Gill)

if in some cases curving, northeast strike. The Mine fault dips 65°N.E. and shows a horizontal displacement, as measured along the fault plane, of 135 feet (N.E. side offset to the S.E.). That this is one of the earliest of the several faults is indicated by the fact that it is itself offset by northeast-striking faults both east and west of the principal ore-shoot of the Stabell vein, which occupies the Mine fault. The fault cutting the Stabell vein east of the ore-shoot is known as the Blouin Lake fault and is defined on the surface by a drift-filled depression which terminates on the east the rock ridge exposed in the near vicinity of the mine. The fault consists of a zone of sheared and contorted rock with a width of around 200 feet, in which are several well defined individual faults or slips. Although locally a number of these dip at about 70° to the northwest, the fault-zone as a whole dips vertically and strikes N.30°E. The horizontal component of movement along the Blouin Lake fault, as indicated by its displacement of the Mine fault, amounts to 160 feet (N.W. side to the N.E.). Displacement in a like direction characterizes two other strong northeasterly-striking faults — the West and the Legault — and also a number of smaller subsidiary faults of similar strike. About 800 feet northwesterly from the main ore-shoot, the West fault offsets the Mine fault with a horizontal displacement of about 300 feet; and 150 feet still farther to the northwest, the Legault fault, which contains the Legault vein of the Legault Gold Mines, Limited, property adjoining Greene Stabell on the west, shows a horizontal displacement of 100 feet. Both of these faults dip to the southeast, for the most part at a fairly steep angle.

Intrusives cutting the Keewatin rocks in the vicinity of the mine, and exclusive of the granodiorite of the batholith, consist chiefly of several dykes of porphyry, mostly granodiorite but ranging to related rocks of more basic composition. The granodiorite porphyry as represented in the Stabell dyke for the most part occupies the Mine fault and is clearly later than this fault. The dyke is in turn paralleled by the Stabell vein. Age relationships between other dykes of granodiorite porphyry and the northeast-striking faults to the west of the mine are not so clear, although there is considerable evidence that these faults are, in part at least, post-porphyry in age. It has been noted already that they are later than the Mine fault, which is offset by them. The petrographic character of the dykes of granodiorite porphyry in the vicinity of the mine has been fully described by Cooke (1). More recent underground work has revealed dykes of similar nature but including some of more basic composition and, in one instance, of much finer grain. Four types in all are recognized at the mine, where they are designated porphyry No. 1, 2, and 3, and hornblende porphyry. Porphyries No. 1, 2, and 3 appear to be merely different phases of the granodiorite porphyry, although a 25-foot dyke representing a relatively basic phase of the series, as revealed in the long north cross-cut on the 600-foot level of the mine where it is intrusive into trachyte, is a diorite porphyry consisting essentially of labradorite (Ab40) and hornblende in the approximate ratio of three to one. The hornblende porphyry occurs as relatively narrow dykes of fine-grained, light-greyish rock in which are a few pheno-

(1) *Op. cit.*, pp. 257-258.

crysts of hornblende with still fewer of feldspar, the latter almost entirely altered to epidote. Like the Stabell dyke of granodiorite porphyry, the hornblende porphyry dyke follows the Mine fault, but it is much less persistent and only locally in evidence. The granodiorite porphyry is intrusive as dykes not only into the Keewatin, but also into the adjacent granodiorite, as has been shown by diamond drilling of the latter. It is believed that the several porphyries are all closely related genetically and that they are a later differentiate of the magma from which the granodiorite was derived.

There is also at the mine an example of the youngest of the intrusive series, a narrow dyke of olivine diabase that cuts through, and is clearly later than, the ore-bearing Stabell vein. It was intersected in the drift on the vein on the 600-foot level in Keewatin rocks, southeast of the Blouin Lake fault, and its probable continuation was cut in the new workings to the northeast, where it is intrusive into granodiorite and occupies a similar position relative to the fault. A northeast strike, characteristic of other and larger diabase dykes of the area, is hereby indicated.

The vein structure defined by the Mine fault has been established for a total length of over 1,900 feet. On the west, the vein-fracture, as revealed at the surface, has been faulted-off to the northeast by the West fault, beyond which it has not been traced; to the east, however, it is still open for as far as the drift has been carried on the 600-foot level. Holes drilled from the surface at 300 and 700 feet, respectively, beyond the eastern limit of that drift gave little or no indication of the further continuity of the vein in this direction. The vein, as developed, carried ore only for a maximum length of some 300 feet in that portion lying northwest of its intersection with the Blouin Lake fault. The main ore-shoot bottomed at a vertical depth of 490 feet. Below a vertical depth of 100 feet, the vein-fracture or Mine fault is occupied by the Stabell dyke of granodiorite porphyry for a length of about 150 feet northwest of where the main cross-cuts from the shaft intersect the vein and for as far southeast as the fault has been opened-up in underground workings. Between a depth of about 100 feet and the surface, the dyke seems to have branched-off steeply from the fault, since at the surface it lies chiefly to the north of it; but it is known that, farther to the southeast, it cuts obliquely across the fault. Both the vein and the ore it contains are confined to the fault and for the most part follow the walls of the porphyry dyke. The vein, apart from where it widens to form the main ore-shoot, consists of blebs or small lenses of mineralized quartz lying at intervals along the fault, either on the foot- or hanging-wall of the porphyry dyke. As pointed out by Cooke (1), there seems to be no doubt that the porphyry occupies a pre-existent fault and was succeeded by the vein-forming solutions. On the surface, and as opened-up in underground workings, the main or Stabell vein throughout the greater part of its length traverses medium to coarse-grained, massive andesite, and it was in this massive rock that the pricinpal ore-shoot was deposited.

(1) *Op. cit.*, pp. 258-259.

The principal ore-zone, from which virtually all the ore has now been extracted, occurred in that section of the vein which, on the surface, extended for 210 feet northwest of the shaft-reference point (2), and for 60 feet in the opposite direction, a total of 270 feet. From here downward to the 450-foot level, the ore-zone raked irregularly to the southeast at an angle of approximately 70°, as a consequence of which, on the lower horizon, the entire ore-zone was to the southeast of the shaft-reference point, commencing at a point 70 feet from it and extending to 220 feet, a total length of 150 feet. One of the best portions of the ore-zone permitted of continuous stoping between the first (150-foot) and second (285-foot) levels of the mine over a total length of 240 feet and extending about equally on either side of the shaft-reference point. In addition, there was a 65-foot ore section northwest of the reference point which, owing to deposition on both sides of the porphyry dyke, overlapped the above. Ore deposition below the 450-foot level was unimportant, and the main ore-shoot bottomed at a vertical depth of 490 feet, although a small amount of ore (representing a part of the same zone) was recovered from just above the 600-foot level near the border of the intersecting Blouin Lake fault. There seems to have been little difference between the upper, or hanging-wall, and the lower, or footwall, of the porphyry dyke as favouring ore deposition, since about an equal amount of ore was found on each wall. For example, between the 150- and 285-foot levels, ore in that section of the vein southeast of the shaft-reference point followed the hanging-wall of the dyke, whereas to the northwest it lay for the most part along the footwall. Elsewhere in the zone, deposition of ore on either side of the dyke was common and resulted in overlapping lenses of ore with the porphyry dyke standing as a pillar between them. The dyke might average six or seven feet in width. Ore deposition in the Mine fault, independent of the dyke, is exemplified by that portion of the ore-zone lying between a vertical depth of about 100 feet and the surface. As was noted above, the dyke does not occupy the fault between these horizons. The better ore-bodies of the zone were unquestionably the ones that occurred with the porphyry dyke. Individual lenses of ore in the central and upper portion of the zone had an average stoping width of about six feet; their width in the lower portion of the zone averaged much less than this, possibly only three feet.

Apart from the genetic association which would appear to be highly probable as between the ore and the granodiorite porphyry represented in the Stabell dyke, there would also appear to be a relationship between the ore-zone and the form assumed by the dyke either originally or as the result of later shearing or faulting. The better sections of ore were found in the vein alongside the dyke where the latter is continuous and regular. Much less ore was found in the fault itself where not occupied by the dyke, and little or none where the dyke is irregular or discontinuous either as the result of its having originally taken the form of a series of small lenses, even if fairly closely spaced, or as the result of shearing and faulting by which sections of the dyke have to some extent been affected. Thus, there would appear to be some connection between the southeastern rake

(2) By the "shaft-reference point" is meant the intersection with the vein of a line drawn through the shaft normal to the strike of the vein.

of the ore-zone and the irregular nature of the dyke on the northwest of the zone, and more particularly since the irregularity more or less accompanies the zone downward along a like, southeastern rake or pitch. The relationship is particularly evident on the 450-foot level of the mine. There is also a possible connection between the bottoming of the ore-zone between the 450- and 600-foot horizons of the mine and the disappearance of the porphyry dyke in part of the area of the downward projection of the zone at the 600-foot level. The dyke, however, reappears both on the southeast and northwest at this horizon, clear evidence of its somewhat lenticular habit. The fact that it lenses-out and apparently terminates in the Mine fault some 150 feet northwest of the shaft-reference point, throughout which distance, on the two levels, it is irregularly lenticular and broken up, would indicate less favourable possibilities for the occurrence of ore in this direction than to the southeast. In the latter direction, however, beyond the Blouin Lake fault, vein conditions where disclosed by workings on the 450- and 600-foot horizons are essentially similar to those in the productive portion of the vein northwest of the fault. Nevertheless, development here gave little encouragement, although a small patch of ore was found on the upper of these two levels. A possible explanation is that very different horizons of the vein may be represented on either side of the Blouin Lake fault as the result of movement in the vertical plane. The vertical component of movement along this fault is, however, unknown. The relation of the fault to the known ore-shoot is also of interest, but since the shoot, although raking toward the fault, is terminated before reaching it, the fault, if it is presumed to be entirely post-ore, could not have influenced the termination of the ore in any way. There is, however, a possible connection between them if the fault not only succeeded but also preceded the emplacement of the vein. There is conclusive evidence of its post-vein character, and some indication also, as will be shown later, that it was first developed prior to the period of vein deposition. Since the fault intersects the vein at right angles and dips vertically, the same structural relationship between them as exhibited on upper levels of the mine should be maintained at depth.

The future of the original Greene Stabell mine depends upon whether or not there are ore-bodies at depths below the present workings, since the Stabell vein has been rather thoroughly tested along its strike, with negative results so far as finding new ore is concerned. Some diamond-drill holes were put down in the hope — which was not realized — of cutting ore in the vein below the 600-foot level in the area of the downward projection of the main ore-zone, but, apart from this, the ground below the 600-foot horizon has not as yet been systematically tested. In this connection it should be noted that, since the vein dips at about 70° north whereas the beds in which it lies dip at nearly the same angle in the opposite direction, it rapidly passes on its dip into successively lower, or more northerly-lying, horizons of the volcanics. Since, however, in consequence of its more southerly strike than that of the volcanics it cuts obliquely across the beds at about 35°, this effect of the dip is more or less offset as the vein is followed along its southeasterly strike. Below the 600-foot level, that portion of the vein in the vicinity of the main ore-shoot would first pass,

on its dip, through the 65-foot band of massive trachyte and into the area of more schistose, serpentinized lavas. It is questionable whether this more schistose rock would prove as favourable to ore deposition as the massive andesite in which the principal ore-body occurred. As already indicated, that portion of the vein lying to the southeast of the Blouin Lake fault may, as the result of its strike, be expected to remain to considerable depth in the same massive andesite band as that in which the principal ore-shoot occurred. It should also be noted that the porphyry dyke occupies the Mine fault throughout the length it has been opened-up in underground workings easterly beyond the Blouin Lake fault.

The Stabell vein material consists of white, to darker and somewhat bluish, quartz mineralized chiefly with pyrrhotite and chalcopyrite, together with some pyrite, magnetite, sphalerite, tellurides, and gold. From his study of surface exposures, Cooke (1) concluded that the gold is closely connected with the chalcopyrite, and that the latter (and hence also the gold) occurs chiefly with or near the Stabell dyke and decreases in amount in going westward along the vein, away from the dyke. Quartz and pyrrhotite were found to have a wider range of distribution. Study of the ore in polished section by Maurice Haycock (2) led him to conclude that much of the gold occurs in the quartz independently of the sulphide minerals and chiefly in association with small amounts of the telluride, calaverite. Peter Price (3), from his rather extensive study of the ores, chiefly in polished section, has given probably the most comprehensive report on the subject, which may be summarized here as follows: The vein quartz is of two generations. The earlier pre-dates the metallic minerals, and was fractured to permit of the injection of an intricate network of veinlets of the second generation of quartz together with minor amounts of carbonate, sericite, and all of the metallic minerals with the exception of pyrite, which appears to have been introduced before the later quartz veinlets. The sequence of metallic mineralization is as follows: (1) pyrite, (2) magnetite, (3) pyrrhotite, (4) chalcopyrite, (5) tellurides and gold. The chalcopyrite is in part contemporaneous with the pyrrhotite, but for the most part later. It is an "associate and carrier of the gold minerals", and occurs generally as a series of irregular aggregates strung out along veinlets of the later quartz, and sometimes as minute veinlets cutting the older quartz. Native gold and at least three tellurides are present. There is a tendency for the gold and tellurides to occur along boundaries between quartz and chalcopyrite or pyrrhotite, and between chalcopyrite and pyrrhotite; in the latter case they may be completely surrounded by sulphides. Particles of gold and tellurides show some tendency to occur wholly within chalcopyrite, and, more rarely, within pyrrhotite. Gold and tellurides are also found free in the quartz, but, in such cases, often as small clusters near other gold particles at sulphide boundaries or strung out along minute, later quartz veinlets. The gold particles are, in general, of minute average size.

