CANADA
DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH
BUREAU OF GEOLOGY AND TOPOGRAPHY

GEOLOGICAL SURVEY

MEMOIR 231

BOUSQUET-JOANNÈS AREA, QUEBEC

BY

H. C. Gunning

OTTAWA
EDMOND CLOUTIER
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
1941

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Bousquet-Joannès Area, Quebec

CHAPTER I

INTRODUCTION

Joannès township lies immediately east of Rouyn township and is adjoined on the east by Bousquet, which is west of Cadillac township. Each township is 10 miles square. This report deals with the northern half of each, or a total area of 100 square miles. The area lies astride Quebec's Southern Gold Belt, between the productive camps of Rouyn and Cadillac townships. For 20 miles it covers the contact between "Keewatin" and "Timiskaming" strata, and up to the present has never been mapped in as great detail as the areas to the east and west. It is, therefore, a missing link, geologically as well as economically, in a highly important metalliferous region.

Field work was done in Bousquet township in 1937 and in Joannès in 1938. Base maps supplied by the Topographical Survey, showing township lines, surveyed mining claims, drainage, and culture, on a scale of 1,000 feet to 1 inch, were used. Geology was plotted on these from compass and pace traverses spaced on the average about 600 feet apart. Bousquet township is not subdivided into lots and, therefore, surveyed mineral claims, which nearly cover the area mapped, served as the principal control for the traverses. Joannès township is subdivided and the traverses there were run north and south between range lines a mile apart, and tied in at each end to lot posts 860 feet apart on the range lines. A few critical areas and some mining properties were mapped in greater detail by plane-table or more closely spaced traverses.

The area has the low relief typical of much of this part of the Canadian Shield and an exceptionally large part is swamp. Furthermore, practically all of it is in green bush with considerable underbrush. For these reasons it is unsuited to detailed investigations; no attempt was made to find every outcrop, for to do so where it is often impossible to see more than a few feet would require an inordinate amount of time. Many of the large areas shown as outcrop on the accompanying maps are in reality elevated tracts in which rock can be seen only at intervals by pulling off moss and a light cover of soil. The paucity of exposures prohibits detailed subdivision of the strata in parts of the area, particularly in places occupied by volcanic rocks whose lithological variations are more complex and unpredictable than those exhibited by sediments. The lack of outcrops also necesitates reliance on undesirably few structural observations, for good structural observations are rarely obtained except on bare rock, washed clean by rain.

In 1937 the writer was ably assisted in the field by J. C. Coulson. Duncan A. McNaughton and Patrick Mason Hurley carried out about half the investigations of 1938 with a degree of willingness and intelligence that the writer greatly appreciates. No small part of the information obtained was generously contributed by those geologists, engineers, and prospectors engaged in the development of the mineral deposits of the area, and it is a real pleasure to thank these gentlemen. Of particular help were Lloyd Almond, Nelson Bidgood, D. M. Giachino, Julius Cohen, J. M. Cormie, A. W. Derby, T. Duval, Mr. Dwyer, A. H. Hastie, J. W. Hoskings, A. MacLean, W. C. Martin, D. J. Russell, E. D. Shaw, Albert Thompson, Jim Thompson, and others. Previous reports by W. F. James, J. B. Mawdsley, H. C. Cooke, L. V. Bell, Alex. MacLean, A. H. Lang, and J. E. Hawley greatly facilitated the investigations. The writer is indebted to J. E. Hawley, and to colleagues of the Geological Survey, for helpful discussion of the problems of the region. The work is a direct continuation of that done by the writer in 1934 in Cadillac township, described in Memoir 206, Geological Survey, Canada.

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CHAPTER II

GEOLOGY

INTRODUCTION

The regional geological setting of the area may be seen best on Map 328A, Rouyn-Bell River area, of the Geological Survey, Canada. The contact betweeen Keewatin volcanic rocks on the north and younger Timiskaming sediments on the south is shown trending east-west about 2 miles south of the north boundaries of Joannès and Bousquet townships. From 6 to 15 miles south of the contact the sediments are intruded by increasingly large bodies of granite until finally they appear only as pendants or xenoliths in the great southern batholiths. To the north the volcanic rocks continue for several tens of miles, contain a number of intercalations of sedimentary rocks, and are intruded by large and small granitic bodies. The main band of sediment in the Keewatin, the Cléricy band, is shown as a northwesterly trending syncline, younger than the adjoining greenstone.

The area was first mapped systematically by James and Mawdsley in 1924 and 1925. Most of it was re-examined by A. H. Lang in 1934 for the preparation of a revised edition of the Kinojevis sheet, Map 2085. After this work the conception of the geology of the region was as follows. All the pre-granite strata were classified as either Keewatin or Timiskaming. The southern sediments were believed to overlie the Keewatin volcanic rocks to the north and the general structure across the strike was believed, tentatively, to be homoclinal, with successively younger strata on the south. Sedimentary strata to the north of the Keewatin-Timiskaming contact were classified as late Keewatin or as Timiskaming infolded in the older volcanic rocks, and a narrow band of volcanic rocks in Bousquet township about 2 miles south of the contact was classified as Timiskaming and was thought to be interbedded with the sedimentary rocks. Although work to the west had indicated that the Timiskaming strata lay unconformably on the Keewatin, no evidence of unconformable relations was found east of Kinojevis River and it was concluded that there was a gradual passage from the dominantly volcanic Keewatin on the north to the overlying Timiskaming sediments on the south. "The division between the Timiskaming and the Keewatin has been drawn at the southern edge of the main body of volcanics where they adjoin younger sediments which have interbanded with them a number of volcanic bands".[1] The mapping had been done rapidly, of necessity, and no time was available for a careful search for structural data. The homoclinal, south-facing structure of the Timiskaming sediments was, therefore, based more on a lack of adequate structural observations than on a sufficiency of determinations to prove it; nevertheless, no evidence of a major syncline in the series had been obtained.

[1] Geol. Surv., Canada, Sum. Rept. 1925, pt. C, p. 58.

SUMMARY STATEMENT OF RESULTS

The results obtained by the writer indicate that the whole succession of pre-granite, Archæan strata is conformable and consists of volcanic rocks overlain by sediments that are in turn covered by more volcanic rocks. The latter are overlain by a second group of sediments that are the youngest pre-granite strata. The two groups of sediments are lithologically alike and are of Timiskaming type, and the two volcanic groups are also alike and of Keewatin type. Lacking any proven unconformity, the writer can see no way of making a subdivision into Keewatin and Timiskaming, and, accordingly, the Archæan strata are divided into four groups to which local names, already established by work to the east, are given. The regional structure, instead of being homoclinal with successively younger beds to the south, is synclinal and the direct westward continuation of that established by recent detailed work in the Cadillac and Malartic areas (*See* Figure 1). The Cadillac "break", a major shear zone that persists for at least 30 miles to the east, has been traced westward across Bousquet township. The horizontal displacement on the northeasterly trending Davidson Creek fault, in western Joannès township, is about one-third of the previous estimate, and correlations across the fault have been changed accordingly.

Table of Formations

	Recent	Clay, silt, sand
	Pleistocene	Boulder clay, gravel, sand
Proterozoic?		Dykes of quartz gabbro
Archæan		Lamprophyre dykes
		Granite, quartz syenite, albite alaskite, quartz albitite, acidic porphyries, granodiorite to quartz diorite
		Diorite, quartz diorite, amphibolite
	Cadillac group	Greywacke, slate, conglomerate, tuff, magnetite, and iron formation
	Blake River group	Basic to acidic lavas and ejectamenta; some greywacke and conglomerate; schistose derivatives of the volcanic and sedimentary rocks
	Kewagama group	Greywacke, conglomerate, greenstone
	Malartic group	Basic lavas, tuff, agglomerate

MALARTIC GROUP

Rocks of the Malartic group are very poorly exposed in the extreme northeast corner of Bousquet township, chiefly on the shores of Chassignolle and Kewagama Lakes. Most of the outcrops are of andesitic lava, massive to schistose, striking north of west and dipping at 60 degrees and more to

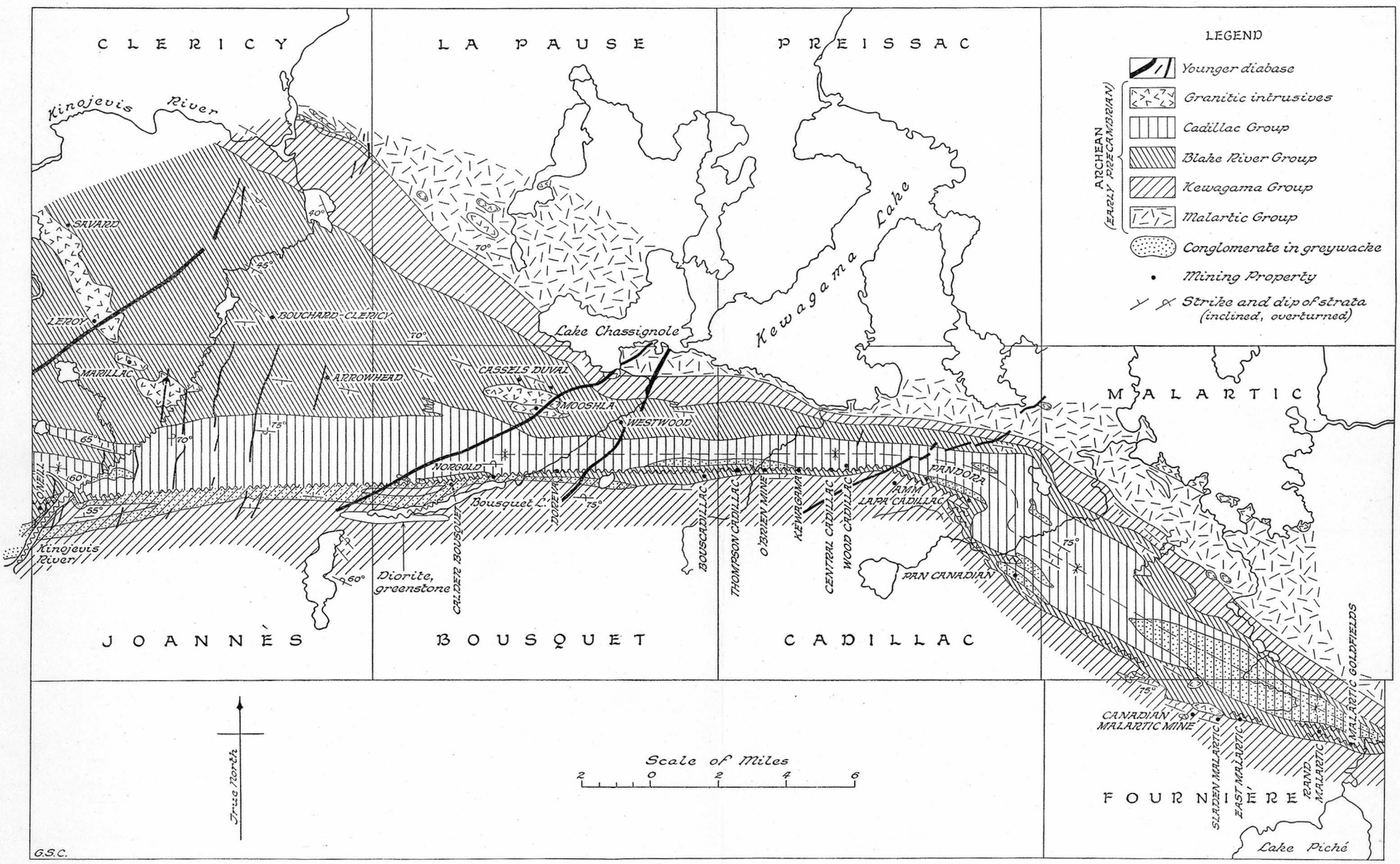

Figure 1. Generalized map of Joannès-Malartic area, Quebec.

the south. A few are of andesitic agglomerate and tuff. Some of the lava is amphibolitized and much of it is heavily charged with epidote. Dioritic layers exposed alongside the quartz gabbro dyke that crosses the mouth of Bousquet River are either dykes or thick, coarse-grained flows; the outcrops are too limited for definite determination.

The south contact of the group is drift covered and its position as shown on the accompanying map (No. 612A) is very approximate, particularly in the low, wet ground around the mouth and east of Bousquet River.

KEWAGAMA GROUP

The Kewagama group includes the Kewagama and Fournière sediments of the Cadillac area.[1] On the north limb of the regional syncline it is poorly exposed in a band from 3,000 to about 4,500 feet wide that strikes west and northwest across the northern part of the east half of Bousquet township. On the south limb the whole southern part of the area mapped is underlain by these strata. Greywacke is the only rock exposed in the north limb. Conglomerate is interbedded with greywacke at the north or upper edge of the south limb across widths that decrease from about a mile at the west side of Joannès township to nil at the middle of the east half of Bousquet township. There are a few exposures of sheared conglomerate in greywacke 3,000 feet south of the east end of Kiekkiek Lake. Limited exposures of greenstone south and west of the west end of Kiekkiek Lake are tentatively assumed to represent a narrow layer of lava intercalated with the sediments.

The greywacke of the north limb is chiefly siliceous or arkosic, but includes a number of dark grey, argillaceous beds, few of which are more than a few inches thick. The essential constituents are microscopic grains of quartz, feldspar, and biotite, and metamorphism has produced phyllite and mica schist. The beds are locally contorted and broken by faults of small displacement. Small, tortuous veins of quartz with white mica and occasional small amounts of pyrite are fairly abundant. The sediments half a mile west of the mouth of Bousquet River and 1,500 feet south of Chassignolle Lake are intruded by irregular dykes of feldspar porphyry and near them are feldspathized and in part converted to fissile, black, mica schist. Bedding and schistosity dip south to southwest at 55 to 80 degrees, somewhat lower than is usual on the north limb.

The contact betwen the Kewagama and Blake River groups is exposed in two places. On the old road from Bousquet River to Chassignolle Lake, banded, tuffaceous greenstone is bordered conformably on the north by arkosic and argillaceous greywacke. The evidence of conformity is much better 2 miles to the east, between Bousquet River and Cadillac townships, where the contact between well-bedded greywacke and dense, green andesite can be seen in several places over a length of 3,000 feet or more. Not only are the bedding planes parallel to the contact of the andesite, but andesite and greywacke are interbedded. A band of greenstone is bordered on the north and south by greywacke and decreases in thickness from 200 feet on the west to 125 feet on the east. Presumably, it then dies out entirely, for it does not appear at all in the next exposures 2,000 feet farther east.

[1] Geol. Surv., Canada, Mem. 206, pp. 5 and 19.

The greywacke south of it decreases in width from 150 feet to 60 feet on the west and is bordered conformably on the south by more greenstone. Apparently it is fingering out westward in greenstone in the same manner that the northern greenstone fingers out eastward in greywacke. One could hardly wish for better evidence of the interfingering and strict conformity of the two groups of rocks.

On the south limb of the regional syncline, strata of the Kewagama group are moderately well exposed all across the map-area. Greywacke is most abundant, but the sediments grade from argillite to almost pure quartzite and arkose. Beds usually vary in thickness from less than an inch to about 4 feet, though some are much thicker. Argillaceous beds are dark grey to black, soft, and thin, and stand out on weathered surfaces clearly from the thicker, pale grey to white weathering, more siliceous strata. On fresh-broken surfaces all but the most highly feldspathic beds are dark grey and it is difficult or impossible to distinguish individual beds. Tiny metacrysts of brown biotite are common in all varieties, but are more abundant and smaller in the argillaceous beds. The vast majority of individual beds are uniformly fine grained across their entire width and sharply defined from one another, so that alternations of thin beds resemble varved sediments. Crossbedding is practically entirely absent or has been destroyed by metamorphism, and remarkably few beds reveal gradations in grain size across their width. A common feature, which at first glance resembles crossbedding, is a slicing along planes now tightly sealed that transect the bedding planes at small angles. The total amount of displacement along this myriad of tiny faults must be very great. One of the most discouraging features for a geologist is the absence of distinctive beds or groups of beds that could be used as horizon markers. The monotonous succession of similar beds, except where conglomerate occurs, prohibits precise correlations between outcrops separated by drift-covered areas. This difficulty is increased by the lenticular character of the beds and the slicing mentioned above. In many places the original rock is completely altered to mica schist, chlorite schist, or amphibolite.

A typical specimen of siliceous greywacke is a massive, grey rock with glittering flakes of biotite on the cleavage planes. The maximum grain diameter is about half a millimetre, and quartz forms 50 to 60 per cent of the rock. Feldspar, chiefly albite, is less abundant than quartz except in the more arkosic varieties, and the grains are smaller. Biotite is present in variable amount, commonly forming, with a little pale green chlorite, about 10 per cent of the rock. Minor accessories are apatite, pyrite, tourmaline, rutile, carbonate, and, in the more high-grade metamorphic types, grains of garnet and crystals of staurolite.

Conglomerate occurs chiefly along the northern edge of the south limb. Immediately west of Norman Lake, in the eastern half of Bousquet township, it appears with intercalated greywacke across a width of 1,000 feet to the south of the Cadillac belt of volcanic rocks. It seems to die out east of the lake beneath a large, swamp-covered area. On the west it thickens to 1,200 feet and then thins to about 500 feet at Bousquet River and maintains that width for another 6,500 feet, with little or no intercalated greywacke. West of the river a few narrow layers of conglomerate appear in the several hundred feet of greywacke and tuff north of the

main conglomerate horizon. The thickness of these northernmost greywacke beds increases to the west so that the main conglomeratic horizon bends southward until, at the middle of the north shore of Kiekkiek Lake, it is 2,000 feet away from the Cadillac "break." For the next mile, along the north shore of Kiekkiek Lake, the strata are so intensely carbonated that their original character is almost impossible to determine. However, a few pebbles have escaped destruction and demonstrate the persistence of the conglomeratic horizon, although the position of the north contact cannot be determined. West of the carbonated area the conglomerate-greywacke zone is 1,600 feet wide at the Bousquet-Joannès line. For 2 miles west of the line outcrops are few, but the strata between this point and Kinojevis River are well exposed. They consist of greywackes interbanded with conglomerate beds ranging in thickness from a few inches to several hundred feet. In western Joannès the conglomeratic section divides; the main conglomerate-bearing part, from 1,000 to 2,500 feet thick, lies well to the south, and one or more narrower beds occur in greywacke for over half a mile to the north.

The conglomerate has pebbles of felsite, feldspar porphyry, quartz porphyry, greywacke, and a few of granite, diorite, and quartz. They range from a fraction of an inch to about 5 feet in diameter, and lie in a matrix of coarse greywacke. Most of the pebbles are deformed into spheroids or discs; those of the acidic intrusives are less deformed than the others and many of them, particularly the smaller, are nearly round. The proportion of pebbles to matrix varies greatly. In western Joannès some of the sedimentary beds are partly to completely amphibolitized; in extreme cases even the pebbles are completely destroyed or small remnants of the larger acidic ones are all that can be recognized.

A few small exposures of schistose pebble-conglomerate were found 3,000 feeet south of the east end of Kiekkiek Lake. They probably represent a lenticular bed or group of beds intercalated in greywacke, well to the south of the horizon at which conglomerate usually occurs.

A lenticular band of greenstone and diorite is shown on the accompanying maps (Sheets 2 and 3) south and west of the west end of Kiekkiek Lake. Exposures are small and widely scattered. In Bousquet township a few ill-defined pillows were identified in adesite on the railway 8,500 feet east of the Joannès boundary. The other exposures show massive andesite and fine-grained diorite, in places amphibolitized and intruded by quartz syenite. In Joannès township just north of the railway, 200 feet of black, slaty sediment is bordered north and south by fine-grained diorite and pinches out entirely within 300 feet to the east. The rock is in part converted to actinolite schist, and some of it contains abundant small metacrysts of biotite and chloritoid. Also, there seems to be at least one layer of greywacke in greenstone south of the railway in Joannès township. These latter exposures, however, are in dense bush and so limited that the precise relations of the strata could not be determined, especially as a wide variety of strikes were obtained in scattered outcrops, suggesting that there may be complicated folding or faulting. A short way to the north, on the railway grade, greenstone and sediment are highly sheared and are intruded by amphibolite and by quartz syenite. The extreme limits of the belt of greenstone and diorite are not known for there are large drift-covered areas

to the east, west, and south of the known exposures. Neither were any contacts between these rocks and sediments of the Kewagama group observed. In view of the fact that there is much contortion all around the west end of Kiekkiek Lake and also at least one major fault, the possibility was considered that the layer of greenstone and diorite might be a westward continuation of the Cadillac belt of the Blake River group, carried southward by complex folding or faulting or a combination of both. The available information is meagre, but it does not support such a possibility. Therefore, the tentative conclusion has been reached that the layer of greenstone and diorite is a part of the Kewagama group, interbedded in the normal sediments.

The contact between the Kewagama and Blake River groups on the south limb of the syncline is conformable, so far as known. On the Doreva and Sudbury Contact properties, east of Bousquet River, tuff, greywacke, and greenstone are intercalated in the contact zone, so that it is difficult to place the contact within a few tens of feet. West of the river narrow beds of agglomerate and fine-grained tuff occur in greywacke at the north edge of the Kewagama group on Doreva and Norgold ground, for several hundred feet south of the Cadillac "break." They indicate a gradational passage from sedimentation to volcanism. Farther west, at the Calder-Bousquet property, the broad shear zone of the Cadillac "break" separates greenstone from sediments on the south. Near Cadillac township, on Bouscadillac claims, a single exposure at the contact is greatly sheared, but the attitude of volcanic and sedimentary beds near the contact is parallel. West of Kinojevis River the contact is sheared in one place but in several others is clearly conformable, with greywacke and conglomerate resting against greenstone and agglomerate.

BLAKE RIVER GROUP

The Blake River group is an assemblage of lava, tuff, and agglomerate, with a few minor interbeds of fine-grained sediment, that lies between the predominantly sedimentary Kewagama and Cadillac groups on both limbs of the regional syncline. In the north limb it is much thicker than to the south and underlies nearly the whole northern part of the present map-area. The development in the southern limb is a continuation of what was called the Cadillac belt in Cadillac and Malartic townships. It has been traced as a narrow belt for about 8 miles across the eastern part of Bousquet township, beyond which point it may or may not continue, beneath swamp and overburden, to Kinojevis River. West of Davidson Creek there are apparently two synclinal troughs in the group, occupied by sediments of the overlying Cadillac group.

NORTH AREA—PETROLOGY

The rocks of the northern area are the westward continuation of the Keewatin-like Blake River volcanic rocks of Cadillac township.[1] Lavas are the most abundant, but there is much tuff and agglomerate. True sediment is practically absent except in a few places along the south contact zone.

[1] Geol. Surv., Canada, Mem. 206, p. 6.

The lavas include andesite, dacite, rhyolite, trachyte, and probably a few layers of basalt; the ejectamenta are of the same general range in composition and vary from fine-grained, bedded tuff to unsorted, pyroclastic breccia with fragments several feet in diameter. Flow breccia is also fairly abundant.

The typical andesite is dark green and devoid of quartz. The texture is dense to crystalline, depending partly on the thickness of the flow. Many flows are pillowed and some are amygdaloidal. Crystalline types resemble diorite and are generally rich in dark green amphibole. The flows vary from 3 or 4 feet to about 200 feet in thickness, but the majority are probably between 10 and 60 feet. Porphyritic lava is rare, but does occur in the western half of Bousquet township and a few other places. The phenocrysts are white feldspar, one-eighth inch or less in diameter, and stand out prominently on the green weathered surface, but are almost undiscernible in the fresh-broken rock. Typical of most of the andesitic flows are irregular patches of pale green epidote, scattered irregularly throughout the darker green rock or concentrated in the spaces between pillows. Narrow seams of epidote, calcite, and quartz are also of common occurrence. The writer classifies as dacite those lavas that weather pale olive-green to grey, distinctly lighter in colour than andesite. Tiny grains of quartz are rarely visible, and the textures and structures are similar to those of andesite. No hard and fast division can be made between the two types. Basalt is darker than, but otherwise similar to, andesite. The writer restricts the term to those flows that are practically black, and found very little in the area.

Microscopic examination does not assist much in arriving at a precise petrologic nomenclature. All the rocks are highly altered, even where they appear fresh, and where the minutest original textures are apparent on the weathered surface. In general the feldspar is altered, beyond identification, to a mixture of epidote, sericite, zoisite, chlorite, and carbonate, and that which remains is predominantly albite, varying from the pure mineral to about Ab_{94}. No potash feldspar was surely distinguished, but tiny grains in some sections may be orthoclase. Pale green to straw-coloured hornblende is always present, generally in large amount in basic and intermediate lava, and it is partly to completely chloritized. Accessory minerals include apatite, rutile, brown or green biotite, pyrite, magnetite, titanite, leucoxene, and variable small percentages of quartz.

The dioritic phases contain 25 per cent and more of hornblende and except that the grain is coarser are identical with normal andesite. These dioritic flows cannot be differentiated from intrusive bodies of diorite and quartz diorite unless intrusive relations can be found in exposures, but this can rarely be done. Where the feldspar is sufficiently well preserved, it generally exhibits, in the lava, a trachytic texture that is not present in intrusive bodies. Micrographic intergrowths of quartz and feldspar are present in both flows and dykes, but seem to be more abundant and better developed in the dykes.

Rhyolite and trachyte invariably weather pale grey to white, or buff if much pyrite is present. The fresh rock is pale grey to dark grey. Pillows are very rarely developed and flow banding is not common. The texture is dense, cherty, or porphyritic, with well-defined phenocrysts of quartz or

albite up to one-eighth inch in diameter. By far the largest proportion of the rhyolite is porphyritic and nearly all the quartz phenocrysts are partly resorbed. The cryptocrystalline groundmass is also quartz and albite and many rhyolites are more than 50 per cent quartz. Accessory minerals are sericite, very abundant in the more schistose varieties, and small amounts of chlorite, biotite, apatite, rutile, epidote, carbonate, and pyrite. Trachyte is similar to rhyolite, but contains little or no quartz. Feldspar laths from one-sixteenth to half an inch in length are close packed with trachytic texture, with or without a random bluish quartz eye among them.

There are all gradations between the two types of rock, just as there are from rhyolite through dacite to andesite and basalt. Some types of trachyte and rhyolite are strikingly beautiful, grey to greenish grey porphyries. The general lack of structures diagnostic of flows is troublesome, making it difficult to prove that some of these acidic rocks are not intrusive. However, the lithologic similarity and approximately equal metamorphism of pillowed and non-pillowed exposures, and the restriction of the acid volcanics to the upper part of the Blake River group leave little doubt in the writer's mind that the whole assemblage is volcanic. No doubt some sills and dykes were intruded as the volcanic pile accumulated, but they are essentially volcanic and in no way related to the later hypabyssal and batholithic invasions of the region. This probably accounts for certain masses of rhyolite and rhyolite breccia that clearly invade greenstone and rhyolite at the Arrowhead mine and in western Bousquet township, respectively. Also included in this class may be some or all of the sill-like, but in places very irregular, bodies of quartz porphyry at and east of Cassels Duval mine.

Many varieties of agglomerate are represented in the Blake River group, but the most abundant are rhyolitic and trachytic, pyroclastic breccias. They are composed of fragments of rhyolite and trachyte, with a few pieces of dacite and andesite, that vary in size from dust-like particles to blocks several feet across. There are also andesitic and dacitic flow breccias in which the proportion of fragments to lava matrix varies tremendously. The most striking fragmental rocks are in western Joannès township, particularly north and south of the syncline of Cadillac sediments in range VIII, where large amounts of coarse rhyolite breccia are interbedded with flows of rhyolite and trachyte. White, angular to subangular fragments of cherty rhyolite, from a fraction of an inch to 2 feet across, are set in a slightly darker, dull grey, fine-grained, fragmental groundmass. The fragments contain a few micro-phenocrysts of sericitized albite in a groundmass of interlocking grains of feldspar (albite?) and quartz with an average grain size of about 0·03 millimetre. The matrix is a crystal tuff of albite crystals and a few tiny rock fragments, the whole almost completely altered to chlorite, carbonate, epidote, and sericite.

The writer classifies as tuff those pyroclastic rocks in which the largest fragments, if at all abundant, are smaller than a walnut. There are many varieties in the Blake River group: crystal tuff, lithic tuff, waterlain beds of tuffaceous material too fine grained for the fragments to be discernible to the naked eye, and unsorted accumulations of the same material. The composition varies from andesitic to rhyolitic. Thin-bedded varieties are

abundant in the southern part of the group in western Bousquet and are altered to slaty chlorite tuff, chlorite schist, and phyllite, and to sericite-carbonate schist. Especially along the contact zone between the Blake River and Cadillac groups where intercalation of volcanic and sedimentary material occurs and the rocks are sheared, it is difficult and in places impossible to differentiate true sediment from tuff. Many of the tuff beds there are pale green to greyish green, hard, and exceedingly dense. They consist of minute particles of quartz and feldspar and varying proportions of chlorite, sericite, epidote, and other secondary minerals. Crystal tuff resembles sheared feldspar porphyry in some places, but is generally more variable in texture and composition and more schistose than the porphyries of the region. It is grey-green in colour. Grey and grey-green, dacitic tuff is fairly abundant in western Joannès township and occurs elsewhere. It is bedded or unsorted and contains fragments of black, rhyolitic material and of argillite that can be distinguished by the naked eye.

A few narrow beds of normal greywacke were observed within the group, chiefly within about 1,000 feet of the contact of the Cadillac group. They are generally altered to biotite schist or phyllite.

Pseudo-amygdaloid occurs across a width of 100 to 200 feet in the southern part of the group in western Bousquet township (*See* Thompson Bousquet, Westwood, and Warrenmac properties). It is a highly chloritic and carbonated tuff, with poor, slaty cleavage, in which hydrothermal solutions have formed "eyes" or "amygdules" of quartz and ankerite. Most of them are less than a quarter of an inch in diameter, but on the west, at the Warrenmac property, they have developed as nodules an inch and more across. The finer grained varieties closely resemble dacitic amygdaloid, and the rock type approximately follows a horizon in the bedded rocks.

DISTRIBUTION OF ROCKS IN THE NORTH AREA

In Cadillac township the writer divided the Blake River volcanic rocks into three parts: a lower or northern half of greenstone; a middle, thin section with rhyolite predominant; and an upper part consisting largely of tuff and agglomerate.[1] In Bousquet and Joannès townships the northern area has the same general succession, from predominantly andesitic lavas in the lower part of the group to rhyolite with much pyroclastic material in the upper part. The middle rhyolite horizon of Cadillac township has been traced west almost to the centre line of Bousquet township, but beyond, though rhyolite is abundant at about the same horizon, it is also found above and below that horizon in amounts that vary greatly in different parts of the area. Much andesitic lava is mixed with pyroclastics and rhyolite on the southern or upper part of the group in Joannès township for several miles east of the Davidson Creek fault, where thick bush and limited exposures render detailed mapping difficult and unsatisfactory.

At the Cadillac township line the northern greenstone division is half a mile wide and increases only slightly in width for nearly 4 miles to the west. It consists predominantly of andesitic lava, in part pillowed

[1] Geol. Surv., Canada, Mem. 206, p. 6.

and in places amygdaloidal. Flows of dacite and of rhyolite are present in minor proportion, particularly near the southern edge of the division east of Bousquet River. West of the river there is some dacite and rhyolite along the northern edge of the group and also some narrow beds of siliceous tuff, but thin flows of rhyolite are also interbedded with andesite along the southern edge of the greenstone division. About 3 miles from the Cadillac township line the strike of the strata gradually changes from nearly due west to northwest and the thickness of andesite increases to at least a mile just west of the centre line of Bousquet township, where the north contact of the group passes into LaPause township. West of that to within 1¼ miles of Joannès township, there are moderately good exposures of massive, pillowed and amygdaloidal andesite, with lesser amounts of agglomerate and flow breccia. Some of the lava is coarsely crystalline and resembles diorite, but no proof that any of these varieties were intrusive was found by the writer. A few narrow layers of quartz porphyry in the southern part of the division, north of the Cassels Duval shaft and on the Mic-Mac claims to the east, are interpreted as rhyolite by the writer, but may be in part intrusive. An andesite holding rounded to oval, white-weathering nodules (pale chlorite, quartz, epidote, and zoisite), generally about half an inch in diameter, is exposed on the centre line of the township just south of the old Cléricy-Bousquet Rapids trail and in several exposures along and south of the trail for 4,000 feet to the west. It occurs again, beyond a drift-covered area, on the LaPause township line 10,200 feet east of Joannès township. It seems to characterize a zone several hundred feet wide along the strike of the lavas, as it does at approximately the same horizon in Cadillac township.[1] Only three exposures of the rock were found in the intervening western half of Bousquet township, but they are approximately at the same stratigraphic horizon.

It would appear from very few exposures that the southern edge of the andesite division extends north of west from just north of the west nose of the Mooshla granodiorite body to the southeast corner of claims held by E. J. Thompson, 6,500 feet from Joannès township. The contact has been drawn through exposures in which andesite and andesitic tuff are bordered on the south by rhyolite and quartz-sericite schist, presumably derived from rhyolite and dacite. To the west, in the northwest corner of Bousquet township and the northeast corner of Joannès township, there are no exposures in an area of over 2 square miles. Beyond this the andesitic division of the Blake River group extends a mile and more south from the north boundary of the area mapped, but within it there is much rhyolite, rhyolite breccia, and siliceous schist in a zone that is over 1,000 feet wide in the northwest corner of the Arrowhead Mines property, but noses out to the west. Structural determinations were insufficient to prove whether this zone is interbedded with the more basic lavas or whether it is a synclinal trough of the overlying rhyolites. Andesitic rocks are exposed on the Arrowhead property for about 1,500 feet south of the rhyolite zone and extend eastward into Bousquet township where they pinch out in rhyolite, in which there are also narrow intercalations of andesite. To the west of the Arrowhead, andesitic rocks underlie all of range X and are intercalated to a minor extent with the flows to the

[1] Geol. Surv., Canada, Mem. 206, p. 7.

south. There are several bodies of diorite in range X and a few layers of dacite and tuff. West of the Davidson Creek fault andesite is restricted to exposures in ranges IX and X and to a few outcrops in range VIII near the fault. It is difficult to draw any exact boundary between the two divisions of the Blake River group all across Joannès township, because of the interbedding of greenstone and rhyolite. Andesite, dacite, and associated agglomerate are the main rock types of the group within the big bend of Kinojevis River, west of the Davidson Creek fault.

The central rhyolite division of the Blake River group, which, as already stated, can be traced west for nearly 4 miles from the Cadillac boundary, is best exposed on the Thompson Bousquet property where it is 500 to 600 feet wide and contains only narrow intercalations of dacite, trachyte, greenstone, and tuff. Exposures are few between there and the Cadillac boundary, but there are enough to be reasonably sure that the zone is continuous. Interbedding of rhyolite and tuff on the south, as a general rule, makes the drawing of the south boundary of the zone more arbitrary than that of the north. The extension of the rhyolite horizon from Bousquet River to the Mooshla granodiorite is based on small exposures of porphyritic rhyolite and quartz-sericite schist, mostly in trenches. Beyond the granodiorite it loses its identity and forms a part of the southern division of the Blake River group, though it is to be noted that rhyolite and sericite schist are most abundant for several miles to the west along the northern part of the southern division. Thus, the exposures in the western claims of the Vaughan group are almost entirely of quartz-sericite schist and schistose rhyolite. They represent a thickness of about 1,000 feet of rocks that must have been largely rhyolite originally. There is too little information available to establish the exact stratigraphic relations between these exposures and those of rhyolite in the northern part of the Arrowhead property or the great mass of rhyolite in westernmost Bousquet township. It may be noted, however, that if one assumes the existence of an easterly plunging syncline whose axis trends south of east through the Arrowhead rhyolite, then each of the three areas mentioned occupies about the same stratigraphic position in the upper part of the Blake River group. No structural determinations favouring or against such a structure were obtained.

Dense to porphyritic rhyolite is exposed in numerous outcrops west of the Davidson Creek fault both north and south of the narrower band of Cadillac sediments. To the south it is associated with trachyte and a large proportion of rhyolite breccia similar to that of the Horne mine at Noranda. To the north of the sediments identical rocks are exposed, but on the whole the proportion of lava and tuff is greater.

The southern division of the north area of the Blake River group is distinguished in the eastern half of Bousquet township by large proportions of tuff and siliceous agglomerate, but is somewhat of a wastebasket division in that it includes considerable amounts of greenstone, trachyte, and rhyolite. At the Cadillac boundary rhyolite and rhyolite breccia occur along the southern edge of the group and north of this are a few small exposures of tuff, greenstone, and pyritic chlorite schist. The southern layer of rhyolite and rhyolite breccia can be traced westward almost to the centre line of Bousquet township and includes trachyte in some places. It varies in width from about 700 to 1,500 feet. The rocks are hard and

massive, in contrast with the softer schists and tuffs to the north. The rocks between this southern layer and the central band of rhyolite are best exposed on the Thompson Bousquet property. For about 600 feet south of the central band they are predominantly green to grey andesite and dacite flows and tuffs, but include trachyte, rhyolite, and some green agglomerate. These strata are massive to schistose, but definitely more highly sheared than those to the north. For 500 feet farther south scattered exposures are highly sheared. They vary in colour from dark green to pale grey and white and are in the main chloritic phyllite and slate and sericite schist with some thin layers of pseudo-amygdaloid. Considerable widths are carbonated and pyritized and a few mud seams are evidence of faulting in the broad, sheared zone. Alteration is so intense that the original character of much of the assemblage cannot be determined, but it was probably a mixture of andesitic to rhyolitic tuff and some thin flows of dacite, trachyte, and rhyolite. The southern 400 to 500 feet of the Thompson Bousquet section is drift covered, but from exposures on adjoining properties it seems safe to assume that it is underlain by massive, acidic, volcanic rocks that pass gradually into the schistose types on the north. The zone of schistose tuffs and associated rocks continues west across the properties of Westwood Cadillac and Warrenmac mines, a distance of about 3 miles, and may continue for another mile or more beneath drift. A number of auriferous deposits of similar type have been found along it.