The fine nature of the gold mineralization and the fact that a considerable part of it is associated with the sulphides, and more particularly

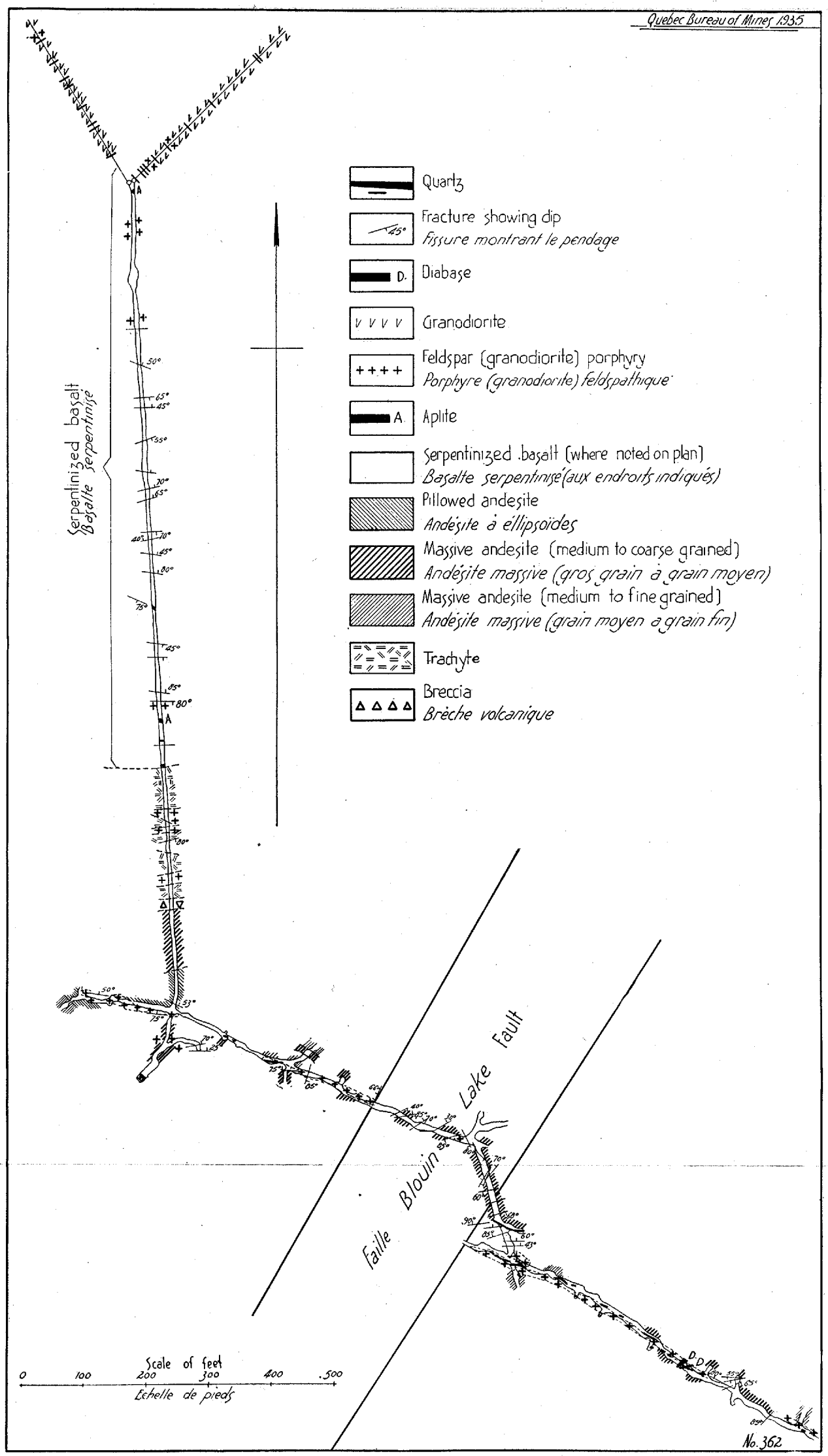
(1) Geol. Surv. Can., Summ. Rept., Part C1, 1923, p. 83.
(2) Mines Branch, Dep't. of Mines.
(3) Private report to Greene Stabell Mines, Limited.

with chalcopyrite which occurs in sufficient amount to constitute a by-product copper ore, resulted in the adoption of a milling practice involving fine grinding with flotation as well as cyanidation. The flotation concentrate, carrying most of the copper and a considerable part of the gold, was shipped to Noranda for treatment. A recovery of about 30 per cent of the gold by straight cyanidation was reported.

STABELL LAKE VEIN:

Over half a mile northeast from the No. 1 shaft (2,800 feet, N.64°E.), near the southeastern margin of Stabell lake in ground optioned from Stabell Lake Gold Mines, Limited, underground work has been undertaken with the object of developing the vein material that had been indicated by diamond drilling from the surface. The vein matter is within the main granodiorite mass in a wedge-shaped area bordered on the south by the easterly-striking granodiorite-Keewatin contact and on the northwest by the Blouin Lake fault-zone, which strikes northeasterly. Three of the diamond-drill holes, spaced at intervals over 360 feet in a northeast direction, had indicated the occurrence of vein material carrying gold values up to $32 per ton over narrow widths, and one hole (No. 4*A*), a wide mineralized zone carrying low average values. Intermediate holes, however, showed little indication of ore values, so that no correlation could be made between the various vein intersections. The wide vein intersection mentioned, which was the only one examined by the writer, consists largely of silicified, schistose granodiorite sparsely mineralized with fine pyrite and chalcopyrite and carrying low values in gold. No tourmaline was seen. The quartz crystals of the vein matter show a series of minute, parallel fractures normal to their direction of elongation, which presumably is in the direction of vein-strike. The vein material is quite different in character from that of the vein that has been developed in the underground workings on this property, as will appear from what follows. It may well be, however, that some of the other intersections of vein material obtained in drilling, and more particularly those showing relatively high values over narrow widths, are of material similar to that of the vein opened-up in the mine. None of the vein structures indicated by diamond drilling have as yet been cut in underground workings.

The vein under development was not known until disclosed by actual mining operations. It was cut on the 400-foot level (the only level established at the date of the writer's examination), at a point in the main cross-cut 200 feet northwest of the shaft. The fracture it occupies is for the most part strong and well defined, and consists either of a simple fracture varying in width from a few inches to upwards of two feet, or of a series of closely-spaced, superimposed fractures or shears forming a zone with a width of twelve feet or more. Although rather variable both as to strike and dip, the vein-fracture strikes approximately N.50°E. and dips rather flatly, about 25°, to the southeast. Toward the southwest, however, as it approaches the margin of the granodiorite, the fracture steepens to a dip of as high as 50° and at the same time the strike changes, until it roughly parallels the east-west striking granodiorite-Keewatin contact. For the most part, the vein lies in somewhat fractured, and in places foliated,



(*After W. F. James and J. E. Gill*)

Map No. 362. — **Geological plan of underground workings on the 600-foot level. Greene Stabell Mines, Limited.**

granodiorite which, petrographically, is very like that of the Bourlamaque batholith elsewhere, but contains a very minor amount of primary quartz. Lying above the vein, however, and revealed chiefly in the cross-cut from the shaft to the drift on the vein, is a body of dark grey, fine-grained tock intrusive into the granodiorite and presumably corresponding to an andesite in composition. The fact that only minor amounts of similar rock were encountered elsewhere, either in the shaft above the level or in the drift on the vein, would suggest that the body strikes northwest, about parallel to the cross-cut, and that it dips at a fairly low angle. There is evidence elsewhere of somewhat similar structure, as in the southwest drift, where the vein fracture cuts across an earlier, schistose structure in the granodiorite striking northwesterly and followed in part by narrow dykes, presumably also of andesite. The vein fracture, as seen in the southwest drift, passes through a strong, gouge-filled fault without notable displacement and would thus appear to be definitely later than the fault. The latter strikes N.35°E. and dips 50°N.W. It is thus parallel to, and probably an offshoot from, the Blouin Lake fault-zone. It this be so, it provides at least an indication that the Blouin Lake fault is pre-ore in age. What appears to be the same narrow dyke of olivine diabase already described as cutting through the Stabell vein on the east side of the Blouin Lake fault was intersected in the main cross-cut a short distance northwest of the shaft, where it attains a thickness of four feet and strikes N.45°E. with a steep, northwest dip.

The vein has been opened-up for a total length of nearly 400 feet. For the most part it is narrow, more particularly where of ore grade; in such places it would probably average less than one foot, although, in addition to the vein-filling proper, there is commonly a related silicification and mineralization of the wall-rock close to the vein. The main ore-shoot, as developed, has a length of about 90 feet northeast from the point where the vein was intersected in the main cross-cut. It is reported by the Company that, over this distance, an average value of $21 per ton (gold at present valuation) was obtained over an average width of one and a half feet. On the dip, this section of the vein has been opened-up for a total of about 175 feet, by a winze for 120 feet and by raises and stopes for 55 feet. The material indicated seems essentially similar to that revealed by the drift. Beyond the point mentioned, 90 feet northeast from the cross-cut, the vein is not as well defined and is poorly mineralized. Southwest from the cross-cut, the drift showed somewhat greater widths of poorly mineralized, white vein material with considerable carbonate over a length of about 100 feet, beyond which better mineralization was encountered, with sphalerite and sufficiently high gold values to indicate the probability for the development here of some small sections of ore. It has yet to be demonstrated whether or not this vein forms one of a series of flatly-dipping lenses possibly related to the Blouin Lake fault or to the main granodiorite-Keewatin contact as subsidiary structures. The northeast strike parallel to that of the Blouin Lake fault is rather suggestive in this connection.

The gold-bearing vein matter is essentially similar in appearance to that of the Stabell vein, with the exception that it is characterized by rather abundant sphalerite and less chalcopyrite, with little, if any, pyr-

rhotite. Pyrite is present. Chalcopyrite, in particular, frequently occurs as veinlets cutting through the quartz. Sphalerite is said to be one of the best indicators of gold values in this vein. Actual milling has shown that, with this ore, a satisfactory gold recovery can be obtained by cyanidation without recourse to flotation, which was necessary in the case of the ore from the Stabell vein. However, the ore of the two occurrences (the material from the vein in granodiorite was examined by the writer only under a hand lens) is sufficiently alike to indicate the probability of the origin of both from a common source. This is particularly interesting in view of the fact that the Stabell vein occurs in the Keewatin lavas 1,000 feet south from the granodiorite contact, whereas the other vein is within the granodiorite itself. Furthermore, the vein material of both is in marked contrast to the white-quartz-tourmaline-pyrite mineralization typically associated with the Bourlamaque granodiorite, which would suggest that this intrusive is capable of giving rise to gold deposits with rather widely varied types of mineralization. It is assumed that the granodiorite porphyry of the dyke with which the Stabell vein is believed to be related genetically is a differentiate of the batholith, and that the granodiorite of the latter is the source rock of the newly-developed vein, which it encloses.

Total development carried out in the original Greene Stabell mine from the four main levels at vertical depths of 150, 285, 450, and 600 feet, up to the time work was suspended in June, 1936, is as follows: drifting, 3,540 feet (on the Stabell vein); cross-cutting, 2,830 feet. Slightly over a quarter of a mile of cross-cutting is represented in the north cross-cut which was driven on the 600-foot level with the object of exploring the vicinity of the contact of the Keewatin lavas with the main granodiorite. Ore milled from the Stabell vein at the completion of stoping operations amounted to a total of 64,891 tons; early estimates had placed the probable tonnage at 50,000 but of higher average grade than was realized in actual milling. The new (No. 2) shaft on the Stabell Lake Gold Mines property has been sunk to 400 feet, with lateral workings as yet confined to that level. At the time of the writer's recent visit, preparations were under way to deepen the shaft. Colin Johnson is resident manager of the mine.

In the foregoing description of the Stabell vein and vicinity as developed from the No. 1 shaft, much of the data has been obtained from the excellent plans and sections prepared chiefly by B. S. W. Buffam in the interests of W. F. James and J. E. Gill, who acted as consulting geologists to the Company

Sullivan Consolidated Mines, Limited

The first discovery of gold in the eastern part of the Rouyn-Bell River belt was made by J. J. Sullivan who, with Hertel Authier in July, 1911, staked the property that has since become the Sullivan mine. The discovery consisted of a gold-bearing quartz vein exposed on the eastern shore of lake Montigny, at a point about four miles southeasterly from its outlet. The property now comprises 890 acres, made up of mining concession No. 123 and blocks *O* and *P* in the northern part of range IX and the south-

ern part of range X. The northwestern corner of the property adjoins the holdings of Siscoe Gold Mines, Limited.

Prior to 1928, work on the property had been limited to surface exploration, which included stripping and trenching. In March of that year, Sullivan Gold Mines, Limited, was incorporated to develop the property. Camp buildings were erected, diamond drilling was commenced, and also, in November, the sinking of a shaft, which, however, was later abandoned. In the following year, the present two-compartment shaft was started in mining concession No. 123, east of the original shaft-site. It was sunk to a depth of 273 feet and, early in 1930, lateral work was commenced on the bottom level; but in March, underground work was suspended, owing partly to inadequate pumping facilities. Diamond drilling aggregating about 1,000 feet was also completed at that time. The mine then lay idle until the spring of 1932, except that, during the summer of 1930, it was de-watered for examination by Hollinger interests under an option agreement. The present Company was incorporated in March, 1932, following which more extensive operations were commenced and continued until the fall of 1933. Development included diamond drilling, the installation of new machinery, deepening of the shaft to 370 feet, and extensive underground exploration on the 150-, 250-, and 350-foot horizons. To the close of this period — September, 1933 — funds for development were provided chiefly through financing by Sudbury Basin Mines, Limited, and Ventures, Limited. Early in 1934, however, when operations were resumed, finances were arranged chiefly by other interests, namely, the present directors of the Company. Erection of a mill was at once commenced and in June, 1934, it was operating on the basis of 50 tons per day, power being provided by a Diesel plant. In the late summer of the same year this source of power was discontinued in favour of electric power furnished by the Northern Quebec Power Company from its substation near Blouin lake. In June, 1935, the mill was stepped-up to treat 100 tons per day, and in October of the same year was treating 113 tons daily.