The corresponding rocks in the western half of Bousquet township are a confusing mixture of acidic to basic lava and pyroclastic material, in part converted to sericite schist. The proportion of basic material is small. Sericite schist is developed principally in the northern half of the division, mixed with massive rhyolite breccia. Along the south edge there are bodies of green to grey feldspar porphyry on Mooshla and Norgold claims that are interpreted as porphyritic lava, although no very clear proof of their volcanic origin was obtained. Elsewhere in the southern 1,000 feet or so of the group there are intercalations of greywacke and mica schist similar to rocks of the Cadillac group. For this reason and the fact that siliceous tuffs are interbedded to some extent in the northern edge of the Cadillac group, the contact between the two groups is arbitrarily placed; it might in places be moved nearly 1,000 feet to the north. This mingling of sedimentary and volcanic material continues westward to a locality 2 miles east of the Joannès boundary where the contact of the two groups turns southward for half a mile. Along this southward trending stretch the sedimentary and volcanic rocks interfinger. The volcanic rocks consist of andesitic tuff, agglomerate, and lava alternating with rhyolite, rhyolite breccia, and sericite-carbonate schist.

To the west as far as the Davidson Creek fault there are very few exposures near the contact and none completely across it. The best, in lots 27 to 29, rge. VIII, Joannès tp., are of grey-green, dacitic tuff with many small but clearly visible fragments of rhyolite, dacite, and argillite. Identical material is exposed in several outcrops west of the Davidson Creek fault on both sides of the narrower syncline of Cadillac strata. This fact is important in considering the displacement along the fault.

ROCKS WITHIN THE BIG BEND OF KINOJEVIS RIVER

The volcanic rocks within the big bend of Kinojevis River, at the extreme western edge of Joannès township, are bordered on three sides by sediments. Their inclusion as part of the Blake River group is dependent upon interpretations of regional structure and displacement along the Davidson Creek fault, matters that are discussed later in the section on structure. The area has been studied by Cooke, James, and Mawdsley, and in greater detail by J. E. Hawley (1933). The Thompson Creek fault divides the volcanic rocks into two parts. The rocks north of the fault are dacitic to andesitic lavas and flow breccia, the former predominating. They are massive to schistose and pale to dark green. Exposures of porphyritic andesite on the south bank of Kinojevis River at the Rouyn township line are cut and partly replaced by very irregular seams of hard black material that proved to be a mixture of epidote, zoisite, quartz, and titanite, with numerous black, submiscroscopic particles that may be graphite. The andesite is amygdaloidal in places and contains a few pillows. South of the fault the rocks are dacitic to andesitic lava, flow breccia, and agglomerate, in places converted to chlorite schist. Much of the agglomerate contains rounded to angular fragments of dacite that weather pale green to white and are from 1 inch to 2 feet in diameter. The groundmass is slightly more basic and weathers pale green. Nearly identical flow breccias are abundant in the western part of the O'Neill Thompson property. Normal dark green andesite is most plentiful near Kinojevis River, around and west of an irregular body of diorite.

Immediately north and south of the Thompson Creek fault there are a few exposures of conglomerate and greywacke. The latter is thin bedded, dark grey, and lithologically similar to the Cadillac and Kewagama greywackes. The conglomerate contains cobbles and small pebbles of rhyolite, felsite, and feldspar porphyry, all of which might easily be of volcanic origin. There are also a few small pebbles of greywacke and dacite. Some narrow beds exposed in the O'Neill mine hold small, angular, grey fragments that suggest a tuffaceous origin. The conglomerate is exposed principally along and not far north of the southern contact of the sedimentary band and in several exposures north of the fault. Pebble conglomerate is most abundant in the former place and coarse conglomerate in the latter. Along the south contact the rocks are carbonatized in varying degree and to a lesser extent veined and replaced by quartz and tourmaline, so that the identification of the contact is a difficult matter. As the amount of displacement on the Thompson Creek fault is unknown, there is no assurance that the sediments exposed on each side of it are parts of the same assemblage, though the assumption that they are has been made by the writer. The band of sediments on the south side of the fault continues westward for several miles, as far as McWatters mine where the ore deposits lie in it. Other auriferous deposits have been found along the south contact between that mine and Joannès township; those on the O'Neill Thompson property have the same position.

SOUTH AREA OF THE BLAKE RIVER GROUP

The southern development of the Blake River group, the so-called Cadillac belt of volcanic rocks, enters Bousquet township at the property of Bouscadillac Gold Mines, where the main highway crosses the township

line. It has been traced westward, by widely separated exposures and some drill holes, practically to the centre line of the township. Beyond that there are exposures of andesite on the Calder-Bousquet property and a few narrow beds of tuff on intervening claims of Norgold and Doreva Mines. Thus the belt may be said to continue, perhaps discontinuously, for 8 miles across Bousquet township. No exposures have been found farther west, but it could continue in an almost straight line for several miles beneath a large drift-covered area. Scattered exposures in the north parts of lots 22 and 23, rge. VI, Joannès tp., show that there can be no appreciable thickness of volcanic rocks in the most likely place for a continuation of the belt, unless a narrow band of actinolite schist be considered as part of it. Farther west along the same horizon a narrow layer of diorite and amphibolite with a few associated beds of tuff extends along the railway for over a mile east from Kinojevis River. Possibly this layer is the western continuation of the Cadillac belt.

Eastward from Bousquet township the Cadillac belt has been traced for over 20 miles across Cadillac, Malartic, and Fournière townships. All the most important mineral deposits of that region lie in or very close to the belt.[1] Because of lack of outcrops its boundaries were not accurately located in the western half mile of Cadillac township. Recent drilling has shown that it is displaced southward on the west end of the Thompson Cadillac property, probably by a northeasterly striking fault. Map 399A, therefore, shows this section a little far north, so that the contacts do not join exactly with those on the present map of Bousquet township.

At Bouscadillac mine the belt is 800 feet wide and lies south of the Cadillac " break " (*See* Figure 2), separated from it by 150 feet or less of greywacke and conglomerate that are thought to belong to the Cadillac group. The rocks of the belt are andesitic agglomerate, porphyritic andesite, normal andesite, in part pillowed, and a few small bodies of diorite. Agglomerate lies on the south and is just under 600 feet wide, but includes in its southern part small bodies of andesite, porphyritic andesite, and diorite. It is a green rock that weathers pale green to grey. Fine-grained phases are difficult to distinguish from normal andesite, though they usually weather to a paler shade. The proportion and size of the fragments vary greatly. The largest observed is 5 feet by 11 and of crude triangular shape. All are of andesitic to dacitic composition, similar to the matrix. The rock is moderately to highly sheared. This rock continues for at least 4 miles to the west, but has not been found to the east, in Cadillac township.

To the north of the agglomerate, but separated from it in one place by 20 feet of pillowed andesite, is a layer of grey to brown weathering, porphyritic andesite that increases in thickness from about 100 feet at the east side of the property to 300 feet at the west. This rock continues for 2 miles west from the Cadillac boundary, but must then thin rapidly and end in a drift-covered area. It persists for about 4 miles eastward into Cadillac township and is the host for several of the richest gold veins in that area. Where not sheared it is distinctly porphyritic, with phenocrysts of albite up to one-fourth inch long. It also contains ellipsoidal structures that closely resemble the normal pillows of andesite, and is,

[1] Geol. Surv., Canada, Mem. 206, Maps 399A, 400A (1937).

therefore, assumed to be a flow rock (Bell and MacLean, 1929, page 26). In many places it is sheared and carbonated to a brown or green schist, the principal constituents of which are ankeritic carbonate, pale brown biotite, and chlorite. A few small bodies of diorite intrude it.

At the mine the porphyritic andesite is bordered on the north by 150 feet or so of fine-grained, argillaceous to siliceous greywacke. The contact is conformable in places, in others it is marked by a narrow, graphitic shear zone. This band of sediments continues for at least 4 miles to the west and in that distance thickens and includes several narrow beds of conglomerate, but maintains the same position between the schists of the Cadillac "break" and the volcanic rocks to the south. It is debatable whether the sediments should be considered to belong to the Blake River group and to be part of the Cadillac belt, or to belong to the Cadillac group. In Cadillac township conglomerate and greywacke occur in the Blake River group as part of the Cadillac belt. The sediments are represented on the accompanying map (No. 612A) as being a part of the Cadillac group because they are lithologically identical with rocks of that group.

Half a mile west of the Cadillac boundary a few feet of sheared andesite lies between the sediments and the porphyritic andesite to the south. This band of lava increases in thickness to the west and includes some layers with well-preserved pillows. It is conformable with the sediments.

West of Norman Lake the Cadillac belt of Blake River rocks contains beds of tuff and greywacke, largely converted to schist, in addition to andesite and agglomerate. The proportion of tuff and greywacke apparently increases toward the centre of the township, and the belt either changes rapidly to, or wedges out in, an assemblage of greywacke and some bedded tuff that cannot be differentiated on lithologic grounds from strata of the Kewagama group and are represented on the accompanying map (No. 613A) as the northern edge of that group. However, 3 miles farther west, on Calder-Bousquet claims, there are two exposures of andesite and agglomerate that testify to the recurrence of volcanic activity at the correct horizon. Diamond drilling has shown that these rocks, in part converted to schist along the Cadillac "break", continue another half mile west, to a body of granite. It may also be that the apparent disappearance of the Cadillac belt for 3 miles is due to its being eliminated by displacement along the Cadillac "break", for at Calder-Bousquet the shear zone is south of the exposures of greenstone, instead of north of them as at Bouscadillac.

Very little is known of the band of schist and schistose conglomerate (5C on Sheet 1) on the Bouscadillac property. It is considered to be a northern part of the Cadillac belt and apparently dies out about 3 miles west of Cadillac township. It could, perhaps, be considered as a part of the Cadillac "break" as that major shear zone lies within it and much of the rock composing it is reduced to soft schist. The band consists of a mixture of mica schist, chlorite schist, talcose schist and serpentine, schistose conglomerate that is in part at least agglomeratic, and a few more massive bodies that can be identified as greywacke and andesitic lava or tuff. Additional details are given in the descriptions of the Brown Bousquet and Bouscadillac properties. There are also lenticular intrusions of quartz

albitite and of albite porphyry. The presence of some rocks of volcanic origin and the fact that greenstone is exposed north of the " break " not far east in Cadillac township, justifies the inclusion of the schistose layer as part of the Blake River group.

RELATIONS TO THE CADILLAC GROUP

The evidence obtained in Bousquet and Joannès townships supports that obtained in Cadillac and Malartic townships to the east, and indicates that the Blake River group is overlain conformably by the Cadillac group of sediments. Nowhere was any evidence of angular discordance discovered. In the north limb of the major syncline the contact is nowhere completely exposed in the east half of Bousquet township, but can be closely placed between outcrops of greywacke and acidic volcanic rocks. It is remarkably straight and in several places the complete change from vulcanism to sedimentation took place within a width of 10 or 15 feet. (The contact at Westwood Cadillac mine is described on page 106.) West of the centre line the contact swings northward and for nearly 3 miles is very difficult to place within several hundred feet. Sediments, volcanic rocks, and schists, presumably derived from both, are intercalated in an intricate manner. Then the contact, through interfingering of the two types of rock, turns south for half a mile, beyond which it continues west for several miles under drift. These facts point clearly to a gradual change from vulcanism to sedimentation through a lengthy period of alternative deposition. In Joannès township a few narrow beds of greywacke were observed in the uppermost part of the Blake River group and one layer of agglomerate lies in Cadillac greywacke in range VII, lots 16 and 17. In the latter place the change from greywacke to andesitic tuff is so gradual that one is in doubt exactly where to place the contact.

Very little information as to the relations of the two groups is obtainable on the south limb, for the Cadillac " break " and associated schists confuse the issue. The long, narrow band of greywacke and conglomerate that lies between the "break" and the volcanic rocks to the south in eastern Bousquet is certainly in conformity with the adjoining greenstone. The contact is exposed in several places and can be seen underground at Bouscadillac mine. The question is whether these sediments have been rightly classed as being part of the Cadillac group.

CADILLAC GROUP

Sediments of the Cadillac group form the central synclinal trough of the area, and west of the Davidson Creek fault form two narrower synclinal bands. The group consists chiefly of greywacke, a small proportion of conglomerate, numerous narrow beds of magnetite and iron formation, and, especially along the northern edge, dense, siliceous tuff beds intercalated with and difficult to distinguish from normal greywacke. Greywacke varies from argillaceous to quartzitic and arkosic and is lithologically identical with that of the Kewagama group. East of the Davidson Creek fault the soft, dark grey, argillaceous varieties form only a small proportion of the group, scattered throughout it in beds rarely more than a few inches thick and forming the fine-grained tops of some thicker layers,

the bottoms of which are arkosic or quartzitic. They are more abundant in the two bands west of the fault, and constitute nearly half of the exposed rock, in places forming beds several feet thick.

Conglomerate was found in only one place west of the Davidson Creek fault, on the west bank of the creek near its mouth. Elsewhere the coarsest sediment is a few small pebble beds. The one body of conglomerate contains some layers of arenaceous greywacke, but is otherwise composed of well-rounded to subangular pebbles from about a quarter of an inch to 6 inches in diameter, set in a fine-grained to distinctly clastic greywacke matrix. The pebbles are of grey to brown rhyolite, felsite and feldspar porphyry, dacite, and a few of greywacke and green, chloritic phyllite that may have been greenstone originally. The pebbles form fully 50 per cent of the exposed rock, and over half of them are 2 inches or less in diameter. The rock resembles an indurated stream gravel and differs from the ordinary conglomerate of the Cadillac and Kewagama groups in the abundance and small size of the pebbles. Identical in appearance, however, is a conglomerate a mile northeast by east, on the east side of Davidson Creek. This occurs as several beds from a few feet to about 200 feet thick, interbedded with arkosic greywacke. The strata are intricately folded and in part converted to amphibolite. Some of the pebbles are distinctly angular, but the same feature was noted to a lesser extent in the exposures west of Davidson Creek. It may be noted here that except for a rare pebble of greywacke the pebbles in composition and appearance closely resemble the fragments of the acidic breccia of the Blake River group across Davidson Creek, except that the latter are much more angular. The conglomerate forms, with its associated greywacke, an isolated group of outcrops and the strata are intricately folded. Therefore, their relation to the rest of the Cadillac group is not well established, and the exposures west of the creek are too small to clarify the relations there. It may be that these rocks should not be classified as part of the Cadillac group at all, that they are representative of a younger series, infolded in the older strata. This is suggested by the strike, which at the end of the exposures east of the creek is southwest, parallel to the creek and almost directly towards the exposures of similar conglomerate 3,000 feet away on the west side of the creek. This seems to indicate that the strata may not be greatly displaced at the fault, despite the fact that strata of the Blake River and Cadillac groups and several later diabase dykes are offset several thousand feet; but if so the conglomerate is younger than the diabase dykes and, therefore, distinctly younger than the Blake River and Cadillac strata.

Elsewhere in Joannès township only a few, narrow, pebbly beds of greywacke, too small to map, were found within the Cadillac group. In Bousquet township a single small outcrop of coarse conglomerate, 400 feet south of the highway and 4,500 feet east of the Joannès boundary, may lie north of the Cadillac "break" and, therefore, belong in the Cadillac group. A thin bed of conglomerate occurs in greywacke 2½ miles to the northeast. To the east there are small and large bodies of the rock, incompletely exposed, along the south side of the group for 1½ miles from Cadillac township. In all these exposures the rock is identical with the conglomerate of the Kewagama group, described on a preceding page. There are also thin beds of similar conglomerate in the narrow band of sediment that lies immediately south of the Cadillac "break" in the western

half of Bousquet township. The conglomerate on Brown Cadillac claims, at the extreme eastern side of the township, contains boulders up to 5 feet in diameter and is a very irregular mass such as might be deposited in the fan of a mountain stream.

There are many sedimentary beds rich in magnetite in the Cadillac group in Bousquet township, but none was observed in Joannès. They range in thickness up to about 25 feet, and vary from layers of siliceous greywacke with 25 per cent or less of disseminated magnetite to beds a foot or two thick, and less, of almost pure iron oxide. Those observed are shown on the accompanying maps (Nos. 612A and 613A). In only one or two places was true banded iron formation observed. The development of these iron-rich beds appears to decrease westward from the central and eastern part of Cadillac township, where magnetite and true iron formation reach their maximum development. A similar decrease has been noted to the east of that area. A number of areas of strong local attraction were encountered in drift-covered parts of the Cadillac group in Bousquet township; they presumably indicate that magnetite is more abundant than the accompanying maps suggest. For more detailed descriptions of the iron formation the reader is referred to Memoir 206, page 9.

INTRUSIVE ROCKS

Intrusive rocks are not abundant in the area, but have a wide range in composition from lamprophyre, amphibolite, and gabbro through diorite and granodiorite to granite and quartz syenite. The oldest are masses of diorite and quartz diorite, and possibly some bodies of sheared quartz porphyry that occur in the Blake River group. Diorite and quartz diorite are found in the volcanic rocks of the Malartic and Blake River groups and are difficult to distinguish from massive, basic flows unless the exposures are unusually good. Some are definitely intrusive, however, and similar dioritic rocks cut sediments of the Cadillac group. They are highly altered and presumably represent the earliest plutonic injections of the area. Relatively massive and fresh are two stock-like bodies that grade in composition from quartz diorite to granite, one in north-central Bousquet, the other in northwest Joannès township. They will be referred to as granodiorite. In addition, there are irregular intrusive masses and dykes of granite, alaskite, quartz porphyry, quartz syenite, and quartz albitite, all so far as known belonging to one period of invasion. Most of them lie well within the area of the Blake River group, along the northern side of the area mapped. The Cadillac group is devoid of intrusive rocks, except for small dykes of diorite and amphibolite and one body of granite in western Bousquet. Nevertheless it is thought that the main period of intrusion is post-Cadillac. The youngest intrusive rocks are the many prominent dykes of quartz gabbro; they are known to cut alaskite and granodiorite.

QUARTZ PORPHYRY IN THE BLAKE RIVER GROUP

Considerable rhycolite is shown on the accompanying maps in the northern area of the Blake River group. Much of it is certainly lava and volcanic agglomerate, and distinct pillows were noted in several places. Nevertheless, some of the smaller bodies are definitely intrusive, and as

many exposures show no contacts some doubt exists as to how much intrusive material is present. The few bodies proved intrusive are similar lithologically to others definitely extrusive. A special study of the problem was made at the Arrowhead mine where there are favourable exposures on the hill immediately northwest of the shaft. Sill-like, lenticular bodies of schistose quartz porphyry, from a few feet to over 100 feet thick, lie in andesitic lava. Parts of them contain fragments, commonly an inch or two across, of quartz porphyry less schistose than the matrix, and in some places the rock is a normal rhyolite breccia. Small and large quartz veins and lenses, accompanied by some tourmaline and variable proportions of albite, cut the porphyry. Several of the thin, wedge-like ends of the porphyry bodies consist entirely of quartz. Under the microscope the fragments and matrix are seen to be identical except that the latter is slightly more schistose. Phenocrysts of bluish to grey, watery quartz from 1 to 2 millimetres in diameter and a few smaller ones of albite lie in a groundmass of the same minerals with accessory amounts of biotite, epidote, and apatite, and a rare grain of tourmaline. The grain size of the groundmass averages close to 0·02 millimetre. The acidic bodies definitely intrude the andesite, but quartz phenocrysts persist right to the contact, so that there is no noticeable chilling. The adjoining andesite is in places baked and altered to a grey weathering, felsitic rock not unlike the finer grained phases of the intrusive. Also there are small inclusions of andesite in the porphyry in a few places. The porphyry is sheared to the same extent as the andesite and in places the planes of schistosity cut across the contacts at sharp angles. Small faults offset andesite and porphyry.

There seem to be two main alternatives in considering the origin of these acidic intrusives. They may be sills of porphyry and breccia injected into the volcanic assemblage while overlying flows were being extruded. In that case they are truly a part of the Blake River group. Such intrusive bodies are almost bound to occur in some abundance in any great assemblage of lava and pyroclastics and are a well-known feature of the more recent lava fields of the world. The other alternative is that they may be hypabyssal intrusives of early Archæan age, older and, therefore, more highly sheared than the late Archæan acidic intrusives of the area. As no such intrusive bodies have been definitely proved to exist in this part of Quebec the writer favours the first alternative. This conclusion is somewhat similar to that reached by M. E. Hurst for the troublesome bodies of quartz porphyry and breccia at Porcupine, Ontario.[1] He says "The bodies of quartz porphyry that occur in the vicinity of Pearl Lake and in the area south of Dome mine are believed to mark the vents from which the acidic flows and pyroclastics mentioned above were erupted. It is thought that, when volcanic activity ceased, the lava in the vents solidified in the form of plugs or stock-like masses of quartz-porphyry: minor outlets branching from the main vent were occupied by tongues or smaller satellitic bodies of similar material; and narrow dykes and sheets of quartz porphyry were injected into the adjoining greenstones."

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[1] Recent Studies in Porcupine Area; Trans. Can. Inst. Min. Met., vol. 39, p. 450 (1936).

DIORITE AND QUARTZ DIORITE

Even more troublesome than the quartz porphyries are a number of bodies of diorite. These are green to almost black rocks consisting of variable proportions of hornblende and feldspar, and a few small eyes of quartz, and always much altered to secondary minerals. The main difficulty where they occur in the volcanic groups is in distinguishing them from thick basic flows. A few small bodies that are definitely dykes were recognized in the Blake River group, but others mapped as diorite may be flows. They are holocrystalline rocks resembling intrusives, but some flows are also known to be coarsely crystalline.

Definitely intrusive diorite and quartz diorite was found in each of the four groups of Archæan strata, so there is no doubt of their post-Cadillac age. Their degree of alteration suggests that they are older than the granitic intrusives of the area.

A body of diorite on the third level of the Bouscadillac mine is a holocrystalline rock with grain size averaging close to 2 millimetres. About 50 per cent is albite (An_6) charged with epidote and some chlorite. There is nearly an equal amount of pale green amphibole, in part altered to chlorite. Quartz forms about 2 per cent of the rock and is interstitial to feldspar and hornblende. Titanite is present in small amount. Similar but with varying proportions of hornblende are several dykes in the Cadillac group, on the Brown Cadillac property close to the Cadillac township line, on the highway in western Bousquet on Calder-Bousquet claims, and in the eastern half of Joannès township. In some of these bodies and others in the north area of the Blake River group, much of the quartz is in graphic intergrowth with feldspar. In some places tiny opalescent "eyes" of quartz are visible. Presumably the feldspar was more calcic originally and has been converted to albite since the rock solidified. A striking feature of the diorite dykes in greywacke is their occurrence in areas of extreme amphibolitization. This is particularly true on the Brown Cadillac claims where large areas of greywacke are partly converted to amphibolite, and in central and western Joannès township.

Of particular interest are two bodies of diorite in western Joannès township, on either side of Kinojevis River at the railway. The one west of the river lies in volcanic rocks of the Blake River group and the other is bordered by greywacke and conglomerate of the Kewagama group.[1] The latter is exposed in a large rock cut on the railway a quarter mile east of the Kinojevis bridge, and in other cuts to the east. In the first cut the diorite is conformable in conglomerate and greywacke and strikes east of north, dipping 60 degrees to the east. An exposed width of 375 feet of rock is mapped as diorite, with highly amphibolitized conglomerate to the west and drift to the east. The west or bottom contact is difficult to identify as the rock grades into amphibolitized conglomerate in which only a few acidic pebbles have escaped complete alteration. A number of northerly striking faults and shear zones that dip vertical to steeply east complicate the relations. However, the lower 25 feet or so of the diorite is a dark green, fine-grained rock resembling andesite. About 70 per cent of it is pale bluish green to straw-coloured hornblende in long prisms and

[1] Hawley, J. E., 1933, pp. 21 and 66.

sheaves that are bent and broken. The dense groundmass consists of plagioclase feldspar and a very small percentage of quartz. Magnetite, biotite, chlorite, and epidote are minor accessories. Above this the rock changes gradually to a holocrystalline quartz diorite of gabbroic texture with an average grain size of 3 mm. in the coarser phases. In it there is 5 per cent of quartz, partly as small opalescent phenocrysts but largely in graphic intergrowths with albite. Albite and the same blue-green hornblende in approximately equal amounts constitute most of the remainder, the hornblende remarkably fresh and strongly poikilitic. An irregular width of about 50 feet of this rock passes gradually eastward or upward into much finer grained amphibolite and dioritic amphibolite that continues for nearly 300 feet to the east end of the rock cut. This upper part is similar to the basal phase, but slightly coarser in grain. Weathered exposures above the rock cut show considerable variation in texture, from a very fine-grained, basic diorite to medium-grained hornblende porphyry, amphibolite, and feldspathic amphibolite. Some phases are gneissic, in others the feldspar is concentrated along narrow layers and in irregular bodies like small xenoliths or feldspathic segregations. The rock is cut by gently dipping veins and lenticular masses of quartz and tourmaline up to a yard across, that occupy tension cracks between steeply dipping faults and shear zones; these veins contain pyrite with some pyrrhotite and some of them are auriferous. Dioritic rock continues for more than a mile east of the first rock cut, but in that distance is chiefly amphibolite and feldspathic amphibolite; only a few small patches of true quartz diorite were found in the moderately good exposures.

It is quite apparent that the rock has been amphibolitized along with the enclosing sediments, and that the textural and compositional variations in the cross-section in the first rock cut are not those of a normal intrusive. Instead, they resemble those that occur in some of the basic lava flows of the region. There is a narrow, fine-grained, basal part, overlain by a crystalline part that grades in turn into a thick, fine-grained upper part. If one follows this analogy the diorite becomes a thick andesitic flow, top facing southeast in agreement with structural observations in sediments to the south and southeast. Like the adjoining sediments it has been intensely amphibolitized, possibly in part converted to a pseudo-diorite by the same metamorphic process. Malcolm MacGregor[1] has recently given an exceptionally clear exposition of similar phenomena. A rude banding preserved in the diorite and amphibolite east of the first rock cut suggests that those rocks are derived from bedded greywacke or tuff. This may account for the absence, in most exposures, of true quartz diorite, if that rock can only be formed from lava. In the large cut 2,000 feet east of the first a few narrow green beds that are definitely tuff were recognized.

The diorite west of Kinojevis River is much less typical than that to the east. It is an irregular, sill-like mass with a blunt southwest end in lava. Intense carbonatization, absent across the river, has veiled the relations along the upper side of the body, where it borders carbonatized greenstone. The body is known from drilling to dip northwest at 65 degrees, and as Hawley has noted (1933, page 21), normal diorite appears chiefly in the

[1] Geological Magazine, vol. 75, No. 11, pp. 481-496 (Nov. 1938).

lower part. Even there it surrounds irregular layers and masses of greenstone or other highly altered rocks and the writer succeeded in finding only two small exposures where diorite seemed to intrude the older rocks. In most places it is impossible to separate with any assurance the dioritic material from chloritic and slightly amphibolitized greenstone, and quite impossible to draw a contact around a body or bodies that can be clearly shown to be intrusive. It is worth noting that Cooke (1931, page 81) distinguished five flows and determined their tops in a locality that Hawley in 1933 mapped entirely as diorite. On examination of the same place in 1938 the present writer decided that there is nearly 100 feet of andesite about where Cooke found it, but no structural observations were obtained. The lava is bordered on the west by diorite, fine-grained and apparently conformable with the bedding of the greenstone. No definite proof that the diorite is intrusive was found in this place. It is quite possible that the exact exposures on which Cooke determined tops were not found by the present writer, as the area is wooded. The writer cites these facts not as criticism of the earlier workers, or as evidence that either of them is in error, but as an illustration of the difficulty of dealing with the diorite. It is to be observed that the coarser parts of Cooke's flows, which he states attain a grain size of half a millimetre, would closely resemble fine-grained phases of Hawley's diorite. Rock that should be termed diorite is definitely present, but whether or not it is mostly intrusive or largely lava, in part carbonated and slightly amphibolitized, is, in the writer's opinion, impossible of determination. The divergence of the views of two geologists of the standing of Cooke and Hawley would seem to support this conclusion. It would seem that the metamorphism of lava, already in part of dioritic appearance, could explain the occurrence, in the same manner as suggested for the diorite on the east side of the river.

A similar problem exists regarding extensive outcrops of rock of dioritic to diabasic appearance half a mile west of the west end of Kiekkiek Lake. The rock is massive to schistose and some exposures would normally be mapped as andesite. On the other hand, in one place towards the west end of the exposures the diorite seems to have intruded and metamorphosed a band of slate, and no distinctive flow textures were observed in the locality. Actinolite is developed at the edge of the sediment and within it there are prominent porphyroblasts of biotite and chloritoid. The dioritic rock is, therefore, probably intrusive.

GRANODIORITE

Two major intrusive bodies cut the volcanic rocks of the Blake River group, one in north-central Bousquet, the other in northwest Joannès township. Both bodies, but particularly the mass in Joannès, show considerable variation in composition. As no single rock name can be applied, the term granodiorite is used in a broad sense to indicate that the bodies are intermediate between granite and diorite. They resemble other bodies in northwest Quebec that are usually referred to as granodiorite.

The Bousquet body is more than a mile long and 3,000 feet wide. It crosses the north-south centre line of the township at Mooshla mine and is bordered on the south by a smaller body of albite alaskite. Most of the mass is a holocrystalline, grey rock with a green tinge. The average grain

size is between 2 and 5 mm. Hand specimens show 20 to 50 per cent of green, chloritized, ferromagnesian minerals, distributed evenly or in patches in grey to white feldspar. In most places quartz is discernible as random opalescent " eyes " up to 5 mm. in diameter. Pyrite occurs as tiny grains throughout. Local feldspathic segregations assume a white or pink colour and small dykes of albitite and feldspar porphyry cut the main mass. Under the microscope the feldspar is seen to be full of tiny granules of epidote, clinozoisite, chlorite, and carbonate, except the narrow rims of almost pure albite bordering the larger crystals. The altered feldspar is also albite; no potash feldspar was found in the four sections examined. Quartz forms 5 to 10 per cent of the rock. Green hornblende largely or completely altered to chlorite is the chief ferromagnesian mineral. Brown to green biotite, apatite, magnetite, sericite, and large grains of titanite are the other accessories. Technically the rock is in large part albite tonalite, and closely resembles albitic phases of the Bourlamaque batholith. The feldspar may have been much more calcic originally than it is now.[1] The intrusive is older than the albite alaskite that borders it on the south, and is cut by narrow shear zones, in some of which there are veins of quartz and pyrite. Some of these are auriferous. Its shape and the general conformity of the north contact with the strike of the Blake River strata suggest that it is a large, sill-like intrusive, and that it may dip steeply south with the older rocks.

A dense " contact rock " is developed in places along the north edge of the body. It is exceedingly hard and tough, and greenish grey to brownish white in colour. Minute quartz phenocrysts rounded by resorption are irregularly distributed in a dense groundmass that averages 0·1 mm. in grain size and consists of about equal proportions of quartz and feldspar almost completely altered to sericite and undetermined dusty specks. There are small areas of micropegmatite. The manner in which the rock grades into andesite and into granodiorite suggests that it is a hybrid rock, produced by heat and the action of magmatic exhalations along the contact zone of the intrusive mass. It might, therefore, be expected to be of very irregular development along the contact, after the manner of the notoriously erratic deposits of contact metamorphic silicates.

The intrusive mass in northwest Joannès is much more variable in appearance and composition than the body in Bousquet. It is one of those intrusives often called " soakers " in Quebec that alter the adjoining rocks profoundly and exhibit a remarkable diversity of rock types, presumably partly by differentiation and partly by assimilation of older rocks. It is the southeast end of a long but relatively narrow body or series of bodies extending 8 miles to the northwest. In the part studied, the rock varies in composition from quartz diorite and granodiorite to albite granite and feldspar porphyry, and in colour from grey and pink to dark green. The most typical phase, however, cannot be distinguished in appearance from the Bousquet granodiorite. Tiny "eyes" of quartz are visible in many of the more femic phases. Some small exposures of quartz porphyry may be offshoots of the main mass or later dykes. Some exposures of greenstone within the main body are interpreted as inclusions of lava in various stages of alteration.

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[1] Gussow, W. C.: Trans., Roy. Soc., Canada, sec. IV, 1937, pp. 134-144.

A thin section of the most typical phase is 15 per cent quartz, partly in graphic intergrowth with feldspar, and about 50 per cent albite-oligoclase to pure albite. Accessories and alteration products include epidote, chlorite, leucoxene, pyrite, apatite, magnetite, and a few grains of carbonate. Large exposures of a finely crystalline green rock in the southern part of lot 25, range X, were thought in the field to be altered andesite; under the microscope it is seen to be a hybrid rock containing about 50 per cent of micropegmatitic intergrowth of quartz and albite (An_{2-3}). Despite abundant inclusions of chlorite and epidote the feldspar is remarkably clear and fresh looking. Chlorite and epidote have also formed along narrow seams that traverse the rock. Pyrite is present and, in places, some disseminated chalcopyrite.

ALBITE ALASKITE

A body of albite alaskite lies immediately south of the Mooshla granodiorite in north-central Bousquet township. It is an odd rock and in the past has been termed aplite and silicified greywacke. The mass is at least 6,000 feet long from east to west and 1,500 feet wide, and about equal parts of it lie east and west of the centre line of the township. It wedges out on the east in a long, narrow nose. In that part the rock is less schistose than elsewhere and varies from aplite to white feldspar porphyry. The main body is a siliceous, dark grey, slightly schistose rock that weathers pale grey to white. The exposures have a coarse, sugary texture and feel gritty when scratched with the hammer. Thin sections show 20 to 30 per cent quartz and 50 to 65 per cent albite, Ab_{95}. The grain size is between 1 and 2 mm. Most of the quartz grains have sutured borders, but a small percentage is in micropegmatite. The very minor proportion of accessory minerals includes carbonate, sericite, and a little epidote, chlorite, rutile, and apatite. The rock might be called a leucocratic albite granite, but the very small proportion of femic minerals justifies the term albite alaskite. It is cut by auriferous veins, including that of Mooshla mine, and near them has been altered by hydrothermal solutions. In at least one place tiny needles of tourmaline thus introduced impart a dioritic appearance.

Except for the narrow east nose where the alaskite clearly intrudes the volcanic rocks of the Blake River group, the only contact exposed is at the township centre line along the north edge of the alaskite body. At that place the alaskite intrudes the granodiorite to the north. It carries altered fragments of it and sends out small dykes and very irregular tongues into it for distances of about 50 feet from the contact. The south contact has not been identified, but presumably lies beneath drift not far south of the southern exposures. A drill hole not far west of the township centre line encountered, in its southern part, narrow widths of dense, silicified rock that resembles altered tuff in the alaskite, so that the contact may be nearby.

ALBITE-QUARTZ SYENITE AND RELATED PORPHYRIES

In different parts of the area there are dykes and small bodies of acidic rock generally regarded as part of the normal granitic intrusives of the region. They are all grey to brown, massive and fresh in appearance, and, except for the smaller dykes, which are generally porphyritic, are holocrystalline rocks with or without phenocrysts of feldspar.

Exposures on the south shore of Chassignolle Lake west of the mouth of Bousquet River are probably part of one of the largest of these bodies. The rock is grey with a pink tinge and speckled with green, femic minerals that are now completely altered to chlorite and epidote and form 10 to 15 per cent of the rock. Quartz constitutes less than 5 per cent. There are about equal proportions of potash and plagioclase feldspar, in part intergrown as microperthite. The potash feldspar is microcline, the plagioclase chiefly albite, but clear rims around some of the more altered grains are oligoclase. Apatite and titanite are accessory and the feldspar is sericitized. Some of the chlorite is secondary after hornblende. The rock might best be called a quartz-albite syenite.

Dykes to the east and west of this, in the Blake River and Kewagama groups, are of similar composition but of porphyritic texture, with small phenocrysts of feldspar. They are really porphyritic albite-quartz syenite, but are usually referred to in the area as feldspar porphyry. Very similar in appearance are dykes and irregular bodies in greenstone, poorly exposed on the railway at Kiekkiek Lake in Joannès and Bousquet townships. They are fine-grained to porphyritic, holocrystalline rocks of grey to pink colour. Microscopic study shows phenocrysts of albite up to 3 mm. in length in a more finely crystalline matrix of quartz and albite. Quartz forms less than 10 per cent of the rock. There are minor proportions of biotite, chlorite, titanite, magnetite, and epidote. Of interest are a few small grains of garnet, as being uncommon in the rocks of the area though quite abundant in granite of the LaCorne batholith a few miles to the northeast. The rock is a quartz rich, porphyritic albite syenite, approaching albite granite in composition.

GRANITE

There are several exposures of granite in western Bousquet township, one on the highway and three others to the east for 4,500 feet. The rock is unique for the map-area. It is pale grey in colour, holocrystalline, and contains a high percentage of quartz. In the eastern exposures it is strikingly porphyritic, with phenocrysts of dark, smoky quartz up to 5 mm. across set in the white weathering, crystalline matrix. The exposure on the highway is more even grained. It is not known whether all the outcrops are parts of one large body or if there are two or more separate bodies. Trenching and diamond drilling on Calder-Bousquet claims have shown that there is a mass at least 1,500 feet long and 400 feet wide on that property. The rock is in places sheared and cut by narrow veins of dark quartz not unlike that of the phenocrysts. It is also sericitized and chloritized along numerous narrow seams, and slightly mineralized with pyrite and pyrrhotite. Under the microscope the feldspar is seen to be almost completely altered to sericite and carbonate and to consist of plagioclase and orthoclase, in about equal proportions. The plagioclase is probably albite, but could not be accurately determined on account of the extreme alteration. Quartz forms over 25 per cent of the rock and apatite and epidote are present in minor amount. No contacts are exposed in the three western outcrops. At the eastern one the granite intrudes greywacke on the south. Diamond drilling there has shown that the granite body intrudes, and apparently occupies the full width of, the Cadillac belt of greenstone and schist. Whether or not the belt continues west of the intrusive under drift has not yet been ascertained.