Gold production for the period during which the mill operated in 1934 was valued at $140,153, the yield being about $16.96 per ton (gold at present valuation). During 1935, gold to the value of $468,062 was produced, and, in addition, $2,402 worth of silver as a by-product. Total gold production to the end of 1935 was, therefore, in excess of $600,000. The mill at present has an average monthly output of gold valued approximately at $44,500.

The geology of the property has been described at various times in the publications of the Quebec Bureau of Mines and of the Geological Survey of Canada (1). The earlier reports are, necessarily, confined to the surface geology, and even at the time of Hawley's examination in 1930, the mine workings were flooded and development by diamond drilling and underground exploration was sufficient only to suggest the importance of the

(1) See following reports, listed on page 9 under *Selected References*: Bancroft (pp. 220-222), Tanton (pp. 66-68), Mailhiot (pp. 143-146), Cooke *et al* (pp. 253-255), and Hawley (pp. 56-63).

deposits, including vein *A*, the principal ore-bearing vein. It is of interest to note that, although a number of veins are exposed at the surface — some of them with visible gold and said to yield good assay values in places — there is but little indication at the surface of any deposit of commercial interest. The surface projection of the important *A* vein lies for the most part under the lake. It is not considered necessary to give any further description here of the veins as exposed at the surface. Their character is well summarized by Hawley as follows (p. 58): "On the surface, the majority [of the veins] are very narrow stringers in tight easterly-trending fractures in the granodiorite, and, although their lengths range as high as 300 feet, their narrow character does not recommend them ".

Broadly speaking, the deposits are in granodiorite, within the western border of the most westerly projection of the Bourlamaque batholith. Hawley was of the opinion that the batholith did not extend from the Sullivan as far northwest as the Siscoe mine, and that the intrusive at that mine was a separate body. This opinion is supported by the results from two diamond-drill holes drilled from the ice on Montigny lake, in claim A-25726; soapstone having been intersected in each hole. The main batholith may be continuous, however, north of these holes, although dip-needle surveys, both by Hawley and by the Sullivan staff, go to indicate that this is not the case, but rather that the western margin of the batholith lies some 2,000 feet northwest of the Sullivan No. 1 shaft. Full petrographic descriptions of the granodiorite, together with chemical analyses, appear in pages 23-25 of Hawley's report. The rock exposed in the vicinity of the mine is granodiorite, with, however, a few narrow dykes, chiefly of porphyry, and, in addition, some narrow bodies of schistose, green rock formerly regarded as inclusions of green schist. From comparison of these schists with altered dykes cut in underground workings, there is little doubt that most, if not all, of the 'greenish inclusions' in the vicinity of the mine are in reality highly altered and sheared dyke rocks.

Underground work and diamond drilling have revealed an assemblage of dykes, a few of which are very large and play an important structural rôle in connection with the ore deposition. The attitude of the dykes is, therefore, of considerable significance and will be considered in dealing with the structure of the rocks. They fall into two general sets, as do the vein structures. The majority of the dykes are rather narrow, generally ranging from one to five feet in thickness. Petrographically, they are of three types: albitite porphyry, quartz-albite porphyry (aplite), and andesite or andesite porphyry.

Dykes of albitite porphyry are not as abundant as are those of the other types. While definitely porphyritic, the rock appears coarsely granular in texture, owing to the fact that phenocrysts form about 70 per cent of its volume. It is of greyish colour, with some of the feldspars showing a pink or faint purple tinge. Albite (Ab98) is the dominant constituent. There is some orthoclase, and in the groundmass there is a minor amount of quartz which may, however, be largely secondary. Definitely secondary minerals are not particularly abundant but include chlorite, carbonate, epidote, and sericite. Dykes of this type have also been referred to as granodiorite porphyry—the term suggesting their rela-

tionship to the granodiorite, of which they are undoubtedly a differentiate. The principal dyke of albitite porphyry was intersected in the cross-cut on the first level of the mine a short distance northeast of the drift on *A* vein and would appear to correspond to the dyke as exposed at the shore of the lake near the wharf. Although its strike is approximately parallel to that of the *A* vein system, *i.e.*, northwest, its dip of 70° is much steeper. Specimens of rock from the dyke differ from the petrographic description given above (which are of albitite porphyry as cut in drill holes) in that they exhibit some primary bluish quartz as phenocrysts.

Quartz-albite porphyry dykes are commonly narrower, but somewhat more abundant, than the albitite porphyry. They occur chiefly in the area southwest of No. 1 shaft and are light-coloured — white to bluish-grey — and fine in texture, with little or no evidence in hand specimen of the finely porphyritic texture revéaled by the microscope. Albite (Ab98), orthoclase and quartz are the main primary constituents, quartz making up about 25 per cent of the rock. Albite is somewhat more abundant than orthoclase. Ferromagnesian minerals are lacking, and secondary products only sparsely represented. The rock is of fresh appearance. The term 'aplite' is also used to designate such dykes and would seem to be quite applicable were it not for their porphyritic texture.

Dykes of andesite and of andesite porphyry are quite abundant throughout the mine workings. For the most part they are narrow, not exceeding two to three feet, although there are two notable exceptions in which the dykes attain widths of 100 feet or more. The first of these wide dykes defines the No. 4 vein zone, and may have a structural connection with other vein fractures with similar strike and dip; the second, exposed in the southwestern mine workings, is closely connected with the mineralization in the 'Southwestern zone' of the mine. That the andesite series of dykes have a close relationship, structurally, with the veins is indicated by the fact that they may partially fill or follow fractures along which vein solutions later ascended, as, for example, in the case of veins 2 and 3. For the most part, the extent of alteration which the rock has suffered renders determination of its original character difficult. Albite replacement is one phase of this alteration, with the result that the feldspars may now be much more sodic than they originally were. Sufficient material of relatively fresh and massive nature was, however, secured to indicate rather definitely the original mineralogical composition of the rock. The texture varies widely, all gradations having been noted from non-porphyritic types to those with relatively large and abundant phenocrysts. The non-porphyritic and slightly porphyritic phases usually appear finely granular in hand specimens, whereas the definitely porphyritic varieties show phenocrysts of white feldspar set in a dense, dark greenish-grey groundmass.

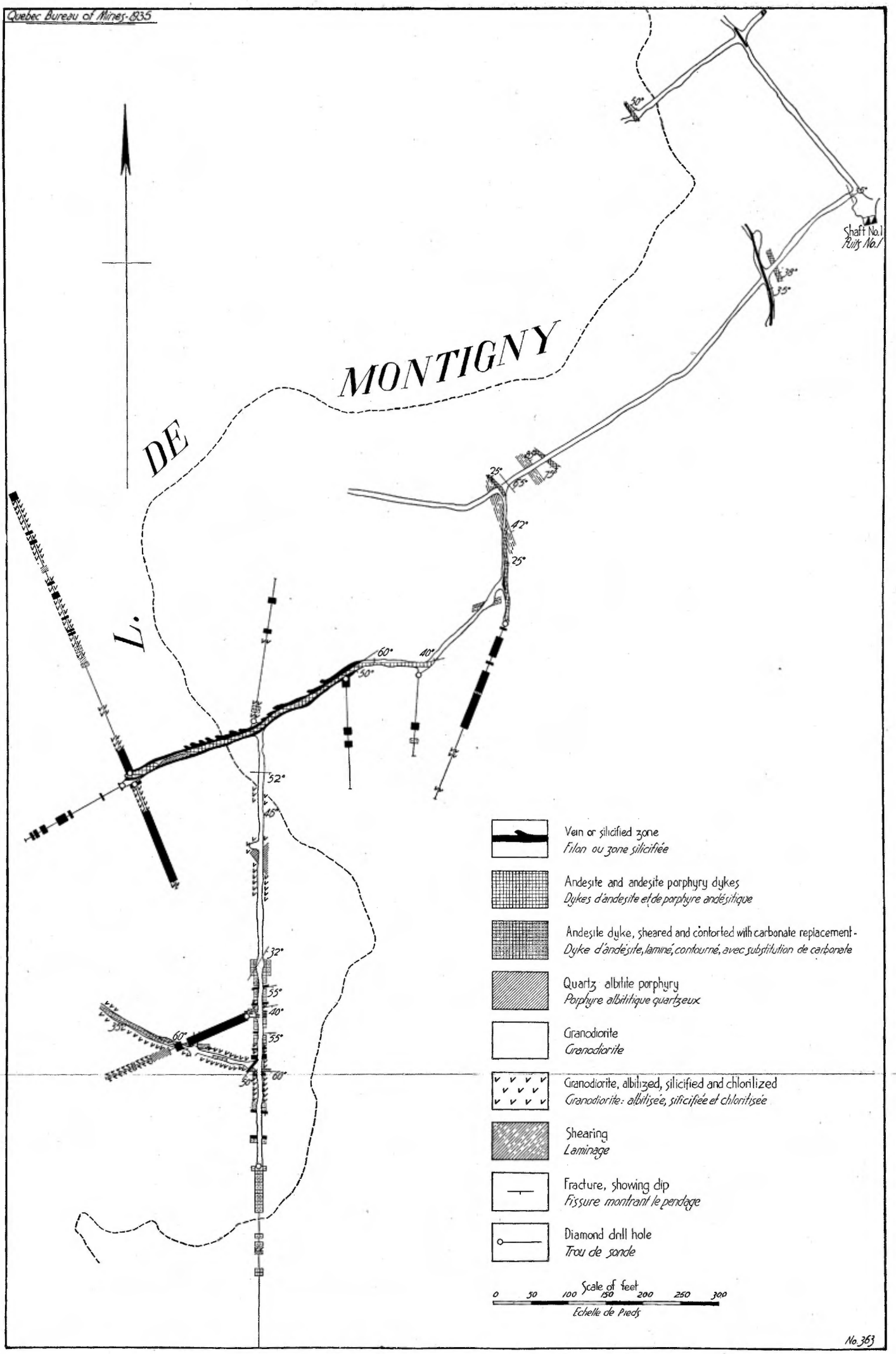
The following description applies to the massive, less altered phases. The rock is characteristically feldspathic, with fairly abundant secondary minerals. Andesine (Ab60-65), with a much smaller proportion of orthoclase, are the major constituents. The feldspars are commonly somewhat altered to sericite. Some quartz is present but is confined to the groundmass and may be secondary. Hornblende, much altered to chlorite, has

been noted, but is not a prominent constituent. Chlorite and carbonate are present in widely varying amount.

The more schistose and altered of the andesite intrusives differ petrographically from the massive ones in that their feldspar is essentially albite, and also in carrying a much higher proportion of chlorite, carbonates, and, in some, secondary quartz. These altered phases will be considered in further detail in connection with the description of the No. 4 and Southwestern zones.

The age relationship between the albitite porphyry and the quartz-albite porphyry or aplite is unknown; they may be more or less contemporaneous. The andesite and andesite porphyry are, however, pretty definitely later. In the southwestern section of the mine, on the second level, a dyke of andesite, although much affected by shearing, may be seen cutting one of quartz-albite porphyry. Further, there is the marked tendency for the andesite dyke material to follow fractures which were later filled by vein material, such fractures being regarded as relatively late structures.

The vein deposits, and also most of the andesite dykes, are controlled by, or fall into, two definite structural patterns, one of which characterizes the deposits in the vicinity and to the northeast of No. 1 shaft, and the other those of the southwestern section of the mine. In places, however, the two structures are known to intersect, and such intersections have had an important influence on ore deposition, as will appear from the description of the deposits that follows. Since both the andesite dykes and the vein fractures that in part at least succeeded them (in some cases being actually in the dykes) correspond in structure, the inference may be drawn that the dykes followed structures developed prior to their intrusion, and that later movements involving the dykes and connected with the vein fractures were essentially similar in their effect. The fact that the andesite dyke rock is softer than the more brittle granodiorite, and thus yielded much more readily to deformation, is an important factor in connection with the localization of movement and fracturing subsequent to the intrusion of these dykes. The prevailing structure in the northeastern part of the mine is exhibited by the attitude of the vein fractures and of the great majority of the dykes cutting the granodiorite. These form a set with a general strike of N.40°W. and a dip averaging about 40° (range 30° to 45°) to the northeast. This structure is exhibited not only in the well-defined vein fractures, but also in numerous minor fractures, slips, or even joints in the rock. From the extent of alteration of the wide No. 4 zone, it is obvious that much of the movement subsequent to intrusion of the andesite took place here, and that it represents a major zone of weakness. It may prove that vein structures of similar attitude are subsidiary to the No. 4 zone and more or less confined to its vicinity. The more important deposits of the mine belong to this structural system and include veins *A*, 2, 3, and 4. The second set of structures, as revealed in mine workings and particularly characteristic of that area southwest of the No. 1 shaft, has a general east-west strike (commonly somewhat north of east) and a dip that varies from vertical to about 45 degrees either to the north or south. North-dipping fractures, or narrow shears, are more common in that part



Map No. 363. — **Geological plan of underground workings on the 250-foot level. Sullivan Consolidated Mines, Limited**

of the mine extending for 900 feet southwest from the shaft, or to the vicinity of survey station 270 on the second level of the mine, but southwest from this point southerly-dipping structures prevail. At the 900-foot limit mentioned, an actual intersection is to be seen: a fracture with dip varying from 40° to 60° north is cut by, and is therefore older than, one of a set dipping 50° to the south. On the whole, vein matter seems to favour the southerly-dipping fractures and especially those that are nearly vertical. Shearing in the wide dyke that defines the Southwest mineralized zone strikes slightly north of east and dips 60° south; the dyke itself is presumed to have the same attitude. Deposits belonging to this structural system include the Southwest zone, a vein newly opened on the first level of the mine, and also the principal veins as exposed at the surface (1). Projected to the surface, the hypothetical intersection of the two structural systems outlined — the No. 4 with the Southwest zone — is 1,300 feet east and 950 feet south of No. 1 shaft.

As already noted, the more important group of veins belong to the first, or northwest-striking (N.40°W.) and northeast-dipping (40°), set. They lie near and to the northeast of No. 1 shaft over a total width of about 600 feet measured normally to their strike. In order of their position from southwest to northeast, they are termed veins *A*, 2, 3, and 4. Vein *A*, as projected at the surface, lies 300 feet southwest of No. 1 shaft but, as a result of its dip, was cut in the shaft between the first and second levels, and in the 350-foot level cross-cut at a point 260 feet northeast of the shaft. It is the most important vein yet developed in the mine and has furnished the major part of the gold produced to date.

Vein *A* has been developed over a maximum length of some 750 feet on the two upper levels, 600 feet of which lies to the northwest of the shaft, or of the main cross-cuts from the shaft. The principal ore-shoot is confined chiefly to that section of the vein in the near vicinity, and to the northwest, of the shaft. It yields ore of good grade over a length of some 350 feet on the first level and continues down to the second level, although here the ore occurs in the form of several lenses, the combined length of which would be around 300 feet. On the third level, however, it appears only in a few short and narrow lenses. Although the fracture is strong and well defined at this lower horizon, vein filling is sparse and consists of quartz in addition to an albite replacement, which in some places forms the inclusions of a vein breccia. The ore-shoot attains its greatest thickness, as much as 30 feet, where opened-up immediately northwest of the cross-cut on the first level; the expansion here is due in part to a flattening in conjunction with a bend in the vein, which swings off in a more westerly direction. Much of the ore in this wider portion of the vein shows a brecciated structure and is exceptionally rich in gold. The fact that the ore-shoot is closely localized in the vicinity of the intersection between vein *A* and the steeply-dipping No. 1 vein (exposed at the surface) upon which No. 1 shaft was sunk, is probably a highly significant one. The ore-shoot for the most part lies near, but chiefly northwest of, the zone of intersection.

(1) Veins outcropping at the surface are shown on Map No. 152, Que. Bur. Mines, Ann. Rept., Part C, 1930, p. 57.

Northwest of the ore-shoot, on the first level, the vein has been developed for an additional 400 feet, throughout the greater part of which there is substantial vein matter, often associated with heavy bands of tourmaline and appearing as layers or as a pseudo-stratification. Mineralization here is, however, sparse, and it is understood that average values are such as to make it questionable whether the material can be mined profitably. Northwest of the main ore-shoot on the second level, the vein is quite different in character. The fracture, although well defined, is for the most part 'dry'. Fracture cleavage here suggests that at least the last movement along it was that of a normal fault. At distances of 390, 485, and 520 feet northwest of the main cross-cut on this level, the *A* vein fracture — which in this vicinity dips rather more flatly than usual, about 25° — is seen to intersect fractures or narrow shear-zones of the east-west system, the attitudes of which are, respectively, as follows: strike N. 63° W., dip 50° N.E.; strike N.80°E., dip vertical; strike N.70°E., dip 50°N. In the *A* vein fracture, at its intersection with these structures and in related, irregular fractures, are occurrences of ore, some of which is said to be of high grade. Vein matter is, on the whole, sparse, although considerable metallic mineralization is in evidence. Intersection of fracture zones has obviously influenced ore deposition here. Further work will, however, be needed to establish the dimensions of such occurrences.

To the southeast of No. 1 shaft or of the main cross-cuts on the various levels, the *A* vein yields only minor amounts of ore, most of which comes from what seems to be the southeastern extremity of the main ore-shoot, represented here chiefly in small, subsidiary occurrences of ore. Rock structure in this vicinity appears to be relatively unfavourable, since the vein fracture tends to split as it is traced toward the southeast, where it enters rock that is irregularly fractured and broken up, thus probably indicating a more disturbed zone. The irregularly fractured nature of the rock here is probably due to the fact that it lies in the area of intersection of the two major fracture systems of the mine as distinct from the intersection of individual members of the two systems — a condition which, as pointed out above, probably had a localizing influence on ore deposition.

Veins 2 and 3 may be grouped with vein *A*, since they are similar structurally and, although not as well mineralized, are similar also in the general character of their vein filling, where such is present. They have as yet been developed only on the bottom (third) level of the mine, where opened-up at points 240 feet and 340 feet, respectively, to the northeast of the drift on vein *A*. On the second level, cross-cutting has not been extended sufficiently to tap them, and on the first level they have not been identified in the workings. The latter circumstance may be taken as indicative of their weaker nature as compared with vein *A*, although the fact that the drift on the first level follows the east-west No. 1 vein for over 250 feet may in part explain why No. 2 vein was not recognized here. In the cross-cut on this level northeast from the drift on No. 1 vein are numerous dykes of andesite porphyry, one of which may correspond to the dyke that follows the No. 3 vein fracture on the third level. Veins 2 and 3 have each been developed for upwards of 350 feet. Each is followed, in part at least, by dykes of andesite porphyry. Some narrow lenses of quartz-

tourmaline, not, however, particularly well mineralized, occur in the No. 2 vein fracture as also in No. 3 vein, although, in the latter, albite replacement material, which in places forms a vein breccia, is more abundant. The fact that these veins are similar in their structure to the ore-bearing *A* vein lends encouragement for their further development.

Vein matter of the *A*, 2, and 3 veins is chiefly quartz with abundant tourmaline, such as is characteristic of gold-bearing veins associated with the Bourlamaque granodiorite and related intrusives. The sequence in the process of vein filling and mineralization seems to have been somewhat as follows:

(1) Solutions that deposited chiefly albite and carbonate ascended along the vein fractures and replaced their walls.

(2) Later movements, evidenced by fracturing and brecciation of the albitized material, were succeeded by the introduction of quartz and tourmaline, with some carbonate. Two generations of quartz may be recognized, more particularly in vein *A* to the northwest of the principal ore-shoot on the first level of the mine. The first is a stony-looking, bluish-grey quartz with which abundant tourmaline may be associated, in some places as massive layers. Injected as lenses into this earlier quartz as conformable layers, and giving rise to the appearance of stratification, is a white quartz, also with abundant associated tourmaline. That such quartz is later is clearly shown by the presence, in places, of tourmaline-coated slip planes along its contact with the darker quartz. The latter appears to be closely associated with the albite replacement material of the veins, and hence connected with the earlier phases of vein emplacement. Microscopic study in thin section of samples from the highly mineralized, principal ore-shoot in vein *A* (in which both types of quartz occur) shows that the bluish-grey quartz is in unusually large crystals, all similarly oriented, and fractured or somewhat granulated in places, most of the fractures showing a more or less parallel alignment. It was also noted that both tourmaline and carbonate were for the most part introduced along fractures in the quartz, carbonate having succeeded the tourmaline.

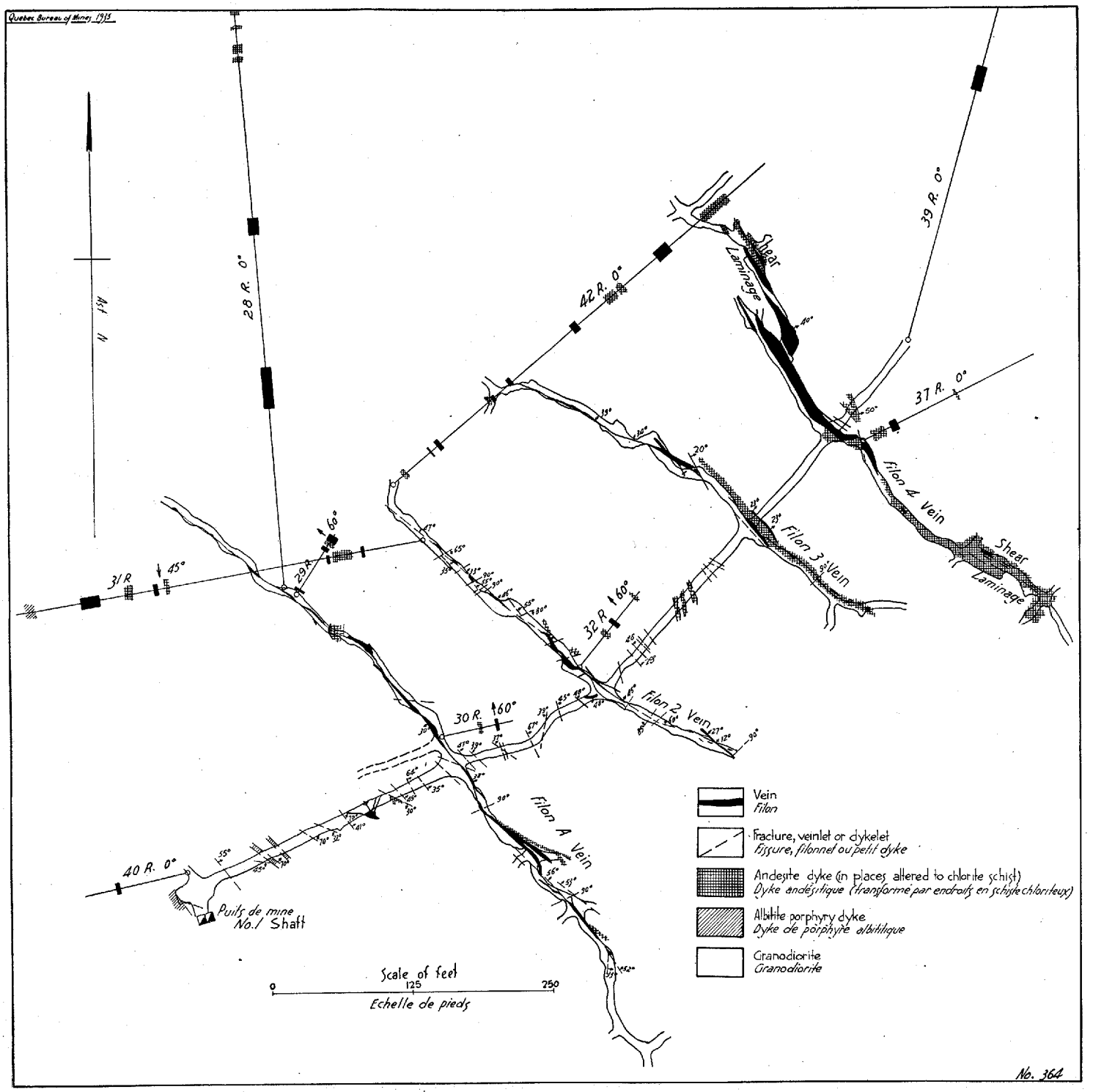
(3) The last phase in the process of vein filling was metallic mineralization, largely pyrite, but including chalcopyrite and gold. Pyrite and chalcopyrite are to be seen filling fractures in both quartz and tourmaline, but more particularly they are associated with remnants of carbonate, which they would appear to have replaced in part. It would thus seem that at least one generation of carbonate filled fractures in the quartz, and that the sulphide minerals had a tendency to follow the same or similar fractures and to replace the carbonate previously deposited.

Milling tests of the ore were made in the Ore Dressing Laboratories of the Mines Branch, Federal Department of Mines. Following is a brief summary of their report: The gangue is a glassy-grey quartz containing small veinlets or disseminated grains of carbonate; a grey, chloritic phase is locally prominent. Small grains of a mineral, grey by reflected light, are also present, but were not identified. Most, if not all, of the gold occurs in the native state. The method of milling recommended is that of concentration by means of blankets, followed by cyanidation of the blanket tailing,

with a possible overall recovery of about 98 per cent of the gold. The milling practice, as recommended, has been adopted. A large percentage of the gold is caught in traps at an early stage in the milling process and is recovered by amalgamation. The mill tests are understood to have been carried out on ore from the *A* vein.

No. 4 vein zone is similar in its strike and dip to the *A*, 2, and 3 veins, but differs from them mineralogically and in structural detail. It has been opened-up on the first and third levels of the mine at points ranging from 450 feet to 550 feet northeast of the drifts on vein *A*. It is a zone rather than a vein proper, and is defined by a large, lenticular andesite dyke, which, on the first level, attains a thickness of over 100 feet, but narrows on the third level to about 22 feet. On each level are rather numerous, smaller related dykes, similar in composition and more or less restricted to the vicinity of the main one. Microscopic examination of the massive rock of the large dyke shows it to be a non-porphyritic, or finely porphyritic, andesite, the principal feldspar being andesine (Ab60) (see page 35). To a considerable degree, however, the dyke has yielded to stresses, as a result of which it is now much altered, essentially to a chlorite schist. Besides chlorite, which may form up to 60 per cent of the rock, there is also present secondary quartz, carbonate, and albite (Ab96). A relatively wide, chloritic shear-zone of this nature, while affording access for the mineral-bearing solutions, does not provide much control for their deposition. As a result, the No. 4 vein-zone consists of a series of related, irregular quartz lenses occurring at intervals throughout the chlorite schist that here represents the wide andesite dyke. It is understood that some of the gold-bearing lenses are of sufficient size in themselves, and that others are sufficiently concentrated as a zone, to constitute mineable ore, more particularly on the third level of the mine, where the dyke is narrower and may thus be assumed to have provided a correspondingly restrictive or confining control over deposition of vein matter within it. In addition, diamond drilling has shown that, in certain places, the granodiorite adjacent to the sheared dyke is fractured and has its original constituents largely replaced by albite (Ab98), carbonate, quartz, chlorite, and pyrite, as well as by gold in sufficient quantity to constitute ore values. Further work will be necessary to determine the importance of the No. 4 zone. The vein matter is more or less peculiar to the zone, consisting of white, fractured quartz with some carbonate, and with abundant associated chloritic material. Only minor amounts of tourmaline are to be noted, and mineralization, consisting of pyrite, is sparse. Visible gold is reported.