QUARTZ ALBITITE AND ALLIED PORPHYRY

Drilling at the Brown Bousquet property has shown that a number of dykes and lenticular bodies of quartz albitite, albite porphyry, and quartz-albite porphyry intrude the schists of the Cadillac "break". They are the western continuation of similar intrusives in Cadillac township.[1] Another dyke of quartz albitite was cut in a drill hole at Bouscadillac mine, in the shear zone. The quartz albitite is a grey to white, porcellaneous rock, consisting of albite and a small percentage of quartz with apatite as the main accessory. Shearing produces a cream to yellowish sericite schist. The porphyries are similar in composition to the quartz albitite, but phenocrysts of quartz or albite or both, up to 2 mm. across, are embedded in the dense matrix.

Quartz albitite is exposed at the north end of a trench in lot 58, rge. VI, Joannès tp., and has been cut in two drill holes at depth. It is in part a fine-grained, crystalline rock and intrudes mica schist and greenstone. There are tiny veins of blue-grey to white quartz in it and a few minute seams of pyrite and chalcopyrite. Albite (An_5) forms 80 to 90 per cent of the rock and quartz about 10 per cent. Carbonate, pyrite, and titanite are present in minor amount.

The highly altered greywacke south of the railroad on lots 10 to 12, rge. VI, Joannès tp., is cut by several small dykes termed porphyrite by Hawley (1933, page 23). "They range from one to five feet in width and follow, or nearly parallel, the strike of the sedimentaries. In places, they have been so strongly sheared that the rock resembles coarse arkose. On a fresh surface, these rocks are dark in colour, but they weather light. Microscopic examination shows that the phenocrysts are all of feldspar (oligoclase), and they are distributed through a matrix consisting of quartz, plagioclase, and biotite, with a little apatite.

"No relation has been established between these rocks and the other intrusives of the area. Since they resemble certain basic phases of the syenite porphyry intrusives, they are grouped tentatively with them".

LAMPROPHYRE DYKES: AMPHIBOLITE

There are a number of dark-coloured, basic dykes in the area, most of them no more than 2 or 3 feet wide and ranging in composition from chloritic andesite to minette. Some of them may be dykes formed during the Malartic and Blake River periods of vulcanism. Others are larger, and probably later. A striking example is the 100-foot lamprophyre dyke at the east end of the 500-foot level in Arrowhead mine. It is a crystalline, almost black rock, with serpentine developed along numerous joints. The maximum grain size is about one-quarter inch. Half the rock is augite, partly converted to uralite and chlorite. Possibly 30 per cent was feldspar originally, but is now largely sericite partly replaced by chlorite and hornblende. A few small flakes of brown biotite and about 3 per cent of magnetite, as octahedra and skeleton crystals, complete the suite except for some tiny crystals of garnet and apatite. The feldspar that remains is albite (An_4). The dyke is shown on company plans to strike nearly due north and dip very steeply, and auriferous quartz veins are mapped as

[1] Geol. Surv., Canada, Mem. 206, p. 21.

stopping at its edge, though some small veins cut the dyke. As the mine was flooded the writer was unable to examine the occurrence, but studied specimens from the dump.

Very similar in appearance though much finer grained is a 35-foot dyke in greywacke 200 feet north of the highway in lot 51, rge. VI, Joannès tp. It strikes east of north. However, on examination it proved to be an amphibolite, consisting almost entirely of hornblende with only a few interstitial grains of feldspar. Titanite and magnetite are abundant accessories and there is a little biotite. More biotite occurs in two exposures of coarse amphibolite that presumably are parts of a northerly trending dyke, on the railway just west of the end of Kiekkiek Lake. A narrow dyke on the line between ranges VII and VIII also contains more biotite than the dyke north of the highway, and some small grains of garnet like the Arrowhead intrusive. The hornblende in each case is a pale green variety of actinolite.

It may be significant that at least two and possibly three of these basic dykes strike nearly due north. The only other intrusive rocks in the area that persistently follow this course are the quartz gabbro dykes of Keweenawan? age in Joannès township. All the acidic intrusives are predominantly conformable with the structure of the enclosing strata. Possibly the basic dykes and the quartz gabbro are of approximately the same age.

QUARTZ GABBRO

Dykes of quartz gabbro from 40 to 300 feet wide are one of the most striking geological features of the area. Two large dykes trend northeast across Bousquet township and each has associated with it a number of smaller, subsidiary dykes. The two dykes vary in width from 200 to 350 feet. The eastern strikes more northerly than the western and the latter crosses into Joannès township. In Joannès township there are at least eight other smaller dykes with a strikingly consistent trend a few degrees east of north. The aggregate width of the eight dykes is about 600 feet.

All the dykes encountered are quartz gabbro, and they may be all of the same age. No dyke intersections were found. Augite, fresh or partly converted to pale green hornblende and chlorite, is the principal constituent. Nearly as abundant is calcic plagioclase, varying in different sections examined from calcic andesine to bytownite. It may be fresh and clear, or considerably altered to sericite and epidote, the degree of alteration varying within a single dyke. Commonly it is cut by seams of pale green chlorite. So far as observed quartz never exceeds 5 per cent, but is present in every section examined, partly interstitial to the augite and feldspar, partly in micropegmatitic intergrowth with feldspar. Magnetite is always present in small amount. Most sections contain a little brown to green biotite, some of it in parallel intergrowth with the secondary hornblende.

Several exposures of the north-trending dykes exhibit striking porphyritic phases. The exposures are parts of the eastern dyke on the Arrowhead claims, and of the dykes that cross the highway on lots 16 and 42. Other dykes may also be porphyritic, for it was found that the large phenocrysts are of irregular distribution, and that they may be

absent from fairly large exposures of a porphyritic dyke. The phenocrysts have a waxy, pale green or yellowish green appearance and commonly are between 1 and 2 inches in diameter. A few have sharp crystal outlines, but by far the most are of round or irregular shape. Under the microscope they are seen to be calcic andesine or labradorite partly or almost completely sericitized. The edges are embayed and corroded. The remainder of the rock is typical quartz gabbro that the writer cannot distinguish from that of the non-porphyritic dykes. Cooke has described similar porphyritic gabbro from other parts of the Rouyn-Harricanaw area, and has assumed that they are probably pre-Cobalt because similar dykes at Matachewan, Ontario, are definitely pre-Cobalt. A very fine description of apparently identical porphyries is given by Alfred E. Barlow in the Ottawa Naturalist for May 1895. For over 70 years before that time these odd porphyritic masses in diabase had been a subject of some interest. They had been termed "Huronite" originally, and as late as 1889 Huronite was included in Dana's System of Mineralogy as a supposed altered form of cordierite. Barlow describes in some detail specimens from eleven localities from Hamilton River, Labrador, to Gunflint Lake, Minnesota. In one specimen from Bear Island, Timagami Lake, the phenocrysts are in "a very typical and fresh olivine diabase."

The quartz gabbro dykes are presumably the youngest rocks in the area. They cut all the Archæan strata and the masses of granodiorite and alaskite in Bousquet township. In all probability, as in Cadillac township, they are later than the main period of gold mineralization.

CHAPTER III

STRUCTURE

GENERAL STATEMENT

The sedimentary and volcanic rocks of the area have been isoclinally folded so that they now strike approximately east and dip very steeply. Over most of the area the dips are persistently within 10 or 15 degrees of vertical and either to the north or south. In the extreme west and in one area north of Kiekkiek Lake the dips are lower and consistently to the north. Faults and shear zones approximately parallel to the bedding planes of the strata were presumably initiated during the period of folding. The tremendous compression to which the rocks were subjected produced a regional schistosity parallel or nearly parallel to the bedding. Readjustments to the final stresses of the folding probably took place largely along the previously initiated faults and shear zones. A number of small, steeply plunging drag-folds that are Z-shaped or very irregular in plan indicate stresses more nearly horizontal than vertical, with a tendency for strata on the north to move east relative to those on the south. It is not known whether these stresses were applied during the late stages of folding or in a later period. The acidic Archæan intrusives invaded the folded strata and their form and location were determined in part by the pre-existing structure. Minor acidic bodies were injected along the Cadillac "break," the major shear zone of the area. Later stresses produced faults transverse to the strike of the bedded strata, but the chief mineral deposits of the area were formed prior to this for they, along with the acidic intrusives and all the older rocks, are displaced by the faults. In all probability the quartz gabbro dykes were intruded after most of these transverse faults had formed, according to evidence obtained in the adjoining Cadillac area.[1] Nevertheless, the largest transverse fault in the area, indeed the only one with a displacement of more than a few feet, is later than and displaces dykes of quartz gabbro. This is the Davidson Creek fault, at the extreme west side of the area. Probably readjustments took place along the old shear zones and faults up to this time, for a gabbro dyke west of Kinojevis River is displaced across the easterly trending Thompson Creek fault. With the exception of the gabbro dykes, this later faulting, a few lamprophyric dykes of uncertain age, and deposits of glacial origin, the post-Archæan record within the area is one of erosion that exposed the deep-seated plutonic rocks and the metalliferous deposits.

[1] Geol. Surv., Canada, Mem. 206, p. 23.

REGIONAL FOLDING

As no evidence of angular discordance has been found within the four groups of Archæan strata, it must be assumed that there has been only one period of regional folding, after these strata were deposited and before the granitic rocks were injected or during their injection. Previous reports, although admitting that the Archæan strata were intricately folded, advanced no proof of the major synclinal structure that is now believed to exist. In 1937 the strata were considered progressively younger on the south and all the sediments were believed younger than the volcanic rocks that form the northern side of the present map-area. The Cadillac belt was believed to be a volcanic layer intercalated in the sediments north and south of it; as these sediments were assigned to the Timiskaming the volcanic layer was likewise assigned to that series.

Very few structural determinations were obtained in the southern part of the adjoining Cadillac area by the writer in 1934 and 1935. In Memoir 206, the conclusion regarding a regional syncline was stated as follows: "The data are too meagre to be accepted as proof but they must be considered as the only available clues to the regional structure. The clues suggest that the Cadillac sediments form the centre of an isoclinal syncline whose axis, striking approximately east-west, would cross the area somewhere in a zone 1,000 to 2,000 feet north of the Cadillac belt of greenstone. The implication is, of course, that the Cadillac belt is the same horizon as the Blake River volcanics, brought up on the south limb of the synclinal structure." In the two succeeding years the writer and J. W. Ambrose obtained many data substantiating the assumed structure, and these findings are presented in Memoir 222 on the Malartic area, which adjoins Cadillac area on the east. Furthermore, in 1939 A. P. Beavan, geologist for O'Brien Gold Mines in Cadillac township, found well-preserved cross-bedding in coarse-grained Kewagama greywacke a few feet south of the conformable contact with the Cadillac belt on the fourth level of the mine. The tops of the beds face north. Also, in a drill hole from the 14th level he identified "a perfect example of grain-sizing in greywacke. The sediment lies between the main porphyry band (of the Cadillac belt) and the Cadillac break, about forty feet south of the shear zone. In a distance of two inches across the strike there are four complete and well-defined gradations from relatively coarse, gritty-looking greywacke to much finer sediment. The tops of the beds face north."[1]

The available evidence immediately east of the present area, therefore, indicates that the Cadillac group occupies the trough of a major syncline and that the rocks to the north and south are older. It will now be shown that the observations in Joannès-Bousquet area, though not as complete as could be wished, support this conception.

The conclusions regarding structure are based almost entirely on determinations of the tops and bottoms of beds or lava flows. Secondary structures such as fracture cleavage and drag-folds are not considered reliable because the structural history is complex and not thoroughly understood. It is certain that drag-folds have formed after the strata were folded and cleavage has developed at the same time, so that these

[1] Personal communication.

features cannot be used in interpreting the major folds unless those dependent on the regional folding can be distinguished with certainty. Considering the amount of contortion and dislocation by faults and shears, one must surely admit that this is a well-nigh impossible task. Reliance has been placed, therefore, only on primary structures such as pillow lavas, grain size, and crossbedding. If, as happens in a few places, such determinations are corroborated by drag-folds and fracture or flow cleavage, so much the better. Most of the drag-folds in the area plunge very steeply, as do most of the intersections of fracture cleavage planes and bedding planes. If they were used in diagnosing the regional folding they would indicate that the syncline plunges equally steeply, a manifest impossibility when the strata on the limbs are essentially parallel for many miles.

The structural observations from which the synclinal structure is deduced are indicated on the accompanying maps. None was made in the Malartic group, so the conclusion that it faces south rests on observations made to the east and west. Fortunately, the group has been traced for many miles to the east and its relation to the overlying Kewagama sediments is established beyond doubt by many determinations, particularly in Malartic township. The northern limb of the Kewagama group in Bousquet township is in much the same position, but several excellent grain size observations were obtained east of Chassignolle Lake, indicating that the beds face south. Eleven determinations, all showing tops south, were made on pillowed andesite of the Blake River group across the northern side of the area. In the northern part of the Cadillac group nine determinations were obtained east of the Davidson Creek fault, all indicating tops south or east. The strata within about a mile to the east of the fault are so contorted that not a great deal of reliance should be placed on the determinations, as there may be minor folds that would confuse the issue.

The conclusion that the strata north of the middle of the Cadillac group have their tops facing south accordingly rests on twenty-one structural determinations within the area. Perhaps equally important is the fact that no north-facing tops were found. In conjunction with the evidence accumulated to the east, it seems to be reasonably well established that this north limb faces south.

On the south limb exactly the same number of observations that are considered reliable show tops facing north, but the distribution by rock groups is different. Only two are in the southern part of the Cadillac group and two in the south area of the Blake River group. The latter were made on pillowed andesite, all the rest being on gradations of grain size in thin beds of greywacke. In several places along the highway in the east half of Joannès township, the form of minor drag-folds and the relation of fracture cleavage to bedding planes support determinations made by grain size. Furthermore, in the same locality one good observation and several poor ones suggest that tops of beds face south. These are interpreted to mean that there are subsidiary folds of some size within the south limb, a conclusion supported by the recognized drag-folds and by several very flat dips in the vicinity. As a matter of fact, it seems remarkable that more reversals of this kind were not encountered.

The conclusion that the south limb of the structure faces north is thus reasonably well supported by structural observations. The final problem is the location of the synclinal axis. Two opposing determinations near the Cadillac township line are nearly equidistant from the north and south contacts, respectively, of the Cadillac group. They are separated by about 2,700 feet of strata. The synclinal axis presumably lies somewhere in this width, that is to say near the middle of the exposed width of the group. On the road to Mooshla mine in western Bousquet township tops of beds face north at a point 2,000 feet north of the Cadillac "break". There is no evidence to show how far north of this the axis may lie. Near the Davidson Creek fault south-facing tops were determined at intervals to within half a mile of the south edge of the Cadillac group. The beds in this part of the area are intricately folded, and outcrops are not sufficiently abundant to reveal full details of the structure. It may even be, as suggested on page 19, that a younger group of rocks is infolded in the Cadillac group at this place; or possibly a southern part of the Cadillac group has been eliminated by faulting along the assumed Cadillac break. It seems, therefore, that the axis of the regional syncline lies somewhere near the middle of the Cadillac group from Cadillac township to the western part of Bousquet township. West of that there is insufficient evidence to show its location.

The writer does not hold that the regional structure is a simple major syncline. Some evidence of minor flexures has already been mentioned. The structural determinations are too few to reveal detailed structure, though lack of observed reversals of tops suggests that subsidiary folds may not be common. Attention must be called to the structural possibilities in one part of the area, however. In the eastern half of range X, Joannès township, the terrain is heavily wooded and outcrops are unsuited to structural study, so that no determinations were made there, and only one was obtained in the adjoining northwest corner of Bousquet township. There a nose of acidic and fragmental volcanic rocks of the Blake River group projects eastward into the northern part of the Cadillac group. The area was studied in greater detail than usual, but as the extreme nose is in timbered ground, where outcrops are scattered and generaly moss-covered, no definite explanation of the structure was obtained. All the rocks are moderately to highly altered and there is almost every conceivable gradation from volcanic to sedimentary material. No determinations of tops of beds were made. The intermingling of volcanic and sedimentary beds suggests interfingering along the strike of volcanic and sedimentary rocks due to rapidly changing conditions of deposition. Although some minor drag-folds were observed, no evidence was obtained to indicate that the arrangement is caused by plunging folds, or by unconformity. Nevertheless, it is not impossible that a synclinal axis may extend north of west from the northwest corner of the Cadillac group to cross the Joannès boundary in the southern part of range X and continue west past the northwest corner of the Arrowhead property. Such a structure could explain the western projection of acidic, volcanic rocks across the northern part of Arrowhead ground and the nose of rhyolite and ejectamenta in Bousquet township. The former would occupy the trough of a syncline and the latter the crest of an easterly plunging anticline.

FOLDING WEST OF THE DAVIDSON CREEK FAULT

The map (No. 615A) shows the lamentably few structural observations obtained west of the Davidson Creek fault. The reasons for the correlations across the fault that have been made are given below. Assuming that the correlations are correct, the folding of the different bands of sedimentary and volcanic rocks may be discussed. The narrow strip of greywacke and slate in ranges VII and VIII may be referred to as the northern band of the Cadillac group; the southern band of sediments along and north of Kinojevis River as the Kinojevis sediments.

Half a dozen structural determinations were obtained in the northern band of the Cadillac group. One beside the Rouyn township line shows that the beds in the southern part of the band have their tops facing north. The others, except one just west of Davidson Creek, are either in areas of contortion or too close to the middle of the band to clarify the main structure. The two observations suggest that the layer is a narrow syncline, and the fact that it apparently narrows to the west and, so far as known, does not continue far into Rouyn township, indicates a gentle easterly plunge. The conclusion is supported by the fact that the rocks of the Blake River group to the north and south of the band are practically identical in containing much acidic breccia and lava that is not common elsewhere in the area. Unfortunately, no structural observations to support or deny the synclinal hypothesis were obtained in the volcanic rocks. Though the data are thus far from adequate, until more information is obtained it must be tentatively concluded that the sediments occupy a narrow synclinal trough on top of the adjoining volcanic rocks.

One rather doubtful determination indicates that the volcanic rocks in ranges VII and VIII face southward and, therefore, underlie the Kinojevis sediments. Three good determinations in and just north of Kinojevis River show that the southern beds of Kinojevis sediments have their tops facing north. Other supporting observations were found in lava south of the sediments on the south bank of the river in Rouyn township. Further determinations indicating that the band of sediments is synclinal have been obtained recently by J. W. Ambrose in Rouyn township[1]. The sediments thin toward Rouyn lake, so presumably the syncline has a gentle easterly plunge. Hawley[2] assumed that the structure is synclinal and that the sediments overlie the volcanic rocks to the south with apparent conformity. There are no exposures of the south contact in Joannès township, but the attitudes of the sediments and lavas are reasonably parallel. The north contact of the sediments is exposed in one place just west of Davidson Creek and is conformable with acidic volcanic rocks, so far as can be told from the limited exposure. A narrow exposure of greywacke in lot 10, range VII, may or may not represent the north edge of the sedimentary band; the contact between sedimentary and volcanic rock is sheared, but otherwise appears conformable.

Although the available evidence indicates that the Kinojevis sediments lie in a syncline, it is worthy of note that the volcanic rocks south of the supposed syncline are not like those to the north. The latter are lavas and

[1] Personal communication.
[2] 1933, p. 17.

agglomerate of trachytic and rhyolitic composition, whereas those to the south are andesite and dacite flows and fragmentals. Possibly exact similarity on the two limbs should not be expected in a structure as wide as this and as deep as it may be assumed to be. On the other hand, it is also possible that there is faulting along the south contact. In most places the contact presumably underlies the river, and strata in the one exposure in the river are greatly crushed. Intercalations of arkose and slate are converted to an autoclastic breccia in which the darker sediment has flowed like putty around fragments of arkose, thus producing a rock like a dark grey conglomerate containing pebbles of greywacke.

No reliable determinations of tops of beds were made in the rocks south and west of Kinojevis River. It is possible to make interpretations from fracture cleavage and drag-folds, but the rocks are so subject to development of such secondary structures by movements connected with the Thompson Creek and Davidson Creek faults that it is extremely risky to rely on them for a solution of the major folding. A single determination by grain size at the west end of the highway bridge over Kinojevis River shows the tops of greywacke beds to be toward the south.

MINOR FOLDS AND LINEAL ELEMENTS

In many places the sedimentary rocks are intricately contorted. Presumably the less competent parts of the volcanic assemblages are similarly deformed, but since bedding planes are not so easily recognized the deformation is apt to pass unrecorded. Much of the contortion is in areas near the major faults and is presumably related to them. Thus the strata on either side of the Davidson Creek fault and in several places along the Cadillac "break" are broken, bent, or reduced to schist. Other localities of extreme variation in strike and dip can hardly be explained in this manner. Of such a nature is the large area of scattered exposures in range VIII, west of the centre line of Joannès township. Limited observations indicate that the structure of the carbonated sediments north of the west end of Kiekkiek Lake is similarly complex. There are certainly interesting structural problems, in these and other smaller areas, that have not been solved by the present study.

In a number of places across the area steeply plunging drag-folds Z-shaped in plan with amplitudes of a foot or two were observed. They are presumably of the same type that is more abundantly developed in Cadillac township.[1] Certainly they cannot be related in origin to the regional folding as they plunge almost vertically, but have formed since the strata were tilted on edge by the movement of beds past one another in an essentially horizontal direction. They indicate a tendency for beds on the north to move east relative to those on the south. Folds S-shaped in plan would indicate an opposite tendency. A few of these were observed in the Cadillac group.

Minor folds and lineal elements presumably dependent on the regional folding were found mainly along the highway in Joannès township. They are gently plunging drag-folds, chiefly in conglomerate and greywacke of

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[1] *See* Memoir 206, p. 27, and Memoir 222.

the northern part of the Kewagama group from the centre line of Joannès to Bousquet township. Those at the west end of the large exposure of greywacke north of the west end of Kiekkiek Lake plunge to the west at 45 degrees. They are of such irregular cross-section that no inferences as to relative direction of movement of beds could be drawn. Of greater interest are drag-folds in rock cuts on the railway and highway for 3½ miles east of the township centre line. Those on the east, south of the highway, plunge at 15 degrees or less to the east. In several localities, for over 2 miles to the west, the drag-folds have their axes within a few degrees of horizontal. Several on the railway about half a mile east of the centre line plunge 25 degrees to the west. All those from which deductions could be drawn are of the form that points to a syncline on the north, in agreement with determinations from primary structures in the same area. Assuming, therefore, that the drag-folds are a result of the major folding, the axis of the major syncline is about parallel to the axes of the drag-folds. In other words, in the area under consideration it plunges gently east and west from a part about 2 miles long that is essentially horizontal.

Another method of attempting to solve the regional structure is by the observation of the attitude of lineal elements such as elongated pebbles, amygdules, and clusters of femic minerals. In this, however, one enters controversial ground because as yet there seems to be no good agreement among geologists as to the manner in which the elements become elongated. One school claims that it is because of rolling, much as a piece of putty assumes a cigar shape when rolled between the hands. Another holds that the elongation is a stretching parallel to the direction of slippage of one bed past another. In the latter event the long axis of any element would lie approximately at right angles to the axis of the related fold, in the former approximately parallel to it. The assumption is, of course, that the movements that caused elongation are due to slippage of upper beds over lower ones as the major fold is developing. If the stretching hypothesis be adopted then elongated pebbles and streaks of biotite in greywacke indicate that the regional syncline has an easterly plunge of 30 to 45 degrees for a mile or more east of Kinojevis River. The lineal elements in the few outcrops for that distance along the highway plunge at 45 to 60 degrees to the west. In most other parts of the area, and even in the locality in eastern Joannès where drag-folds were studied, too few data on the lineal elements were obtained to be of significant value. Vertical elongated amygdules were noted in northwestern Joannès township and it seems probable that many of the pebbles in conglomerate in Bousquet township have their longest axis almost vertical, or straight down the dip of the beds. However, in a great many the horizontal axis in the bedding plane is nearly if not quite as long. In other words the pebbles are oblate ellipsoids or practically discs with the short axis about at right angles to the bedding plane. Many more three dimensional exposures than the writer obtained for study would be necessary before any safe generalization could be drawn.

FAULTS AND SHEAR ZONES

The Archaean strata of the area are broken by faults and shear zones. The latter in particular have been eroded to depressions that are now deeply buried by drift; therefore, very few of them are visible at the surface and their existence has to be inferred or determined from underground developments and drill holes. As in Cadillac township[1] the known faults may be classified in two major groups, each capable of further subdivision. (1) Strike faults approximately parallel to the strike of the strata. (2) Oblique faults that cross the strike of the strata. It so happens that the strike faults also dip approximately parallel to the bedding planes of the strata, so they are essentially bedding faults. The strike faults and their associated wide zones of schist are of particular economic importance because they are older than the auriferous deposits of the area and many of the deposits are found along or close to them. The oblique faults are younger than the auriferous deposits and displace them.

STRIKE FAULTS AND ASSOCIATED SHEAR ZONES

Three principal strike faults and several minor ones are known in the area. The two most important are the Cadillac "break" and the Thompson Creek fault. A third, about which much less is known, partly underlies Kiekkiek Lake and may be called the Kiekkiek Lake fault.

The Cadillac "Break" has been traced 7 miles east of Bousquet township and is believed to continue for another 15 miles through Malartic and Fournière townships (*See* Figure 1). All the producing mines in Cadillac and Fournière townships lie in or close to it. Across Cadillac township, where the information is most complete, it consists of soft, contorted schist of which the principal constituents are mica, chlorite, carbonate, and talc, in widely different proportions. Within it are many gouge-filled seams. In the western third of Cadillac township there is a single well-defined shear zone from 50 to 200 feet wide, striking nearly due east and dipping vertically or very steeply south, that is parallel or nearly so to the bedding. Drag-folds in the schist at O'Brien mine suggest that the north wall of the fault moved up relative to the south, and other minor structures indicate that the north wall has been displaced eastward relative to the south, probably after the original movement. The amount of displacement is not known.

In Bousquet township the break has been intersected in drill holes at seven localities for 8 miles west of the Cadillac boundary. The intersections leave little room for doubt that the fault continues for that distance in an almost straight line. The nature of the fault zone varies greatly in different places. Diamond drilling at the Bouscadillac and Brown Bousquet properties shows a highly schistose zone from 500 to 800 feet wide with several gouge-filled fault planes, and horses of fairly massive rock. This width seemingly decreases greatly between 2 and 4 miles west of Cadillac township, for at the latter distance a drill hole on Sudbury Contact claims shows two zones of soft, talc-chlorite schist, 25 and 40

[1] Geol. Surv., Canada, Mem. 206, p. 26.

feet wide, respectively, separated by 50 feet of greywacke and biotite schist. A quarter mile to the west on Doreva ground a hole penetrated 65 feet of soft, sericite-carbonate schist, but did not continue to the north wall. One hundred feet to the south a sub-parallel shear zone 15 feet wide or less is mineralized with quartz and sulphides. Two miles farther west, on ground held by Norgold Mines, a drill hole intersected 75 feet of soft, talcose, chlorite schist with layers of mica schist and micaceous greywacke for a few feet on either side. A second drill hole cut the south edge of the shear and defined its strike. Beyond another drift-covered gap of 6,000 feet the "break" has been found on Calder-Bousquet ground by drilling at two localities. At the east a 150-foot zone of soft schist and serpentine is bordered on the north by greenstone and on the south by contorted greywacke and conglomerate. Half a mile to the west the zone of schist and serpentine is about 100 feet wide and is similarly bordered. At this place the drilling and some exposures indicate that the shear zone terminates on the west against a body of granite, undoubtedly intruded after the shear zone had formed. In the 8 miles across Bousquet township there are no exposures of the actual shear zone. Presumably, the dip is very steeply north about parallel to that of the enclosing strata. No information is available as to the amount or direction of displacement. It is notable, however, that in the eastern half of Bousquet township the fault lies north of the Cadillac belt of greenstone and to the west it is to the south of the only greenstone known. It may have eliminated part of the belt by displacement.

One of the major structural problems of the area is whether or not the Cadillac "break" continues west beyond the place where it has last been identified. On the accompanying maps the assumption has been made that it does continue across Joannès township in an almost straight line beneath overburden. There is practically no direct evidence for this assumption. The fault may stop altogether, as even the best of faults must do, or it may follow some other course, perhaps dying out but continuing *en échelon* in another place.

In considering the possible westward continuation of the Cadillac "break" several points must be kept in mind. For over 30 miles to the east it or identical strong shear zones have been found at or very close to a single horizon, the Cadillac belt. The fault zone is no narrower nor the shearing less intense on Calder-Bousquet ground than at many places to the east. There is, then, no direct evidence that the fault is dying out on the west. Secondly, if it does continue to the west, the most reasonable assumption, in view of the essentially bedded course to the east, would seem to be that it will continue along the strike of the strata. There is good evidence that the strata continue almost due west across Joannès township. The writer has, therefore, assumed that the fault, if it continues at all, maintains its essentially bedded character, and has attempted to indicate its most likely location on the accompanying maps (Nos. 613A, 614A, and 615A). For about 7 miles across eastern Joannès there is no way of telling where the fault might lie, as a broad strip of ground is drift covered and devoid of exposures. One not too valid assumption has been made, that the numerous beds of conglomerate exposed in range VI all belong to the Kewagama group and are, therefore, south of any possible continuation of the Cadillac belt of volcanic rocks. In other words, that

they lie south of the horizon at which the fault may most reasonably be expected. The reasons for this are that the conglomerate beds seem to be the westward continuations of beds mapped south of the break in western Bousquet township and that no conglomerate is known to occur north of the "break" in the southern part of the Cadillac group across most of Bousquet township. The first place west of Bousquet township where exposures seem to limit the location of the "break" to a narrow gap that could be easily tested by drilling is at the northern parts of lots 21 to 23, range VI. At that place the assumed fault is shown on the map (No. 615A) for a short distance along the small stream valley south of the railroad. The exposures to the north of the fault are siliceous, massive greywacke flecked with biotite. The strata are moderately contorted and cut by small quartz veins, but not more so than in many other parts of the area. The south bank of the stream is a steep slope, some 40 or 50 feet high, that is largely drift covered near the stream. On the flat summit above the slope there are numerous outcrops of greywacke and conglomerate, in part converted to amphibolite and cut by veins of quartz and tourmaline. At the base of the slope, on the south bank of the stream, a flat surface of actinolite schist, dipping at about 65 degrees to the north, is exposed at the water's edge. In one place it is no more than 50 feet north to a small outcrop of siliceous greywacke on the north edge of the little valley. The sudden change in lithology suggests, but does not prove, that a fault may underlie the valley.

A large exposure of greywacke on the railroad half a mile to the west is intensely fractured and veined by quartz stringers. Furthermore, all the outcrops of amphibolite, diorite, and amphibolitized greywacke along the railway for 1½ miles east of Kinojevis River, besides being intensely amphibolitized, are fractured, broken by faults, and mineralized with veins of quartz and tourmaline in a manner that suggests proximity to a major fault. Finally, Hawley (1933, page 73) in describing some mineral showings that are now just north of the railway where it crosses a stream flowing north at the east side of lot 15, says: "a pit..... exposes a strong shear zone along which some faulting undoubtedly occurred. This zone strikes N65E and dips 56 degrees north, and crosses the small stream immediately to the east, below a small fall." The fault he describes is shown on the accompanying map (No. 615A), although the pit is now covered by rubble blasted from the railroad cut to the south. The fault may be subsidiary to a larger one on the north. Supporting this idea is the fact that all the exposures to the west along the railway end abruptly on the north in bluffs or steep slopes facing low, wet ground.

One other consideration bears on the possible continuation of the Cadillac "break" across Joannès township. The Thompson Creek fault strikes west from the big bend of Kinojevis River. It is a wide zone of soft schist almost identical in appearance to the Cadillac "break". It continues west for at least 3 miles. McWatters mine and the mineral deposits of the East Rouyn and O'Neill Thompson properties all lie about the same distance south of it. They are quartz-tourmaline deposits with such associated minerals as tellurides, pyrite, arsenopyrite, native gold, pyrrhotite, and chalcopyrite. The presence of arsenopyrite, tourmaline, and much dark grey quartz like that of Cadillac township, makes the mineralization similar to that along the Cadillac "break" across Bousquet,

Joannès, and Cadillac townships. The inference is that the Cadillac "break" may be the eastward continuation of the Thompson Creek fault. Furthermore, the offset along the Davidson Creek fault, estimated by displacement of the strata at 2,000 to 3,000 feet, is sufficient to bring the Thompson Creek fault about into line with the position assumed for the Joannès continuation of the Cadillac break.

The Thompson Creek Fault, as already stated, is a wide zone of talcose, chloritic, and micaceous schist like the Cadillac "break". It strikes east along the valley of Thompson Creek from Kinojevis River and dips 60 degrees to the north in Joannès township. A crosscut on the second level of O'Neill Thompson mine has penetrated the shear zone for 45 feet without reaching the north wall. There are two, well-defined, narrow fault planes with gouge in the schist. A diabase dyke on the property is apparently displaced 1,100 feet to the east on the north side of the fault. Hawley considers that the fault is a thrust, and the north side has, therefore, been elevated relative to the south. Shearing and contortion on the north side of the valley of Thompson Creek suggest that the whole valley may be underlain by schist and that the shear zone may be nearly 300 feet wide.

The Kiekkiek Lake Fault is exposed on the north shore of Kiekkiek Lake 2 miles from the west end. At that place a smooth rock wall 15 feet high slopes at 80 degrees to the south. The rock on the north is highly carbonated sediments that dip at 30 to 40 degrees to the north; that on the south is nearly vertical, massive, siliceous greywacke showing no carbonate. The abrupt change between these two rock types continues for 1,500 feet in a straight line trending north 55 degrees east, beyond which outcrops are too few to locate a possible fault. The westward continuation of the fault is probably a zone of intense shearing cut in a drill hole 3,300 feet[1] from the exposure on the shore. Possibly the fault continues west beneath the lake and the valley draining into its west end, but no information to prove this has been obtained. The fault, or a branch of it, may also swing north of west to leave the lake about 5,000 feet from the west end and connect with shear zones cut in drill holes about 1,000 feet north of the lake, both east and west of the township line. It is not known what relation, if any, the Kiekiek Lake fault has to the Cadillac "break". It may be an entirely separate structure, a branch of, or an *en échelon* continuation of, the break. Horizontal grooves on the exposed fault wall are indicative of a horizontal displacement.

Several other strike faults are known in the area. One on the west side of Kinojevis River and 1,000 feet north of the highway displaces a diabase dyke over 100 feet, the north wall having moved west relative to the south. There is a shear zone on the Joannès Davidson property in lot 16, range VII, mineralized in places with auriferous quartz and sulphides. The displacement is unknown. The veins at Arrowhead mine lie in a sheared zone approximately parallel in strike and dip to the enclosing volcanic rocks. A zone of soft schist in Westwood Cadillac mine is at least 65 feet wide, strikes east parallel to the enclosing rocks, and contains a gouge-filled fault as well as a small auriferous vein. At Cassels Duval mine south-dipping faults and shear zones along flow contacts have

[1] C. W. Knight and C. W. Workman have informed the writer of the drill intersection.

exerted important structural control on the localization of auriferous veins. In its early stage at least one of these was a thrust fault, such as would be expected to form along bedding planes on the north limb of a syncline during the regional folding. Furthermore, this fault appears as an insignificant shear at the surface, a strong reminder that such faults may easily escape detection. As much of the area is drift covered, it may be assumed with safety that many more faults will be found as mineral developments and consequent detailed investigations proceed. The greater number of the known veins occupy shear zones and fractures that are either incipient strike faults or strike faults of minor displacement.

OBLIQUE FAULTS

Throughout the area the strata are broken by a very large number of oblique faults. Those of appreciable offset are shown on the accompanying maps; in addition, there are many minor ones with displacements up to a foot or two. The reader will find additional details of these in the descriptions of properties. As in Cadillac township (Memoir 206, page 29) the commonest oblique faults strike northeast and northwest and dip 75 to 80 degrees. They apparently belong to a single system that has had the effect of extending in an east-west direction the length of the area originally occupied by the strata. The northeasterly trending faults have left-hand displacements, those striking northwest, right-hand displacements. All these faults are later than and offset the auriferous veins of the area, although the stresses that produced them were probably initiated during the period of mineralization (*See* "Importance of Cross Fractures", Memoir 206, page 45).

The Davidson Creek Fault is the major northeasterly striking, oblique fault of the area. It enters the extreme southwest corner of the area mapped and follows the valleys of Kinojevis River and Davidson Creek. It is doubtful if it should be classified as a representative of the above-described system, as it displaces dykes of quartz gabbro that are not known to be offset by the other northeast faults. The Davidson Creek fault has been described by Cooke, James, and Mawdsley, and by Hawley. However, they were not working in as great detail as the present writer, so it is not surprising that a new conception of the structure has been obtained. Hawley subscribed to Cooke's conclusion that "the southeast side was shifted to the northeast, so that the Keewatin-Timiskaming contact east of Davidson Creek is nearly 3 miles, measured along the fault, from the contact on the west side of Kinojevis River. The fault movement probably had a large vertical component so that the southeast side was thrust upward as well as to the northeast."[1] The present conclusion is that the southeast side moved northeast and downward relative to the northwest. The horizontal component is estimated at about 8,000 feet and the vertical at close to 2 miles. The displacement is less along that part of the fault south of the Thompson Creek fault. These conclusions are based largely on the displacement of several gabbro dykes, shown on the accompanying maps, and on the offset of certain contacts of the bedded Archæean strata. The two dykes mapped on either side of the fault northeast of Kinojevis River are offset 8,000 feet along the fault, as nearly as

[1] Memoir 166, p. 78.

can be established by the available exposures. Although the average dip of the dykes is not known, it is certainly within a few degrees of vertical. The contact between the Cadillac and Blake River groups meets the fault between the two dykes, but is only displaced about 4,000 feet. The bedded strata, and, therefore, the contact also, dip at about 70 degrees northward. The 4,000-foot discrepancy in the two displacements can be explained by concluding that erosion has reached about 2 miles deeper in the Archæan rocks on the west side of the fault than on the east side. In other words the west side has been elevated 2 miles above the east. Naturally the figures are approximate as there is no way of ascertaining the average dips of dykes or strata.