The soft nature of the rock of No. 4 zone will make mining here somewhat more difficult than elsewhere. In the fall of 1935, the zone had been opened-up by drifting over distances of 245 feet on the first level, and 530 feet on the third level. It has been traced for a length of 1,400 feet by diamond drilling from the surface, throughout which distance the presence of gold was indicated. Such drilling shows that the zone widens appreciably toward the southeast, along its strike, but that to the northwest, beyond the 1,400-foot section, and as intersected in three diamond drill holes, it is represented only by a few narrow dykes of andesite porphyry



(*After W. G. Barrett*)

Map No. 364. — **Geological plan of underground workings on the 350-foot level. Sullivan Consolidated Mines, Limited.**

without any defined shear zone such as that indicated throughout the No. 4 zone proper.

The second of the two vein systems, namely, the east-west system, is represented chiefly in three occurrences, all of them to the southwest of No. 1 shaft. A fourth, the No. 1 vein, upon which the shaft was sunk, although gold-bearing, is very narrow and is not dealt with here. First of these occurrences may be mentioned a quartz vein newly opened-up on the first level and situated a short distance southwest of the principal ore-shoot in the *A* vein. It strikes N.70°E. and dips 40°S. The vein matter is about two and a half feet thick and is well mineralized with pyrite, chalcopyrite, sphalerite, and galena, with good values in gold reported throughout the limited distance it had been opened at the time of the writer's examination.

Second is an occurrence on the second level, where, from a point 900 feet southwest of the shaft, drifting has been carried for 365 feet in a southwesterly direction on a barren-looking quartz vein that strikes S.65°W. and dips 60° to the southeast. Following the vein fracture for a considerable part of this length is a dyke of andesite porphyry and, for a lesser distance, one of quartz-albite porphyry. The vein material, consisting chiefly of quartz, shows typically a branching or 'horse tail' structure with reference to the fracture it follows. The vein doubtless corresponds to the one exposed at the surface and termed No. 5 vein in previous reports. Values from sampling underground are understood to be low, although it is reported that some fair assays were obtained in earlier diamond drilling.

The third example of the east-west vein system is the deposit known as the 'Southwest zone', which has been opened on the second level by the long cross-cut some 1,400 feet southwest of the shaft, and which has been probed by diamond drilling from the surface. The drilling had rather consistently indicated ore values in this vicinity, although the drill intersections were never satisfactorily correlated. Drilling results have not been substantiated by the underground work completed to date. The deposit is in many respects comparable with the No. 4 zone and, like it, is defined by a higly sheared dyke or dykes. The original nature of the dyke has not been determined with certainty, owing to the extent of the shearing and alteration. From examination of the least altered material available, it would appear that the original rock had a porphyritic texture and probably an intermediate composition, from which it may be assumed that the dyke is one of the andesite porphyry group. The weaker dyke-rock has yielded to flowage, whereas the granodiorite adjacent to it has fractured. Flowage structure in the dyke rock is preserved chiefly through its replacement by carbonate and chlorite, and it now appears as finely crenulated and contorted banding. The minor bands consist of almost pure chlorite, whereas the wider ones are made up of carbonate, with lesser albite (Ab98), quartz, and some biotite, the constituents being wholly secondary. The lighter colour of the rock of this zone as compared with that of No. 4 is to be accounted for by the fact that carbonatization is here the principal form of replacement, whereas chloritic replacement characterizes the other zone. The principal dyke of the southwest zone attains a width of over 100 feet. Diamond drilling shows a second body a short distance to the south and

there are numerous smaller bodies of similar material in the vicinity with attitude similar to that of the main dyke or zone, which would appear to strike N.80°E. and dip 60° south although, on the other hand, there is suggestion that the strike is slightly south of east. The schistosity or shearing appears to correspond fairly well in strike and dip to that of the dyke itself. Although further work will be required to determine their true nature, present diamond drilling would suggest that the dykes or bodies in the area of the Southwest zone are highly lenticular.

Mineralized deposits in this section of the mine are of two types. One is an irregular replacement of fractured granodiorite adjacent to the dyke. It consists of light, bluish-grey, pyritized material, study of which in thin section indicates a replacement of the original constituents of the granodiorite by quartz and albite (Ab98), both of which are fractured or somewhat granulated and traversed by later veinlets of quartz with chlorite and carbonate. The second type of deposit takes the form of lenses of greyish quartz, well mineralized with fine pyrite and occasionally carrying sphalerite and visible gold. The typical vein material is a fine mosaic of quartz grains with a little albite. Comparison of a specimen from a lens in which good values were obtained with one of well mineralized material of identical appearance but barren or with very low gold values, showed that the quartz mosaic of the former was fractured and crushed in places, whereas in the latter it showed no strain or deformation. It is of interest to note that in places the greyish quartz vein material of the Southwest zone is cut by lenses of white quartz carrying tourmaline, which is a further indication that the veins of the N.W.-S.E. system (the gangue of which is quartz and tourmaline) are the younger of the two vein systems. The mineralized material developed to date in the southwestern section of the mine is low grade. It was estimated by the manager, Mr. MacPherson, that the principal zone, for a length of over 100 feet from where it was intersected in the main crosscut, carries an average of 0.09 oz. in gold per ton. Slightly lower average values were obtained from a drift on the zone.

In addition to equipment and development already mentioned, a new shaft, No. 2, is being sunk in the northeastern section of the mine. It is an incline, following the dip of the *A* and related veins, which will be developed from this new shaft.

J. C. R. MacPherson, who was in charge of the mine, resigned in the late fall of 1935, and was succeeded as manager by I. M. Marshall.

Shawkey Gold Mining Company, Limited

The property of the Shawkey Gold Mining Company, Limited, comprises an area of 637 acres held under mining concession No. 276 and covering the vicinity of the inlet into Montigny lake, in ranges VIII and IX of Dubuisson township. The principal showing was staked by Fred La Palme in 1911 and subsequently became known as the LeBlanc claim. The Martin Gold Mining Company, Limited, was later incorporated to develop the property and in 1917 underground work was commenced as well as the erection of a small mill which was completed in the following year. Work was suspended in 1919, and two years later the property was sold at auction

to John Dalton. In 1922, an option was secured by J. J. Godfrey, of New York, and underground work was resumed, the shaft being deepened to 325 feet and lateral work to the extent of about 300 feet completed. Diamond drilling also formed a part of this programme of exploration. The option lapsed in 1923. Subsequently, J. B. Mosso was instrumental in interesting J. R. Shawkey, who purchased the property. Shawkey Gold Mines, Limited, was incorporated to operate the mine, but very little development was carried out prior to the reorganization of the Company in 1934 as the Shawkey Gold Mining Company, Limited. Actual mining development was commenced by this Company in the fall of 1934.

The rocks in the vicinity of the mine are Keewatin basaltic lavas or greenstone, intruded by irregularly elongated bodies and dykes of syenite porphyry (so designated by Cooke (1)). It was found impossible to determine the attitude of the lava flows at the mine, but on a small island half a mile from the shaft in a direction N.75°W., the contact between two flows is exposed. It strikes N.47°W. and apparently dips steeply to the south, with the tops of the flows facing south. Since the principal vein at the Shawkey has a similar strike and dip, a structural relationship with the flows is suggested. The lavas are for the most part fairly massive, but in places they show schistosity corresponding to that of similar rocks elsewhere in this general vicinity, *i.e.*, striking somewhat north of east and dipping steeply north. In some places, moreover, there are very strong shear-zones in the lavas, the general strike of which appears to be slightly south of east. Although these cannot as yet be satisfactorily correlated, they are almost undoubtedly earlier than the fracture that the vein occupies and are thought to have an important structural bearing on mineral deposition. Intensely sheared chloritic rock in which carbonate veinlets are abundant was intersected in the northwestern portion of the drift on the second level of the mine, beyond the main porphyry body, and, although not so pronounced, in a corresponding position on the first level. Intense shearing was also encountered, but presumably on the opposite side of the porphyry body, in the shaft at the fifth level. A hole drilled from the ice on the lake at a point 735 feet northwest of the shaft, to test the vein on its strike, likewise showed highly sheared rock. It is assumed that shearing of similar nature would have been found had the drifts on the third and fourth levels been extended a sufficient distance to the northwest. Correlation of these several occurrences implies the presence of a strong shear zone striking slightly south of east and dipping south such that it is intersected by the vein both on the northwest strike and on the dip of the latter at progressively deeper horizons corresponding to increasing distance along the southeastern strike of the vein. Between the fourth and fifth levels, for example, the point of intersection is in the vicinity of the shaft. There is also a shear-zone in the lavas of a small island half a mile from the shaft in a direction N.70°W. Its projected strike lies a short distance south of the shaft; if sufficiently continuous it would be intersected by the vein on its southeastern strike and thus lie to the north of that section of the vein to the southeast of the point of intersection. Further development

(1) *Op. cit.*, pp. 243-244.

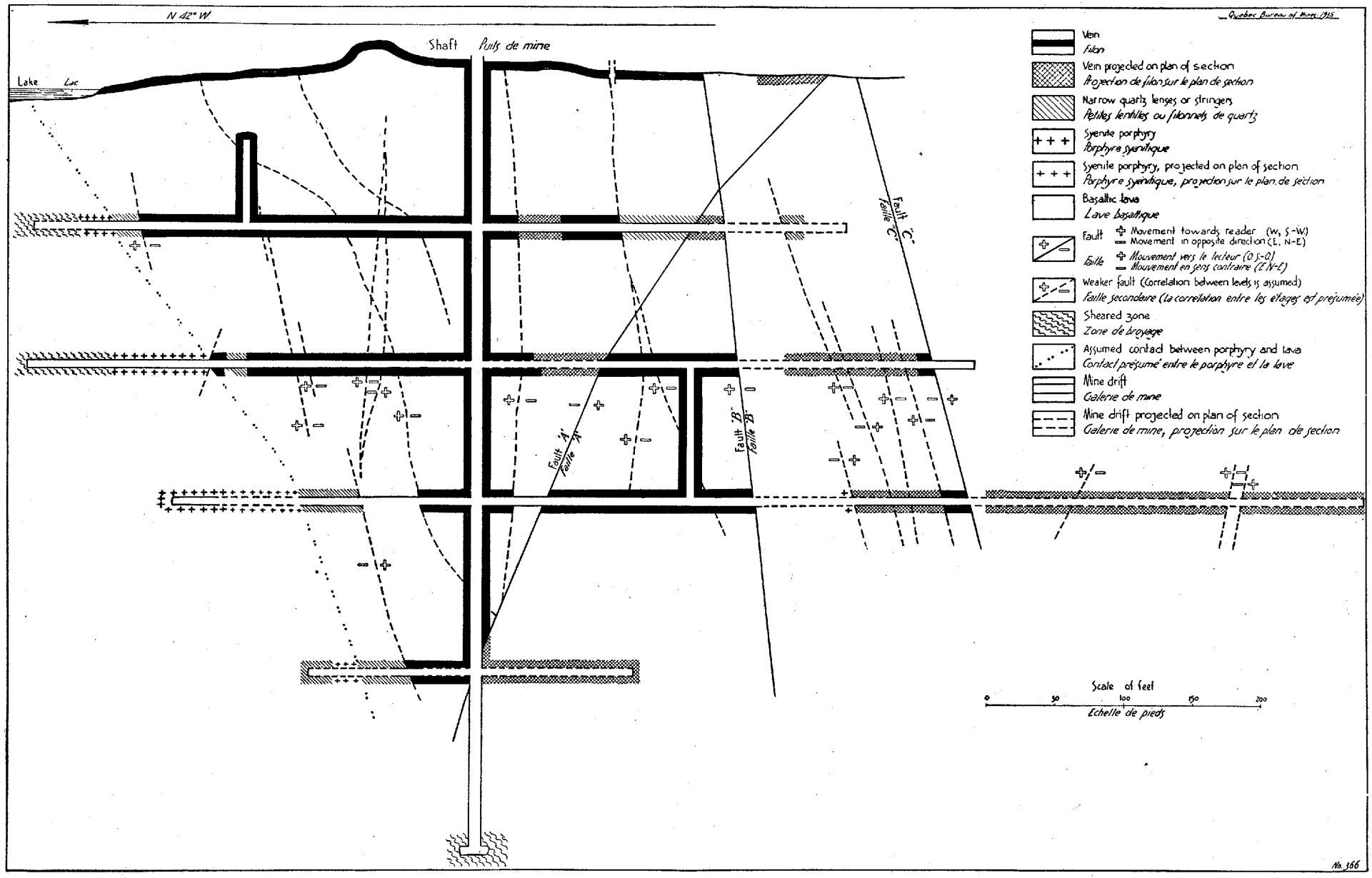
will be necessary to correlate the zones of shearing and to establish definitely their effect on the structure of the vein, and more particularly as concerns its behaviour at depth.

The syenite porphyry is for the most part fresh-looking and massive, although there is evidence of fracturing and some shearing in places. The principal dyke of this rock exposed at the surface is a short distance south of the main vein; there are a number of other dykes in the vicinity. Underground, a body of the porphyry occurs to the northwest of the vein, which terminates against it. This is thought to correspond to the somewhat irregular body of porphyry exposed at the surface on the shore of the lake a short distance south of the northwestern projection of the vein along its strike. It would appear to have the same strike or trend as the other porphyry bodies in the vicinity of the mine, namely, somewhat more westerly than the vein itself. This particular body pitches at 55° to the southeast, and the vein pinches out or abuts against its eastern margin.