The best horizon for determining the horizontal offset across Kinojevis River seems to be the south edge of the southern band of conglomerate in the Kewagama group. Not only is the conglomerate on both sides of the river similar in appearance, but there is a zone some 600 feet thick on each side that is transitional to the south between conglomerate and greywacke. Furthermore, the conglomerate on each side of the river is the most southerly band of conglomerate in the Kewagama group. It is of interest to note that in speaking of the southern conglomerate band on the east side of the river, James and Mawdsley said in 1924: "The conglomerate of the main band to the south is of the coarser variety, contains lenses of greywacke, and resembles fairly closely the southern band of coarse conglomerate west of Kinojevis River" (1924, page 112C). In the same paragraph they remark that this conglomerate differs in appearance from that 2 miles to the north on the east side of Davidson Creek, as the writer has pointed out on a previous page. This early suggested correlation is interesting, for it was discarded later, and the conglomerate west of the river was correlated with the northern layer on the east side of Davidson Creek (Hawley, 1933, page 29). The south contact of the conglomerate on the east side of the river is displaced half a mile to the northeast of that on the west side. A displacement of practically the same amount is indicated for the body of diorite and the conglomerate immediately south of it at the railroad, if these rocks on either side of the river are assumed to be correlatives. In this case it is necessary to make the seemingly reasonable assumption that the diorite and conglomerate east of the river maintain their indicated northerly strike across the east side of the river until they reach the fault. Some other evidence of the smaller offset across Kinojevis River is afforded by two diabase dykes that again must be assumed to be nearly vertical. Two such parallel dykes are exposed on the east side of the river, south of the railway. Two dykes on the west side of the river just north of the highway are also parallel, though somewhat thicker and slightly closer together. If we correlate these dykes, the displacement at the Davidson Creek fault is seen to be close to 4,000 feet. The discrepancy between the displacement of northward dipping strata and vertical dykes again points to the west side of the fault having been thrust upward relative to the east, and in about the same proportion to the horizontal displacement as was estimated from correlations across the fault nearly 3 miles to the north.

The smaller indicated total displacement on the fault where it underlies Kinojevis River might be explained by assuming a rotational

movement. On the other hand, it may be that some part of the displacement of the northeast area was absorbed by adjustment along the Thompson Creek fault. This is possible in spite of the fact that the apparent displacement of a gabbro dyke on the latter is opposite in direction to that of similar dykes on the Davidson Creek fault. The dip of the Davidson Creek fault is not definitely known, but may be assumed from minor structures in the adjoining rocks to be steep to the west. By the present conception the fault is then a thrust, with the northwest side pushed upward and southward relative to the southeast, the vertical component being larger than the horizontal.

Significance of Correlations Across the Davidson Creek Fault. If the present solution of Davidson Creek fault is correct, it entails some very serious revision of our conception of Archæan succession and structure on the west side of the fault. The conglomerate and greywacke of southern Rouyn township, always regarded as Timiskaming since Cooke's work, becomes the western continuation of the north edge of the Kewagama group. Therefore, as in Joannès, Bousquet, and townships to the east, the tops of the beds should face north. Furthermore, the volcanic rocks to the north should overlie them and be the southern edge of the Blake River group. They have been shown as such on the accompanying maps. This is in direct contradiction of the established concept, for the southern sediments have been classified as Timiskaming largely because they were believed to lie on top of the "Keewatin" volcanic rocks. Cooke established such a succession and Hawley confirmed it by many structural observations in the sediments and not a few in the lavas. The writer obtained no good structural determinations in the small area west of Kinojevis River that is included in the present study, and it seems impossible to doubt the observations of men of the ability and experience of Cooke and Hawley. Nevertheless, it seems possible that there may be some unsuspected complication in the structure. Cooke postulated a fault all along the Timiskaming-Keewatin contact in Rouyn township, and Hawley established that there is one for much of the distance. May it be that the sediments do face south not far south of the contact, but that the contact fault has eliminated the north limb of an anticline? As a matter of fact Cooke, in his original structure section along Kinojevis River, showed the sedimentary beds with tops to the north at the contact, but introduced a fault, which neither the present writer nor Hawley has found, to facilitate the conception that the sediments lay on top of the volcanic rocks (Memoir 166, Figure 7). Furthermore, the writer paid a brief visit to the area in the spring of 1939 and found several new exposures that yielded some startling information. At the north-south centre line of Rouyn township Hawley, on his 1933 map, shows the Bouzain Lake fault at the Timiskaming-Keewatin contact. On a new road along the centre line there are now several clean outcrops from 800 to 1,600 feet south of the contact. Excellent examples of cross-bedding in greywacke show that the tops of the beds face north. About 200 yards north of the contact well-preserved pillows in andesite give the same attitude. The dips average about 45 degrees to the north. The intervening ground is a drift-covered valley. The writer does not suggest that this definitely proves that the "Timiskaming" is older than the "Keewatin", but as the attitudes are what would be expected from the

work in Joannès-Bousquet area, there would seem to be a need for further work in Rouyn in the hope that some of the structural anomalies might be explained.

North-striking Faults. There are several north-south faults in eastern Joannès township. The largest observed horizontal offset is 350 feet on a branching fault zone in lot 57, range VI. There are other sub-parallel faults to the west and drusy quartz veins lie in some of them (*See also* page 49). That in lot 57 is close to the Cléricy or Robertson-Vaudray zone, a fault zone postulated by Cooke, James, and Mawdsley (Memoir 166, page 103) and shown on the revised edition of the Kinojevis sheet by A. H. Lang (Map 306A, Geological Survey, 1935). This fault zone, if projected northwards, would pass just east of the Arrowhead mine, near the north-south lamprophyre dyke at the east end of the underground workings. As yet there does not seem to be sufficient evidence in Joannès township to prove or disprove the presence of such a fault, postulated by the earlier workers as extending north and south through Vaudray, Joannès, Cléricy, and Aiguebelle townships. The present mapping in Joannès does suggest that if the fault does exist, the horizontal displacement is not great, probably not over several hundred feet at most, and no such fault is postulated on the accompanying maps. So far as known there is no great displacement along any of the fissures occupied by the north-south diabase dykes that are such a striking feature in Joannès township. They, with the observed north-south faults, do indicate intense fracturing and some faulting along north-south lines all across the township, a feature that is absent or not pronounced for many miles to the east. Possibly this fracturing and faulting represents a period of late Precambrian readjustment.

CHAPTER IV

MINERAL DEPOSITS

HISTORY AND PRESENT STATUS

Crossed by two of the main water routes of the region, Bousquet and Joannès townships have been visited by prospectors for about 30 years. During the past 15 years several determined efforts have been made to develop mines, but until recently no great success has attended any of the efforts and today there is no steady producer in the area. One property, Cassels Duval, is being developed underground on a large scale with some hope of eventually reaching production. In another, Mooshla, there is a small tonnage of rich ore that apparently can be mined and shipped to Noranda. On a few others small amounts of rich gold ore have been obtained during development. About $3,000 worth of gold was saved from a small mill operated for a few months at the O'Neill Thompson mine in western Joannès, but the property is now closed. All the deposits in the area are valuable primarily for their gold content. Much of the area is timbered or covered with a deep mantle of drift, so that prospecting is difficult and expensive. In Joannès township some of the finest examples of Quebec swamps effectively hide any treasure that the underlying rocks may hold. The recent construction of a highway and a railroad across the two townships has improved the accessibility and thereby stimulated interest in the area.

TYPES OF MINERAL DEPOSITS

That the entire area has been subject to mineralization is attested by the multitude of veins and replacement bodies found in all types of rock except the dykes of quartz gabbro. It would be difficult to examine more than a few hundred feet of rock without finding a deposit of some kind. However, the vast majority are barren or very slightly auriferous. Myriads of quartz veins, particularly in the southern half or two-thirds of the area, contain no metallic mineral and obviously are of no economic importance. Only those containing metallic minerals are worthy of attention, and of these only a small proportion have been found sufficiently auriferous to encourage development.

Those deposits that have received appreciable development within the last 15 years or so can be classified in several groups as follows:

(1) Quartz veins and replacements of the Cadillac type, distinguished by their variable proportions of arsenopyrite. Black tourmaline is also present, in some cases very sparingly in quartz or wall-rock, in others abundantly with quartz in irregular replacement masses.

(2) Small quartz-sulphide veins. These are found only around the Mooshla body of quartz diorite and do not contain arsenopyrite nor appreciable amounts of tourmaline.

(3) Pyritic veins and replacements in schist or phyllite.

(4) Quartz-carbonate veins with sulphides, but no arsenopyrite.

(5) Pyritic replacements in massive volcanic rocks.

These five types, and most of the barren quartz veins, were probably formed during the one great period of mineralization following the intrusion of the granitic rocks of the region. They are deep-seated deposits that would be referred to the Mesothermal and Hypothermal groups in Lindgren's genetic classification of mineral deposits.

(6) In addition, there are a few deposits in Joannès township of a type that has not been encountered for 30 miles to the east along the same mineral belt. These are drusy or cavernous veins of white quartz. In the examples studied by the writer, they carry small amounts of pyrite, chalcopyrite, galena, and sphalerite, but only very small amounts of gold. They may represent a later period of mineralization.

DISTRIBUTION AND GENERAL CHARACTERISTICS

(1) *Veins and Replacements of the Cadillac Type.* Deposits of this kind are most abundantly developed along the Cadillac "break," more commonly in the adjoining fractured rocks than in the shear zone itself. They have been found at intervals all across Bousquet and Joannès townships near the shear zone and its possible continuation. They include the deposits at the following properties, from west to east: O'Neill Thompson, several showings to the east in Joannès, Decoeur-Bousquet, Paquin, Calder-Bousquet, Norgold group A, Doreva, Sudbury Contact, Brown Bousquet, and Bouscadillac. A few unimportant deposits of the same type have been found south of the shear zone in rocks of the Kewagama group. Others have been found to the north in the Cadillac group, at wide intervals across both townships. Among these are veins on the following properties: Brown Cadillac, Doreva, a few veins in the southern part of the Westwood claims, and in the west half of Bousquet township, and, finally, veins on the Nelson Gold, Joannès Davidson, and Teck-Hughes claims near the Davidson Creek fault. The most northerly occurrence known to the writer is near the north contact of the Cadillac group in trenches in northwest Bousquet township 2,000 feet west of the northwest corner of claim A57360.

These deposits are typically small, with gold erratically distributed and occasionally in very rich pockets. Besides native gold the metallic constituents include pyrite, arsenopyrite, and minor amounts of pyrrhotite, chalcopyrite, sphalerite, and galena. The quartz is dark grey to mottled grey and white. Associated with it are variable proportions of ankerite, albite in some veins, black tourmaline abundantly to very sparingly present, and some later veinlets of calcite. A little scheelite is present in at least one vein. The wall-rock alteration consists of the development of ferruginous carbonate, sericite, biotite, tourmaline, and albite in some

cases. Acicular crystals of arsenopyrite are commonly more abundant in the wall-rock than in the veins; pyrite accompanies the arsenopyrite in some places. In this way there may develop all gradations between simple veins and replacement bodies cut by a few small quartz veins. Where tourmaline is very abundant it occurs with quartz in veins or in irregular replacement bodies. Examples are some bodies on the O'Neill Thompson property and on claims east of the mouth of Davidson Creek.

The deposits are similar in form and mineral composition to those that have been mined at McWatters mine and in Cadillac township.

Many lenticular veins of similar grey quartz occur in the area. When completely devoid of metallic minerals they generally contain such minerals as albite, muscovite, and chlorite. So far as the writer knows such veins are not auriferous.

(2) *Small Quartz-sulphide Veins.* Deposits of this kind are known only around the Mooshla body of quartz diorite, and have been developed at the Mooshla and Cassels Duval mines. At the former they are a few inches wide, but exceedingly rich in gold. Some veins are massive intergrowths of pyrite and pyrrhotite with minor amounts of chalcopyrite and sphalerite. Others contain considerable quartz and less sulphides. Native gold is present, sometimes finely divided, and in some places where quartz is abundant it is visible in spectacular amount. Calcite, albite, and garnet occur in the veins and there is a little tourmaline in the wall-rock.

At Cassels Duval similar veins of quartz with pyrite, pyrrhotite, and chalcopyrite contain less spectacular though important amounts of native gold that is not often visible to the naked eye. They occur along narrow, bedded shears in greenstone and in wider zones as closely spaced stringers that cut across the strike of the enclosing volcanic rocks. Although individual veins may contain up to about an ounce of gold a ton, the stringer zones as a whole are low grade.

(3) *Pyritic Veins and Replacements in Schist or Phyllite.* These include deposits at Thompson Bousquet, Westwood Cadillac, and O'Leary Malartic properties. They are alined along the strike of the strata for 2½ miles. Pyrite is the predominant mineral and quartz is not usually abundant, except in irregular veins in some places that do not form an integral part of the pyritic deposits. At Thompson Bousquet, pyrite is practically the only metallic mineral in the largest deposit. In other deposits there are smaller amounts of chalcopyrite and sphalerite, the latter generally in small veinlets that cut the pyrite bodies. The degree of carbonation that accompanies the pyrite varies greatly. Garnet occurs in the mineralized zone at O'Leary Malartic, and pyrrhotite, magnetite, and tremolite are found in the wall-rock of a similar type of deposit on claims of E. J. Thompson. The main deposit at Thompson Bousquet is a large, low-grade body of pyritic rock, of doubtful commercial value, with a maximum width of about 60 feet and a length of at least 1,300 feet. From this size the bodies range down to lenticular replacements a few inches wide and a few tens of feet long, alined roughly along the strike of the strata. One or two small shoots containing visible gold have been found, but the metal is generally too finely divided to be perceived.

Developments to date have not been encouraging, but it is apparent that these deposits, along with the vein zones of type (2), offer the best possibilities of large-scale development in the area.

(4) *Quartz-carbonate Veins with Sulphides but no Arsenopyrite.* The only notable representative of this type is the Arrowhead deposit, though a few other veins on the same property and to the west are similar. Perhaps they should be considered a variant of veins of the Cadillac type, with arsenopyrite absent. However, the quartz is more milky in appearance than in the Cadillac veins and ankerite is on the whole more abundant. The veins are equally lenticular and tourmaline is present, in places in large amount. Very similar are veins in western Joannès at the Teck-Hughes and Joannès Davidson properties, but they contain some arsenopyrite.

(5) *Pyritic Replacements in Massive Volcanic Rocks.* This type includes a number of deposits in Joannès township that are as yet of no proved commercial importance. They appear as large, rusty exposures in the acidic rocks of the southern or upper division of the Blake River group, westward from lot 40, range IX, as far as the Davidson Creek fault. West of that fault they were noted in large exposures of rhyolite and agglomerate on and near the power line in range VIII, in the same rocks at the north end of lot 8, range VII, and at a few other places. They have been tested by trenches and pits at a number of places in years past. The rusty weathering bands follow the strike of the enclosing rocks and are due to replacement of flows and agglomerate by pyrite and some pyrrhotite. Widths of 100 feet and more contain disseminations of these sulphides, and lesser widths, up to at least 45 feet, are almost completely replaced by them. In some of the richer bands there are small amounts of chalcopyrite and a few scattered grains of sphalerite, generally discernible only under the microscope. Grains of magnetite accompany the sulphides in most places, and in several localities there are lenticular veins of quartz, some of which contain tourmaline. So far as the writer knows, no such deposit has been found to be appreciably auriferous, but no records were obtained of many of the old workings. Somewhat analogous pyritic rhyolite and rhyolite breccia in Bousquet township has been sampled at a number of places without encouragement, for example on the Cassels Duval, Mic-Mac, and Mooshla properties. Replacement bodies of pyrite and pyrrhotite with a little chalcopyrite have also been found in porphyritic andesite of the Cadillac belt on Brown Bousquet claims and properties to the east. They are not auriferous and in Cadillac township are cut by the auriferous quartz veins.

(6) *Drusy Quartz Veins.* Deposits of this kind occur chiefly along and near the highway in the eastern half of Joannès township. On the south side of the railway grade 1,000 feet east of the highway intersection, there is one good example; a 12-inch vein of white quartz, crystalline and cavernous, lies in a fault that strikes north 22 degrees east and dips 83 degrees to the west. Beds of conglomerate and greywacke are displaced 18 feet to the south on the west side of the fault. The quartz contains a small amount of pyrite, chalcopyrite, sphalerite, and galena. The fault and the vein cut other small veins of the Cadillac type. Sampling is reported to have shown that the vein is not auriferous. Similar veins have

been found about 1,500 feet to the west. A small vein of the same type in lot 51, 200 feet north of the highway, is younger than a lamprophyre dyke whose contact it follows. At the old Polson showing, 300 feet south of the highway in lot 56, the vein is several feet wide and consists of the same white quartz with inclusions of partly replaced rock. It is very sparingly mineralized with sulphides and lies along a vertical fault that strikes due north. The best exposure is in an old pit, but there are similar veins to the north and in the walls of the fault.

All these veins are very different in structure and mineral composition from the other deposits of the area. They are distinctly later than the veins of the Cadillac type. Their north-south strike is radically different from that of the deposits in bedded rocks, and most of them are in or alongside faults that are not occupied by any of the other deposits. They are also of a lower-temperature type than the others. All these facts point to the conclusion that they were not formed during the same period of mineralization as the others. A genetic relation to the late, north-striking dykes of quartz gabbro is perhaps suggested by the fact that there are several of these dykes where most of the veins are found, whereas for many miles to the east, where the dykes strike northeast, none of these veins have been discovered.

The chalcopyrite-bearing quartz veins at Washington Gold Mines may belong to this type.

STRUCTURAL CONTROL

The area exhibits abundant evidence of the great influence of structure in the localization of mineral deposits. Of paramount importance are major faults and shear zones and the subsidiary faults and fissures that are found near them. Contacts between bedded rocks or between intrusive masses and the invaded rocks are also important, for during regional disturbances they have determined in varying degree the location of secondary structures along which ore deposits may then form. Large intrusive bodies tend to act at buttresses during folding and faulting, so that fractures, faults, and shears develop around them and the strata are bent upon the resistant mass. Thick, relatively homogeneous masses of competent volcanic rocks behave in much the same manner and less competent horizons nearby absorb, by breaking or shearing, most of the readjustments that are necessary. Hard, brittle beds, like iron formation or quartzite in less competent argillaceous sediment, for example, fracture to form a porous horizon while the adjoining rock is converted to an impervious schist or phyllite. The porous horizon is then favourable to the ascent of mineralizing solutions that may deposit valuable material in the openings.

THE CADILLAC BREAK

The vital importance of this great shear in the distribution of mineral deposits for 25 miles east of the area under discussion is now well known, and explorations based on the established relation between the break and ore deposits have yielded profitable mines. The writer and others have stressed the relation in previous reports and articles, so that there is no need to discuss it in detail now.

All the important mines for 25 miles to the east of Bousquet township are in or very close to the break. Its continuation across Bousquet township and possible continuation across Joannès have been discussed at some length in the chapter on structure. It has also been pointed out that the Thompson Creek fault, west of Kinojevis River, is either its western continuation or a major shear zone of very similar character.