Although the vein filling is definitely later in age than the syenite porphyry, there is some question as to the age relationship between the fracture that the vein fills and the porphyry. This is due to the fact that, where it has been observed, the intersection between the vein fracture and the porphyry is commonly marked by post-vein faulting. However, at the contact between the two, exposed in workings on the first level of the mine, there is little evidence of such later faulting. Here the vein proper pinches rapidly on approaching the contact, only a few stringers extending on into the porphyry, where they very soon peter out. There is no evidence that the vein fracture itself continues into the porphyry, although there are a few minor, probably related, fractures in the porphyry near the contact. On the other hand, the main vein, on the second level 300 feet southeast of the shaft, is believed to pass through a small body of similar porphyry, and in several other places the vein fracture follows the northeast or southwest border of porphyry bodies or dykes. Present evidence would support the view that the vein fault or fracture was developed prior to the injection of the syenite porphyry, but that the latter was fractured to some extent by later movements along this fault; also that the introduction of the vein-forming solutions — which presumably were derived from the same magmatic source as the syenite porphyry itself — was subsequent to these later movements. It will be seen that the sequence is very similar to that of the Greene Stabell mine as worked out by Cooke (1), although much more conclusive evidence is obtainable at that mine.

The principal vein occupies a strong, well-defined fracture traversing the greenstone with a strike of N.42°W. and a steep but somewhat variable dip, which, on the average, closely approaches vertical. There is, however, a tendency for that part of the vein to the southeast of the shaft to assume a steep dip to the southwest in contrast to its more nearly vertical dip elsewhere. This tendency accounts in part for the fact that the southeastern portion of the vein on lower levels of the mine occupies a somewhat southwesterly position relative to the remainder of the vein. Post-vein faulting is also effective in this connection, but will be considered later.

(1) *Op. cit.*, pp. 258-259.



Map No. 366. — **Vertical section through shaft on strike of No. 1 vein. Shawkey Gold Mining Company, Limited.**

Fault striæ are visible in places along the walls of the vein fracture and although they appear to vary considerably, an inclination of 45 degrees to the northwest is more common. Fracture cleavage in the vein fault taken in conjunction with the direction of inclination of the fault striæ would suggest that movement was such that the southwest side of the fault moved up and to the southeast relative to its other side. There is, of course, the possibility that such movement was merely the late or final phase of activity along the fault and that it differed in its effect from earlier movement. The vein itself is both simple and composite, that is, it may consist of a single lens of quartz or of a series of closely-spaced, parallel lenses or stringers together making up a vein zone. The better portions of the vein are those with the composite structure. In width, the vein varies from as much as twelve feet to only a few inches; it averages about four feet. Except where offset by faulting, it shows considerable continuity. Thus, in the fall of 1935, it had been developed over an average length of 440 feet on each of the three upper levels. More recent reports from the mine are to the effect that it has been found to be much longer than this on the third level. As already noted, the porphyry body against which the vein is terminated on the northwest pitches at 55° to the southeast. Consequently, the vein has a similar rake, as will be seen by reference to the accompanying longitudinal section (Map No.366).

Vein filling consists largely of greyish-white, finely granular quartz containing numerous albitized inclusions of the wall-rock and mineralized chiefly with pyrite. From study of thin sections, the sequence of events in the process of mineralization seems to have been somewhat as follows:

(1) Introduction of solutions from which mainly albite and carbonate were deposited. Chlorite, with some hornblende, is rather common in the vein walls and in the altered, albitic inclusions in the vein, but the relative ages of these minerals are unknown.

(2) Vein quartz entered and replaced, or formed veinlets in, the albitized zones. Some carbonate may have come in contemporaneously.

(3) Carbonate, with some green mica, was introduced, chiefly as veinlets following fractures and crushed zones in the quartz.

(4) Metallic minerals, very largely pyrite, were deposited. These occur most abundantly in disseminated form in or near the albitized walls and vein inclusions, but also in fractures in the vein quartz, and in such cases more commonly in association with carbonate, which they would appear to have replaced. More than one period of pyritization may be represented here. Pyrrhotite and chalcopyrite are sparingly present in the vein matter (1). Gold was not observed in the thin sections examined by the writer, but spectacular gold occurrences were seen in the vein a short distance northwest of the shaft on the second level of the mine and southeast of the shaft on the fourth level. In the first occurrence, the gold was in the quartz gangue, with little other metallic mineralization, and also coating a slip-plane on the wall-rock; in the second, most of the gold was associat-

(1) Mr. Ryan, mine manager, states in a recent communication that pyrrhotite is quite abundant, with some chalcopyrite, in the southeastern part of the vein as newly opened-up on the third level of the mine.

ed with or deposited on pyritized, dark, hornblendic and chloritic material of the vein matter. The gold no doubt was introduced as a late phase of the metallic mineralization.

(5) A late generation of quartz, post-dating mineralization of the vein, is represented in a quartz lens striking at right angles to the principal or No. 1 vein and following a fault by which that vein is offset. It has been opened-up by drifts on the second and third levels of the mine (see Figure 1). Presumably, this generation of vein matter is barren. Parallel veinlets of white, barren-looking quartz, transversely cutting the filling of No. 1 vein and thus forming a ladder structure within it, may be of similar derivation. These veinlets were noted only in and near the raise northwest of the shaft, above and on the first level.

A report by M. H. Haycock (1) on his study of polished sections of the Shawkey ore may be summarized as follows: The gangue is a white, translucent quartz and fine-textured dark-grey country-rock consisting largely of carbonate and silicates. Pyrite is the principal metallic mineral and is sparingly disseminated in the dark country-rock as coarse to fine crystals and irregular grains. Rare, small grains of chalcopyrite occur with the carbonate, and there is a very small amount of pyrrhotite in both gangue and pyrite. Gold was rare in the sections examined, although a few small grains were seen in pyrite and one in the quartz. Mill tests, however, indicated considerable coarse, free gold in the ore. They showed that at least 90 per cent of the gold is free milling and that the ore therefore presents no difficulty in its metallurgical treatment, being amenable to the ordinary methods of cyanidation.

Alteration of wall-rocks is for the most part closely confined to the borders of the vein and, as already indicated, consists largely of albitization and carbonatization. From his study of thin sections, Cooke (2) is of the opinion that the earliest form of wall-rock alteration was that of albitization, succeeded by solutions that deposited pyrite, biotite, and hornblende, all of which were in turn replaced by calcite and some quartz. The main body of porphyry locally shows alteration quite comparable with that commonly associated with granodiorite, as, for example, at the Sullivan and Lamaque mines. Such alteration was noted chiefly on the third level of the mine, northwest of the shaft, where the porphyry is somewhat fractured. Here, heavily tourmalinized quartz lenses are bordered by light-coloured, altered zones rich in carbonate and albite and containing a considerable amount of sericite. There is also some development of vein breccia, in which carbonatized, albitized fragments are engulfed by the tourmaline-quartz vein material. Tourmaline has not been recognized as a constituent of the No. 1 vein proper.

Post-vein faulting through the agency of cross-faults is very extensive throughout the length of the vein as developed up to the close of the field season. Apart from three of the stronger faults, known as *A*, *B*, and *C*, the displacement along such faults is not great, being commonly limited to two or three feet. Although, locally, faults are seen trending in various direc-

(1) Mines Branch, Dept. of Mines, Ottawa, Publication No. 633, 1935.
(2) *Op. cit.*, pp. 244-245.

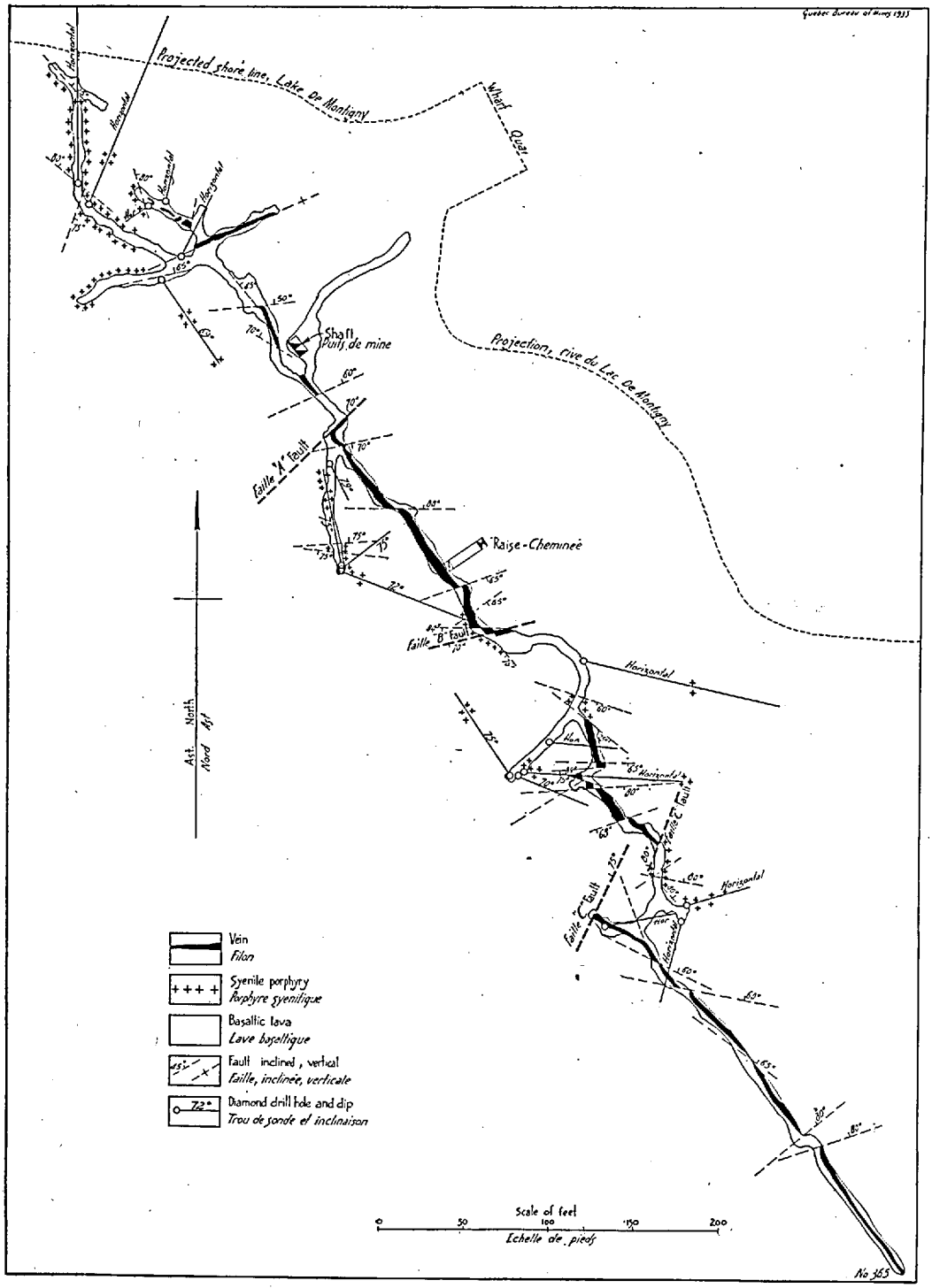


Figure 1. — **Geological plan of underground workings on 325-foot level. Shawkey Gold Mining Company, Limited.**

tions, the great majority strike N.70°E. (E.N.E.) and therefore cut the vein at a steep angle, about 65° (see plan, Figure 1). With notable exceptions, the faults dip fairly steeply to the southeast (see section, Map No.366). Displacement of the vein by fault *B* and by most of the minor cross-faults is to the northeast (as the vein is followed eastward), whereas displacement by the *A* and *C* faults and certain others is to the southwest. The net result is that the vein is displaced somewhat to the southwest. The major displacements have, of course, taken place along the *A*, *B*, and *C* faults.

Fault *A* has the characteristic N.70°E. strike but a curving dip, averaging 60° to the northwest. Horizontal displacement is about 18 feet (S.E. side to the S.W.). The dip of this fault, taken in conjunction with the rake of the vein, is such that its faulting effect is confined to the horizons above the 500-foot level. Fault *B* has the strike and dip characteristic of the faults as a whole, its dip being 82° to the southeast. Displacement in the horizontal plane is nearly 60 feet, but in this case the southeast side has moved to the northeast. Fault *C* has a more northerly strike than the other two and dips 75° southeast. The southeast side of this fault shows a horizontal displacement of about 55 feet, and, as in fault *A*, it has moved to the southwest relative to the other side. At the time of the writer's visit to the property, the vein had not been cut in the workings on the second level beyond (southeast of) fault *C*, although it is reported to have been indicated here by diamond drilling. Faults *B* and *C*, on account of their dip, will continue to affect the vein to considerable depths. However, since the post-vein cross-faulting has been successfully worked out by the management, it is improbable that future mine development will be much hindered by problems concerned with such faulting. Earlier structures, such as the shear zones already outlined, are of more fundamental importance, but these cannot yet be as accurately determined.

The grade of developed ore is understood to average about $12 per ton (gold at $35 per ounce). Stoping widths are variable, averaging about four feet but much wider than this in places. In an official report to shareholders issued in the fall of 1935, the amount of ore developed on the three upper levels of the mine was stated to be as follows: 125-foot level, 420 feet; 225-foot level, 480 feet; 325-foot level, 420 feet. Development of the two latter levels had at that time barely commenced. These figures would indicate that the vein as a whole must be of ore-grade almost throughout the entire lengths developed on the various levels of the mine.

In addition to the principal, or No. 1, vein, there are on the property several others termed veins 2, 3, 4, 5, 6, and 7. Veins 4 and 3 are exposed at 600 feet and 1,200 feet, respectively, to the southeast of the main shaft. They are thus south of No. 1 vein, which they about parallel in strike. Vein No. 4 consists chiefly of a quite irregular, barren-looking quartz lens in rather massive, fractured basalt. Vein No. 3 occupies a shear-zone in pillow lava striking N.65°W. and dipping 70°N. It consists of a series of quartz and carbonate stringers across a width of about three feet. Rather patchy mineralization consists chiefly of pyrite. Low gold values over a width of 15 feet are reported in a drill hole cutting this vein. On the shore of the bay 2,000 feet west of the main shaft is a small quartz lens in coarse, massive basalt. Specks of coarse free gold were observed here.

Of these additional veins, however, No. 2 merits most attention, although its importance remains to be established. It is exposed on the northern point of the peninsula 2,050 feet due north of the main shaft, in a fracture or narrow shear in Keewatin basaltic lava which strikes N.85°W. and dips 80° north. Injected into this structure at intervals are narrow, lenticular blebs of feldspar (acid plagioclase) porphyry. These rarely exceed three feet in width. Vein matter is largely restricted to the disconnected lenses of porphyry, in which it fills irregularly reticulated fractures. A few very small quartz lenses were noted in the main fracture in the lava, independent of the porphyry. Vein matter is thus on the whole quite discontinuous, and its proportion relatively small, so that it would have to be very rich to constitute ore thoughout the vein as a whole. The vein has been trenched for some 160 feet. On the west, it extends almost to the water's edge, where the only evidence of vein matter is a few quartz stringers near the narrow dyke of porphyry. Vein matter consists for the most part of veinlets and narrow lenses made up of albite, vitreous quartz, carbonate, and needles of tourmaline, filling fractures in the carbonatized porphyry. Study of thin-sections indicates that these minerals were introduced in the order listed, quartz being most abundant. Gold, in association with metallic sulphides and probably a telluride, was noted in crushed zones or in fractures, chiefly in the vicinity of the contact between zones of albite and quartz. In addition to pyrite, pyrrhotite is fairly abundant and a little chalcopyrite may be present. Insufficient quantities of a greyish metallic mineral, assumed to be a telluride, were obtained to permit of its identification. Spectacular occurrences of free gold are not uncommon in the vein matter.

Several diamond-drill holes that were put down to intersect the vein gave little encouragement. However, the management reports better results from three bulk samples taken in the trench.

No. 1 vein has been developed by means of a two-compartment shaft to a depth of 580 feet, with lateral workings on the 125-, 225-, 325-, and 450-foot levels. Power for development is provided by a Diesel engine, to be supplemented shortly by a second, larger Diesel plant, which will furnish sufficient power for operation of the 125-ton mill now in the course of construction. Vincent M. Ryan is in charge of the mine.

Earlier descriptions of the Shawkey property are to be found in geological reports by Tanton, Mailhiot, and Cooke (1). Mining operations are dealt with by R. H. Taschereau, Inspector of Mines, in Part *A* of the Annual Report of the Bureau for the years 1934 and 1935.

Gale Gold Mines, Limited

The discoveries of gold on this property were among the earliest made in the district. It was first known as the J. W. Callinan claim, having been staked in Mr. Callinan's interests in 1912, by J. B. Mosso. He, however, allowed his lease to expire, and the claim was re-staked by J. A. Gale, later becoming known as the St. Germain-Gale claim. Subsequently, the

(1) See *Selected References* listed on page 9, as follows: Tanton, p. 68; Mailhiot, pp. 146-148; Cooke *et al*, pp. 242-245.

property was controlled in turn by Lorette Mines, Limited; Northern Aerial Minerals Exploration, Limited; Ruby Oil and Coal Syndicate; and finally by the present Gale Gold Mines, Limited, which Company was incorporated in 1934 to acquire the claim. The property is situated near the eastern shore of the inlet leading into Montigny lake, about a mile south of the lake proper, and is in range VIII, not in range VII as erroneously stated in several earlier geological reports. It comprises M.L. 1152 in addition to certain other claims in the vicinity which are held under option.

The geology of the property has been described in reports by Tanton, Mailhiot, and Cooke (1). The principal outcrop consists of Keewatin lavas intruded by syenite porphyry. The Keewatin rocks are of two related types—fine pillow and amygdaloidal lavas, and massive and moderately coarse andesites. It will be noted from the accompanying geological plan (Map No.367) that, broadly speaking, the fine lavas make up the southern part of the outcrop, and the massive, coarser types the northern part. The syenite porphyry differs from that of the Shawkey mine mainly in that it contains a higher proportion of hornblende and a little primary quartz. There are three principal occurrences of the porphyry. Two of them have the form of fairly persistent, steeply-dipping dykes, and the third is a somewhat irregular mass exposed near the northern edge of the Keewatin lava outcrop. In its main exposure, the southernmost dyke is about 30 feet wide and strikes N.70°W., but traced to the east it swings in a more southerly direction. The other dyke is slightly narrower and has about the same strike, but the swing to the south is not so marked. A number of the gold occurrences on the property are near the porphyry, and more particularly along contacts of the dykes with the lavas, which fact would suggest that the gold deposits are genetically related to the porphyry.

The rocks in the vicinity of the main workings are cut by a series of faults and fractures, most of which are of a rather minor nature, no extensive displacements having been noted. Generally speaking, the fractures fall into two sets, although in individual and somewhat exceptional cases their strike may depart as much as 20 degrees from the average. One set has an average strike of N.80°W. and hence roughly parallels—in some cases actually follows—the contacts of the porphyry dykes; the other set strike N.65°E. and commonly dip steeply to the northwest. Cooke (2) has noted that the faults on this property with northeasterly strike are earlier than the porphyry dykes. Some evidence that might be interpreted in a similar way was found by the writer, but, if this is so, there has also been movement along the faults subsequent to the intrusion of the porphyry and as a result of which the dykes have been offset for appreciable distances. This will be readily seen by reference to the accompanying geological plan. Present evidence indicates that the fractures or faults striking N.80°W. are the younger of the two sets and that each set is post-porphyry in age. In places, shear-zones rather than fractures have developed, but they correspond to

(1) See *Selected References* listed on page 9, as follows: Tanton, pp. 69-70; Mailhiot, pp. 153-154; Cooke *et al*, pp. 269-270.

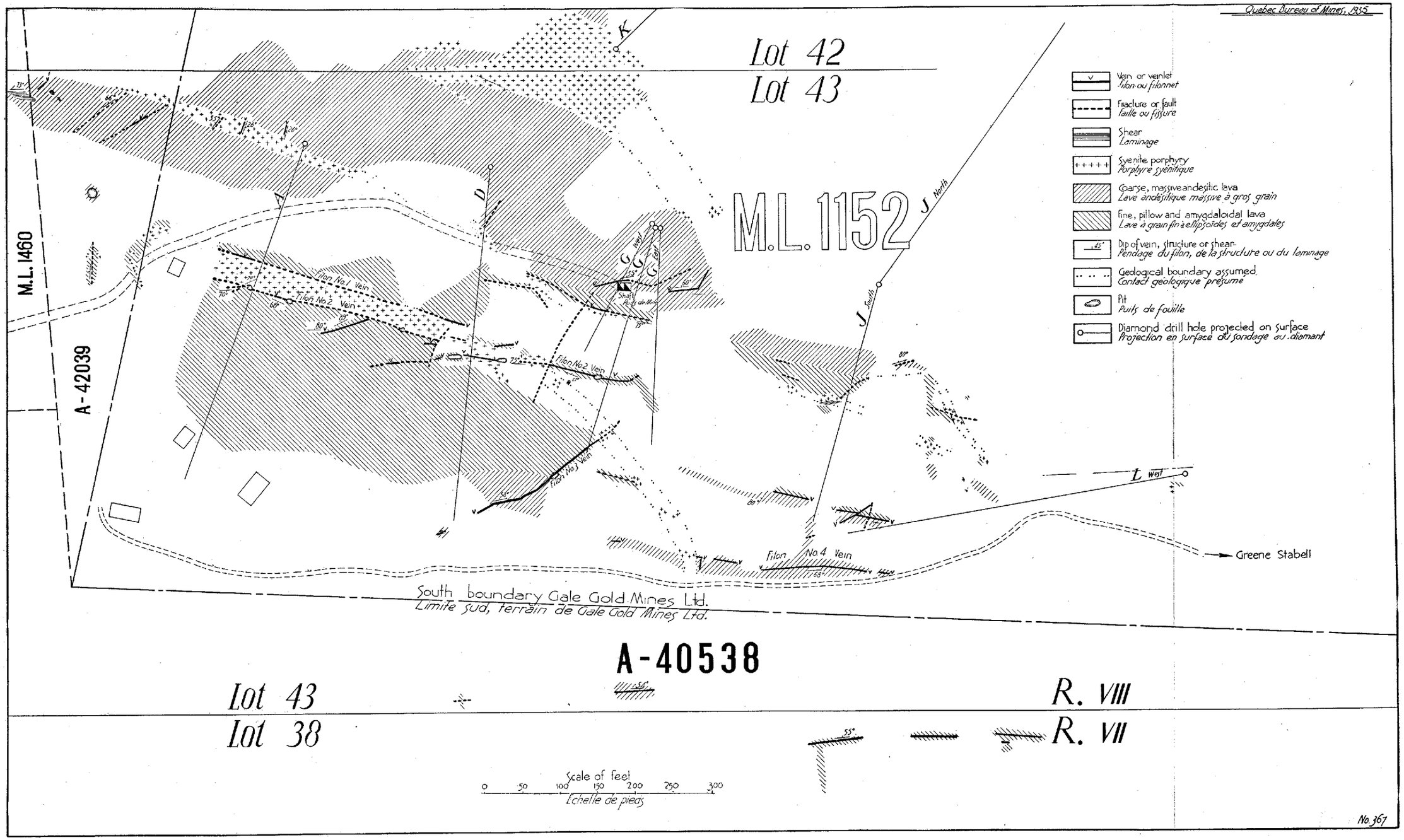
(2) *Op. cit.*, pp. 269-270.

one or other of the two sets of fractures and, as a rule, are not traceable for any considerable distance.

The vein system consists of a series of gold-bearing veinlets and narrow veins occupying fractures of each of the two sets referred to above. With the exception of vein No. 3, and short portions of veins 2 and 4, the majority of the 'veins' fail to maintain a substantial width for any appreciable length and for the most part are better termed veinlets or stringers. The veins of the first set of fractures, *i.e.*, those with average strike of N.80°W., include veins 1, 2, and 4. Veins 1 and 2 are in narrow fractures that follow respectively the north and the south contact between pillow lava and the southerly dyke of syenite porphyry. The fractures at some points carry very narrow lenses or stringers of quartz. Coarse visible gold is to be seen in them, and was noted especially at the junction of No. 2 vein with minor fractures which it occasionally intersects at a low angle. As it continues toward the east, No. 2 vein passes through the porphyry dyke at the point where the latter swings, and also is faulted, to the south. Beyond this, for a length of about 75 feet, the vein matter occupies a well-defined fracture in the lava, dipping 60° north; and here the vein attains a better width, about a foot and a half, and consists of bluish-grey quartz well mineralized with pyrite together with a little pyrrhotite and chalcopyrite. Some actinolite and a little tourmaline were noted in the vein material. Good values are reported in this section of the vein; but a sample of well mineralized material taken by the writer from the dump from a deep, water-filled pit assayed only a few cents in gold per ton.

Vein No. 4, which was discovered and opened-up to some extent during the 1935 field season, is near the southern border of the principal outcrop on the property, 400 feet southeast of the shaft. It occupies a fairly well-defined fracture, two and a half feet wide in places, which traverses massive andesitic lava. The strike is about east-west but somewhat variable and the dip 68° to the south. The vein proper has been traced for more than 200 feet, but appreciable vein matter, consisting of several lenses occurring at intervals and averaging a foot and a half or less in width, are confined to an aggregate length of about 75 feet. In addition, several narrow lenses or stringers, with some related silicification, follow the vein fracture. Vein filling is of white, glassy quartz with considerable amounts of associated chlorite, hornblende, and epidote, each of which, in part at least, is later than the quartz, since they are seen occupying fractures in the latter. Although on the whole rather sparsely mineralized, there is in places rather abundant pyrrhotite and pyrite, with some chalcopyrite and a little magnetite. Coarse visible gold occupying fractures in the vein matter is not uncommon. A sample of well mineralized vein material, from which visible gold was excluded, was submitted by the writer for assay. It carried 0.056 oz. gold per ton.

No. 3 vein is the principal representative of those occupying the second set of fractures, *i.e.*, with an average strike of N.65°E. It occupies a stro g well-defined fracture or shear-zone that attains a width of five feet in places and for the most part traverses massive andesite. Vein filling, although fairly consistent for at least 175 feet, rarely exceeds a width of two feet. The fracture strikes N.60°E. and dips 60° to the northwest; to the northeast, it



Map No. 367. **— Plan showing detailed surface geology in vicinity of shaft. Gale Gold Mines, Limited.**

intersects and slightly offsets the porphyry dyke with which veins 1 and 2 are associated. Vein filling consists chiefly of bluish-grey, somewhat granular, quartz which, together with some carbonate, has engulfed brecciated fragments of the wall-rocks. Plentifully associated with the mineralized inclusions and to some extent with the quartz is a radiated green mineral identified as actinolite. Mineralization consists largely of pyrite, mainly disseminated through the silicified inclusions, but also present in the vein filling. A little pyrrhotite and bornite were noted. Values of the vein material are understood to be low. A representative sample taken by the writer assayed only a trace in gold.

In addition to the veins described there are a number of minor vein fractures distributed throughout the outcrop and corresponding in strike to one or other of the two sets of fractures described. One of them, for example, closely parallels the north contact of the northerly dyke of syenite porphyry. Although often 'dry', or containing only stringers or veinlets, coarse visible gold is not at all uncommon in these minor fractures, and occasionally also there is some sphalerite. Such rather widely distributed gold occurrences, coupled with the fact that the gold-bearing vein No. 4 was discovered only during the 1935 field season and subsequent to the commencement of shaft-sinking operations, would suggest the likelihood of yet other discoveries being made, and that the possibilities of the property had not been exhaustively tested by the less expensive methods of exploration employed prior to the adoption of underground development.

Development prior to that by the present Company consisted in surface exploration, and, in 1932, under the direction of Northern Aerial Minerals Exploration, Limited, a campaign of diamond drilling in addition to further trenching and test-pitting. The core from the drilling has been discarded so that it is difficult to interpret the results. The present Company has installed a mining plant and in the fall of 1935 was prepared to commence underground operations. The plant consists of a small Diesel engine, compressor, hoist, oil storage tanks, etc. New camp buildings, shops, and a wharf on the lake shore, have also been constructed. John Manion is in charge of the mine.

Amity Gold Mines, Limited

Lots 44 to 49, range VI, comprise the Dubuisson township holdings of this Company. The northern contact of the Temiscamian sediments, followed here by a dyke or sill of sheared quartz diabase, passes through the southern part of the claims and to the north is succeeded by Keewatin tuffs, which are followed in turn by lavas in the central and northern sections of the property. Relatively small intrusions of feldspar porphyry, and certain others of altered and somewhat more basic rock that is regarded as diorite porphyry, are fairly common but are confined almost entirely to the area underlain by lavas in the northern third of the property. It is this portion, therefore, that holds the most promise, and it is here, also, that gold-bearing material has been found.

At a point 100 feet south of lot-post 46-47, ranges VI and VII, is a gold-bearing veinlet upon which a 27-foot shaft had been sunk when the

ground formed part of the old Clowse claim (1). The veinlet, only an inch or two in width, follows a one-foot dyke of porphyry which in turn follows a fault that cuts andesitic pillow lava with a strike N.45°W. and a steep dip to the northeast. The vein has been traced for some 75 feet. Vein matter consists of fine, sugary quartz well mineralized with chalcopyrite and known to carry gold. A well mineralized sample taken by the writer yielded 1.02 oz. in gold per ton. Four diamond-drill holes, forming the major part of a campaign of drilling carried out early in 1934, were put down to test the veinlet.

Another hole was drilled in the southern part of lot 46, range VII, where an east-west fault in pillow lava is occupied at intervals by narrow lenses of quartz showing sparse mineralization. Some further drilling was done in lot 47, about 700 feet east of the gold-bearing veinlet referred to in the last paragraph. Here, an east-west shear-zone, bordered in part by narrow dykes of feldspar porphyry, contains a narrow, mineralized quartz lens traceable for only a few feet. Prospecting of the ground by surface exploration, as stripping and trenching, does not appear to have been carried out to any considerable extent, as a guide to the diamond drilling.

Richardson-Pouliot Claims

Lots 40 to 43 on the east side of the narrows between Montigny and Lemoine lakes, and also lots 32 to 37 on the west side, together with the intervening water claims, all in range VI of Dubuisson township, were held during the summer of 1935 by C. Richardson and L. Pouliot. The claims to the west of the narrows are underlain by Temiscamian greywacke, whereas those to the east cover the contact between the Temiscamian sediments and the Keewatin tuffs that lie to the north of them. In lots 40 and 41 there are two prominent east-west ridges of greyish-weathering tuff, intermediate in composition, and for the most part rather uniformly schistose in a direction N.80°W., the schistosity dipping about 80° to the north. Apart from an outcrop of 'older' quartz diabase in lot 41, at the south side of the exposed tuff, younger intrusives have not been recognized here.

The showings consist of a series of more or less lenticular masses composed of white, glassy quartz with tourmaline, fibrous or 'woody' actinolite, chlorite, and sericite, and which for the most part are rather barren of metallic mineralization. The lenses follow the planes of schistosity in their strike and probably also in their dip. On the crest of the rock ridge in lot 41, about 500 feet west of the eastern limit of the lot, is an irregular quartz lens that has been traced for some 100 feet. The vein material, consisting of white quartz with some associated feldspathic material, is very sparsely mineralized with pyrite. It is reported that an assay value of 0.17 oz. in gold per ton was obtained here; a sample taken by the writer gave negative results. A thousand feet to the west and also in lot 41 is another occurrence that lenses-out at either end within a distance of 50 feet and attains a maximum thickness of two end a half feet where a small test pit has been sunk. Mineralization, while patchy, shows a fair amount of pyrrhotite, with a little chalcopyrite and pyrite, following fractures in the vein filling. Assay of

(1) Mailhiot, A., *op. cit.*, p. 157.

well mineralized material selected by the writer gave, however, negative results. Approximately 250 feet to the north of these two showings, and crossing the boundary between lots 41 and 42, a picket line has been run on the strike of a series of lenses that occur at fairly close intervals from the shore of the lake eastward for about half a mile. Most of these appear to be essentially barren of mineralization. Several small test-pits were blasted out during the summer season of 1935.

Godon Claims

These claims, on the north half of lots 29 and 30, range VII, were staked by Alfred Godon. They were optioned for a time by Minrand Gold, Limited, whose property (now Crossroads Gold Mines, Limited) adjoins on the west, but they have now reverted to Mr. Godon. Rock exposures include two prominent knolls, and several small scattered outcrops, of diorite, together with patches of Keewatin agglomerate and tuff, associated with which are small occurrences of what is regarded as a somewhat acidic lava. Some of the diorite, and more particularly certain of its acidic phases, exhibit bluish 'eyes' of quartz. In several places in the diorite, three having been specifically noted, shear-zones or fractures have formed, and associated with them are lenses of white quartz with abundant tourmaline. Although metallic mineralization appears to be lacking or extremely sparse, the favourable geological setting warrants careful prospecting in this vicinity.

Crossroads Gold Mines, Limited

This property was originally known as the Foisie-Kengrow, these being the names of the men who staked the claims, in 1919. Since that time it has been controlled successively by the Union Mining Corporation; Unison Gold Mines, Limited; Lorette Mines, Limited; Minorand Co-operative Company, Limited; Minrand Gold, Limited; and, finally, by the present holders, Crossroads Gold Mines, Limited. The property lies mainly between Montigny lake and the Fournière river, in ranges VII and VIII, and consists of the following claims: M.L. 1693, M.C. 232, M.L. 1478, M.L. 1477A, and claims A. 2468 and 2469.

Some diamond drilling was done on the property in 1922, and in 1925 a shaft was sunk to a depth of 100 feet, at which horizon some underground work was carried out. The mine was again operated in 1932-33, and there has been a certain amount of sporadic development since that time, including a small amount of underground work and diamond drilling, and the assembling of a small mill. At the time the property was visited in 1935, the mine workings were flooded and the records were not available to the writer, so that he can add very little to previous descriptions (1). However, geological mapping in the vicinity, principally on the adjoining Godon claims, has shown that diorite similar to the body in which the deposit occurs is somewhat more widespread than previous examinations had indicated, and that it is rather definitely a post-Keewatin intrusive, probably allied to the Bourlamaque granodiorite batholith.

(1) See following reports, listed on page 9 under *Selected References*: Mailhiot (p. 153), Cooke *et al* (p. 246), Hawley (pp. 72-73).

Kee Claims (Teck Hughes Option)

A portion of the property owned by H. Kee, lying in the southern part of Montigny lake, east of the Parker Island and northwest of the Shawkey claims, was held under option early in 1935 by Teck Hughes interests, by whom some diamond drilling was carried out. The property includes islands numbered 27, 28, and 31, and is made up of the following group of 15 claims: 45029-30, 40833-8, 45339-41, 49202-3, 43249, and 49199. The majority of the claims cover water areas. The only visible mineralized showing of substantial size is a quartz vein, now exposed for only a few feet on the eastern shore of the largest island, No. 31.

In general, the rocks on the northeast side of this island are massive, and rather coarse, amygdular lavas of andesitic composition, whereas those on the southwest side are largely fine, pillowed lavas. A contact between lava flows in the northeastern part of the island indicates that they strike N.63°W., dip nearly vertically, and face toward the south, *i.e.*, their tops are to the south. Cutting the massive lavas exposed in the northwestern part of the island is a dyke of fresh feldspar porphyry which contains a very minor amount of primary quartz. Some shearing in the vicinity of the dyke strikes N.55°W. and dips steeply to the north. There are a few related quartz stringers.

The mineralized quartz vein referred to occupies a fracture, three and a half feet wide, which strikes N.40°W. and dips about vertically. Only a 25-foot section of the vein is exposed, but it seems originally to have been traced farther along its strike in trenches, which are now filled in. The vein as exposed consists of a silicification and replacement of the fractured rock rather than massive quartz. The vein material proper is sugary quartz, ill-defined fractures in which are filled with pyrrhotite. Pyrite is less common and is chiefly in the vein walls, and occasional specks of chalcopyrite may also be noted. The vein matter closely resembles part of that of the main showing on Parker Island (see below), differing only in that it lacks as wide an assemblage of metallic minerals. Assay of the well mineralized material, selected by the writer, gave a gold value of 0.026 oz. per ton.

In addition to diamond drilling in the vicinity of the vein and the feldspar porphyry, some holes were also put down along the water stretch between the island (No. 31) and the Shawkey peninsula. This was done, presumably, to test the possibility of the principal Shawkey vein continuing, along its northwest strike, into this property, and also, no doubt, in an endeavour to pick up the possible southeastern extension of the vein described above. The core from this drilling seems to have been discarded and the drilling results were not furnished the writer by Mr. Kee, to whom the property has reverted.

Kee Claims (Parker Island Group)

These claims are situated in the southwestern part of Montigny lake and include Parker island together with adjacent islands and a part of the southwestern shore of the lake. The principal showing on Parker island was formerly owned by Parker Island Gold Mines, Limited, and was ori-

ginally discovered and staked by B. A. Parker, now deceased. The present group comprises 15 claims numbered M.L. 1412, and A. 45027-8, 45031-4, 51659-62, 46550-2, and 33691.

The property has been described by Mailhiot, Cooke, and more recently, in 1930, by Hawley (1), who gives an account of the development work —trenching and diamond drilling—carried out to that time. In recent years, the property has been idle.

Rocdor Gold Mines, Limited

The holdings of this Company in Dubuisson township include the former G. McChesney claims, comprising the south half of lots 16 to 21, range IX; also lots 16 and 17, and the north half of lots 15 and 23, range VIII. Known rock exposures are confined to the northern part of half-lot 20, range VIII, where there is a small occurrence of volcanic breccia or agglomerate intruded by a narrow dyke of bostonite porphyry. Associated with the dyke is some barren-looking quartz carrying actinolite and sericite. Slip planes in the fractured porphyry are sparsely mineralized with pyrite and chalcopyrite. Trenching was carried out here during the winter of 1934-35.

Claims A-54552 and 54588

These claims are on a small reef in the southwestern part of Montigny lake, on the projection of the boundary between ranges IX and X. The reef consists of pillowed, andesitic lava together with some serpentine. A trench has been blasted into a small irregular quartz lens that strikes S.65°E. and dips 75°N.E. The white, sugary quartz is sparsely mineralized, but in places carries sphalerite, with lesser chalcopyrite, and occasional grains of pyrite and galena. A sample of the better mineralized material selected by the writer assayed only a trace in gold.

West Shore Gold Mines, Limited

The holdings of this Company in Dubuisson township consist of lots 13 to 16, range X. Formerly, the property was held successively by Malartic Extension Gold Mines, Limited, Dubuisson Development Company, and Mission Gold Mines Syndicate, Limited. The principal area of exposed rock is in the northern half of lot 15, about 1,600 feet west of the southwestern shore of Montigny lake. The Keewatin rocks on the property include andesitic lavas, two small outcrops that probably represent narrow bands of volcanic breccia, and several masses of serpentine. The bulk of the intrusive material is hornblendite, but, in addition, there are dykes of highly altered rock cutting the lavas. Although their original nature is obscure, they are assumed to be diorite porphyry and closely allied to the hornblendite. The latter rock, which makes up the northern part of the principal area of outcrop, is reported (2), in places, to contain bluish 'eyes' of quartz, thus suggesting a relationship with the dioritic intrusives of the area, such as that of the Crossroads property.

(1) See *Selected References*, page 9, as follows: Mailhiot (p. 156), Cooke *et al* (pp. 245-246), Hawley (pp. 74-76).

(2) Alton C. Bray, personal communication.

The principal showing consists of a series of narrow lenses of white, sugary quartz, with some carbonate, which are rather sparsely mineralized with pyrrhotite, chalcopyrite, and pyrite. These occur at intervals along a strong, steeply-dipping shear-zone in the hornblendite that has been opened-up by stripping and trenching for some 750 feet. The shear-zone strikes N.70°E. and varies in width up to about 15 feet. The sheared walls are silicified in places and also show a considerable development of biotite. Some fair values in gold are reported from the mineralized vein material. A sample taken by the writer yielded 0.192 oz., or $6.75, in gold per ton (gold at its present valuation).

In addition to this 'shear-zone vein', several small lenticular veins, variable as to both strike and dip, have been found in the hornblendite and in the lavas. They are of sugary quartz, mineralized in places with pyrite.

Development has consisted in fairly extensive surface exploration, including trenching and the sinking of test pits. A. C. Bray was acting in the capacity of consulting engineer.

A. — Intrusive breccia from north half of lot 45, Range VIII, Dubuisson township.

B. — Volcanic breccia from north half of lot 58, Range VIII, on property of Harricana Amalgamated Gold Mines, Inc., Dubuisson township.