The close association across Bousquet township between the break and mineral deposits of the Cadillac type is well shown on the accompanying maps. All the deposits are approximately parallel to it in strike. Those at Bouscadillac, Sudbury Contact, Doreva, Norgold, and Calder-Bousquet, and some veins at Brown Bousquet are immediately south of the shear zone, along subsidiary fissures or shears. Some small auriferous veins have been found within the shear zone itself at Brown Bousquet. No important mineral deposit of this type has yet been found on the north side of the break to the west of Cadillac township. All the deposits mentioned lie within 750 feet of the shear zone. The showings on the Decoeur-Bousquet and Paquin claims in southwest Bousquet lie much farther south, if the break continues west as assumed on the accompanying maps, but the structure there is complicated by a strong fault along Kiekkiek Lake, and a pronounced shear trends west of north through the Decoeur showing, continuing west past other veins in east Joannès township. Across most of Joannès township no veins of importance have been found. The few small ones known are 1,000 feet or less from the projected shear zone, and again on the south side. It is to be noted that a very large proportion of bedrock within several hundred feet of the projection is drift covered, but as Kinojevis River is approached and outcrops increase near the assumed position of the break, there are again a good many quartz-tourmaline veins, some of which contain a little arsenopyrite. For several miles west of Kinojevis River, in Joannès and Rouyn townships, the known deposits of importance are on the south side of the Thompson Creek fault. Veins on the Nelson, Teck-Hughes, and Joannès Davidson properties are well to the north of the break, but are close to the strong Davidson Creek fault.

Developments to date along the Cadillac belt in Bousquet township have not been as encouraging as might be wished, but it must be remembered that a large percentage of the most favourable zone, in close proximity to the main break, is obscured by deep overburden and has not been explored. The auriferous deposits are apt to be small and correspondingly rich, so that much effort is required to find them. The fact that no sodic intrusives, like those in Cadillac township, have been found along the belt west of Brown Bousquet might be considered as an unfavourable sign, as these intrusives are believed to be genetically related to the Cadillac deposits, and occur in the shear zone all across that township. But the knowledge of their significance is so incomplete that any conclusions based on their absence cannot be accepted with great assurance. No such intrusives have been found along the Thompson Creek fault in west Joannès township or for several miles into Rouyn township, as far as the profitable McWatters mine.

The granitic intrusives at and west of Calder-Bousquet add interest to this part of the belt. Furthermore, much remains to be learned of the structure in this western part of Bousquet township, between the highway

and Kiekkiek Lake. Many exposures show unusually flat dips, and at least local contortion; there is intense carbonatization over a large area, and there are scattered showings of the Cadillac type, with some gold content. All these things and the location between the Cadillac break and the Bousquet Lake fault indicate that the area deserves careful consideration. A large proportion of bedrock is deeply buried by clay.

It is very difficult to assess the potential value of ground near the assumed continuation of the break across Joannès township. Some gold has been found in quartz-tourmaline veins along and south of the railway for 7,000 feet east of Kinojevis River. Between that and the centre line of the township there are quartz veins in the few exposures along and for about 2,000 feet south of the railway, but most of them are barren of metallic minerals. A few contain tourmaline, and several show extreme amphibolitization of the wall-rocks. Nothing resembling a valuable mineral deposit was seen by the writer. In the east half of Joannès township there are many barren quartz veins, but very few veins with sulphides. Two small ones with arsenopyrite have been exposed near the north edge of the ridge south of the railway, in lots 40 and 41. A vein zone with arsenopyrite has been stripped on lot 51, 500 feet north of the highway. It contains a little gold. There is a similar vein zone in lot 56, 2,100 feet south of the highway. The record is not impressive.

Even if the break does continue across Joannès township, as assumed, there is no assurance that any worth-while mineral deposit will occur along it. As a matter of fact, the number of barren, "high temperature" quartz veins observed in the contiguous rocks, and the extreme amphibolitization of the sediments in a number of places, create a rather disheartening impression in the writer's mind. Furthermore, there is no evidence to suggest anything but a rather monotonous succession of greywacke and some conglomerate along the assumed break from Bousquet township to the diorite near Kinojevis River. This is not a favourable condition, for a variety of rock types of varying physical character is certainly desirable.

The potential value of this part of Joannès township is, therefore, highly speculative. If some philanthropic organization could be prevailed upon to prove or disprove the existence of the break in one or two of the places where it can be done most efficiently, a start would have been made on the solution of the problem. Perhaps additional expenditures on prospecting would then be justified and might lead to drilling or underground development. The writer has no information indicating any particular location as the most favourable along the projected break. However, exposures north and south of the railway in lots 22 and 23 limit the possible location of the break more closely than in other places, and there are several quartz-tourmaline veins in those on the south.

THE KIEKKIEK LAKE FAULT

Not much is known about the bearing of this fault on mineral deposition. The rocks north of it are intensely carbonatized over a large area on the north shore of Kiekkiek Lake. The Decoeur-Bousquet showing lies along a shear that may be subsidiary to the main fault.

Greenstone is in places highly pyritic around the west end of the lake and is intruded by small bodies of quartz syenite. The fault may continue a long way under drift in the depression west of the lake, but has not been proved to do so.

THE DAVIDSON CREEK FAULT

No definite relation between this fault and auriferous deposits is known. The fault may be entirely later than the deposits as it offsets dykes of quartz gabbro. On the other hand, it may have existed before the dykes were intruded, though this seems unlikely. Deposits at the Teck-Hughes, Joannès Davidson, and Nelson properties are in fractures and shears that strike about east-west and are not proved to be in any way related to the Davidson Creek fault.

OTHER FAULTS AND SHEAR ZONES

The deposits at Thompson Bousquet, Westwood Cadillac, and O'Leary Malartic properties lie in a belt of more than usually schistose rocks in the Blake River group. The chief auriferous vein at Westwood is in a pronounced shear within this belt. The relation between shearing, faulting, and the location of the deposits is, therefore, readily apparent. For about 2 miles west of O'Leary Malartic the continuation of the sheared and faulted belt is drift covered and unexplored.

The relation between bedded shears with subsidiary fractures and the auriferous veins at Cassels Duval and Mic-Mac has been emphasized in the description of those properties. No major fault or shear zone has yet been proved in this part of the area, but it seems probable that the structures that permitted the formation of the deposits are related to stresses produced during and after the intrusion of the Mooshla body of quartz diorite, or at least that that mass exerted an important control on their development. If that is the case they would be more local than regional, and should show some consistent relation to the intrusive body.

The Arrowhead veins have long been known to lie in an altered, sheared zone in volcanic rocks that are much less schistose to the north and south. Large areas of hard, massive, volcanic rocks to the west, and another area of similar rocks to the north and northwest, of Cassels Duval mine are perhaps the least promising prospecting areas in the whole area under discussion, with the possible exception of the monotonous stretches of greywacke well to the south of the Cadillac break.

The occurrence of drusy quartz veins in faults striking nearly due north has already been discussed.

CHAPTER V

DESCRIPTIONS OF PROPERTIES

AMOS-CADILLAC GOLD MINES, LIMITED

This company owns claims A62004 to A62008, inclusive, in eastern Bousquet township, immediately south of Bouscadillac Gold Mines. Several camp buildings were erected late in 1936 and about 2,800 feet of diamond drilling was done before June 1937. Press reports say that a new campaign of trenching and diamond drilling was begun in November 1938.

The claims are apparently underlain entirely by greywacke and mica schist of the Kewagama group. There is a large hill of exposures on claims A62005 and A62008, and a few small outcrops elsewhere in drift-covered terrain sloping to the south. The average strike of the sediments is a few degrees north of east and their dip close to vertical, but they are locally contorted. Of a very large number of lenticular veins observed by the writer the vast majority are small and barren of metallic minerals. They usually contain small amounts of albite, biotite, and muscovite. Small quantities of arsenopyrite and pyrite and less chalcopyrite and pyrrhotite accompany the veins in four places, on claims A62005 and A62006. The greatest proved length of any vein is 90 feet. This is a vein zone up to 4 feet wide of quartz stringers in argillaceous greywacke in the north-central part of claim A62005. The maximum width of quartz is 2 feet and arsenopyrite is developed chiefly for an inch or two in the schistose wall-rock. The zone strikes north 82 degrees east and has been stripped and sampled. Gold content is reported to be negligible.

ARROWHEAD GOLD MINES, LIMITED

Arrowhead Gold Mines owns blocks 7 to 12, inclusive, in the northeast corner of Joannès township. Originally staked in 1923 by R. Hoffman and Fred Thompson the claims were acquired by the Joannès Syndicate in 1929. Arrowhead Consolidated Mines developed the property in succeeding years, but went into bankruptcy in 1932. Early in 1936 the present company resumed development and after additional diamond drilling established levels at 200, 350, and 500 feet in a new shaft. Under the direction of Mr. D. J. Russell about half a mile of work was completed, mostly on the third and first levels. Mining was suspended in December 1937. The mine workings were flooded at the time of the writer's examination in 1938, but Mr. Russell supplied much helpful information. Developments to 1936 have been described by L. V. Bell in his reports for 1930 and 1936. The new shaft is in the northwest corner of block 8.

With the exception of two dykes of quartz gabbro and one of serpentinized lamprophyre, the claims are underlain by volcanic rocks of the Blake River group. These range in composition from rhyolite to basalt,

but andesite and dacite are most abundant except in parts of block 10 where rhyolite and rhyolite breccia occur in wide bands. In other places narrow layers of rhyolite are intercalated with the more basic lavas. The origin and intrusive relations of some of the rhyolite have been discussed on pages 20 and 21. The volcanic rocks strike west to north of west and are approximately vertical, rarely dipping less than 80 degrees to the north or south. In the northern part of block 10 the acidic varieties are largely converted to quartz sericite schist. Near the two principal veins the greenstone is altered to rusty weathering chlorite-carbonate schist and narrower widths of this material are found in other parts of the property. Otherwise the rocks are massive and fresh looking. The large area of exposures at the mine drops suddenly on the east to a north-trending, drift-filled depression. Some have thought that a major north-south fault may underlie this depression, but the data obtained by the writer do not support such a theory, though minor faults may be found there. A drift on the 500-foot level has shown that the west side of the depression is underlain by a serpentinized lamprophyre dyke 100 feet wide that strikes north and dips steeply to the west. This heavily jointed, rather soft rock has probably had an influence in the formation of the depression. Elsewhere the rocks and veins are broken by the usual large number of oblique faults of minor displacement. In those observed by the writer the ones that strike east of north have left-hand displacements and those that strike west of north have right-hand displacements.

MINERAL DEPOSITS

Several veins have been found on the property, but two, known as the "A" and "B" veins, are of greatest importance; these two, and many of the others, strike east-west in schistose greenstone and dip steeply north, parallel to the schistosity. They consist of watery white quartz with intergrown calcite and ankerite, in many cases in layers that impart a pronounced banded appearance to the vein. Black tourmaline is generally present, most commonly in narrow seams parallel to the walls. Pyrite is the most abundant sulphide, pyrrhotite is less common, and chalcopyrite is present in small amount in some places. The quartz is nearly always intensely fractured, along and obliquely across the strike of the vein. Native gold is reported to occur in relatively small shoots and generally, where visible, in the fractures in the quartz. Both veins, and most of the others on the property, consist of discontinuous lenses in the shear that forms the vein zone. Widths of quartz vary from a fraction of an inch to a maximum of about 5 feet. A maximum width of 10 feet of closely spaced quartz veins in schist was found on the surface near the west end of the "B" vein. The "A" and "B" vein zones are 150 to 200 feet apart, "A" being on the south, and both have been traced on the surface for about 1,300 feet east from a quartz gabbro dyke striking east of north through the claims. In neither is the quartz continuous for the whole 1,300 feet. The old surface workings are now largely filled or flooded, but maps supplied by the company show that nearly 400 feet of the western part of the "A" vein and 180 feet of the middle of the "B" vein were essentially barren.

The western projection of the "B" vein would lie in low, drift-covered ground for about 2,000 feet beyond the gabbro dyke. Trenches about on strike at 1,000 and 1,400 feet have exposed similar quartz carbonate veins with pyrite, and the east exposure is said to be auriferous. The "A" vein dies out before it reaches the gabbro dyke, but lenticular quartz veins have been trenched for 220 feet west of the dyke, a short distance to the south of where the "A" vein should be if it continued.

In and alongside the vein zones the greenstone, where not converted to a chlorite-carbonate schist, is altered by the vein solutions to a hard, dense, grey to buff-coloured rock that weathers rusty. Microscopic study of this material shows it veined by many microscopic quartz stringers. The groundmass of the rock consists of clear and finely granular quartz and albite; alongside the quartz stringers are layers of perfectly clear, euhedral albite grains, coarser than the albite of the groundmass. Tiny veinlets of carbonate cut the quartz stringers and tend to replace streaks of chlorite that traverse the rock. A minor amount of sericite is scattered through the groundmass or alongside the quartz veinlets. The predominant alteration is silicification accompanied by the slight development of carbonate and sericite. Noteworthy is the growth of pure albite along the vein walls.

L. V. Bell (1930, pages 28 and 29) has summarized the results of surface sampling prior to 1930. The bulk of the gold has been found to be in the quartz rather than in sulphides or mineralized wall-rock. The best values were found in a prospect shaft sunk 32 feet on the "A" vein at a point 370 feet southwest of the new shaft; there an average of $28 a ton in gold was obtained over a width of 20 inches of quartz. Much lower values were found in pits to the east, and drill hole intersections beneath this part of the vein yielded from $2 to $6.60 a ton in gold across similar widths. All the assays were calculated with gold at $20.67 an ounce. The best average results given for the "B" vein were $3.75 and $6.54 across 10·2 and 5½ feet, respectively, of vein matter in pits northwest of the shaft on "A" vein. Better gold content was said to have been proved in a 90-foot shoot at the extreme east end of the "B" vein.

Resampling of the surface and diamond drilling in 1936 is reported to have yielded more encouraging results (Bell, 1936, page 23). Four hundred feet at the east end of vein "B" was estimated to contain $17.50 a ton in gold across a width of 2 feet, and 100 feet of vein "A" was estimated to contain $35 a ton across 1 foot. The underground work was done on the basis of these estimates.

UNDERGROUND WORKINGS

Mr. Russell kindly supplied the writer with geological maps of the workings, prepared by H. M. Butterfield, which show the veins on the three levels in excellent detail. Both veins dip north at 85 degrees or more. A fault striking west of north lies 70 feet southwest of the shaft, on the surface, and crosses the drift along "B" vein on the 500-foot level 150 feet west of the shaft. That part of the "B" vein east of the fault is called the east section, and the part west of it the centre section. The west section, not yet developed, is near the diabase dyke. The "A" vein does not appear east of this fault.

On the 200-foot level the shaft lies in the "B" vein, and drifts follow the vein for 260 feet northeast and 80 feet west from it. Between 70 and 160 feet east of the shaft the vein is single and averages between 2 and 3 feet in width; its faulted continuation may be represented by somewhat thinner quartz from 30 to 75 feet beyond. These two sections are said to carry hardly enough gold to be classed as ore. Along the rest of the drift quartz occurs as narrow, discontinuous lenses across drift widths, and one 29-foot section at and west of the shaft is reported to have averaged $9.61 in gold a ton across 21·3 inches. Nothing else approaching ore was found. From the west end of the drift a crosscut runs 250 feet on a bearing of south 25 degrees west, to the "A" vein. An intermediate vein, previously indicated by drilling, was cut halfway between the two veins and showed 2 feet of quartz, but its gold content did not encourage more than two rounds of drifting. The "A" vein was developed by drifts for 150 feet to the east and 140 feet to the west of the crosscut. This is the part of the vein that lies at and east of the old prospect shaft. Quartz veins of great irregularity were found all along the drift, the best section being for 75 feet west and 25 feet east of the crosscut. Calculated averages suggest that the full length might contain about $5 in gold a ton, and that the west half might contain twice this amount. The widths estimated varied from 13 to 18 inches, though quartz occurs across the full width of the drift, as lenses separated by rock.

On the 350-foot level the "B" vein is 30 feet northwest of the shaft and is followed by drifts for 70 feet. Several lenticular veins up to 2½ feet wide were encountered in the vein zone. One section 22 feet long is shown as containing $15.66 in gold a ton across an average width of 12·5 inches, and there are lower values to the east.

On the 500-foot level the "B" vein has a total of perhaps 100 feet of possible ore, in several shoots. The richest is at the north end of the crosscut from the shaft, where about 25 feet is estimated to average 1 ounce a ton across 1 foot. On the "A" vein a length of about 30 feet at the south end of the crosscut is estimated to average $12.50 across a width of 10 inches.

The west section of the "B" vein has not been developed underground except by drill holes. On the surface it extends about 240 feet east from the diabase dyke, in a group of trenches now largely caved. In a pit 100 feet east of the dyke the vein is 6½ feet wide, with schist inclusions, and contains a small amount of pyrite. The quartz is white and drusy and carries seams of tourmaline and very little ankerite. In a few other exposures this part of the vein is very lenticular and is well fractured. It is reported that an interesting gold content was found for 65 feet east of the dyke.

A number of other veins have been found on the property. One of these is 900 feet north 25 degrees west from the west end of the "B" vein. It is in schistose rhyolite and has been stripped for 115 feet at the south edge of low ground. It attains a maximum width of 5½ feet and contains a small amount of pyrite, little ankerite, and nests and seams of tourmaline. There are two other smaller veins a few feet south of the large one. Still other veins in rhyolite and rhyolite breccia were noted during the routine mapping of the area to the northwest and it seems to the writer that this northern part of block 10 should be prospected further.

ARROWHEAD EXTENSION CLAIMS

A group of claims immediately west of those of the Arrowhead Gold Mines is referred to as the Arrowhead Extension property. It is reported that they have been or are held by Messrs. Hoffman and Thompson. No work was done on them during the writer's visits, but a good deal of surface work had been done in the past, and some trenching had been done the previous winter by R. Peterson. The old trenches, in lots 47 and 48, range X, expose several quartz veins, some of which contain tourmaline and a little pyrite, in sericite schist and greenstone of the Blake River group. The recent work was done on lot 47, about 800 feet north of the south side of range X. One vein about a foot wide has been traced for 60 feet and contains a small proportion of pyrite and sphalerite. Two hundred and fifty feet to the northwest there are some large exposures of quartz, barren or very sparingly pyritic, that have formed by replacement of andesite. The largest is about 14 by 30 feet as exposed in a stripping.

ATHLONE GOLD MINES, LIMITED

In the summer of 1937 this company, with the supervision of M. C. H. Little, did surface work on a group of fifteen claims in the northwest corner of the east half of Bousquet township. The claims were held under option from Mr. L. Emond. Much of the work, still in progress at the time of the writer's examination, was done about 1,000 feet north of the northeast corner of the Mooshla property. A shear zone in greenstone and schist has been found in three trenches in a length of 500 feet. Lenticular veins up to 3 feet wide occur in the shear zone and the schist is pyritized, in one place across 10 feet and in another across 30 feet. It was reported that some sphalerite had been found in one place. Other work uncovered a number of dykes of feldspar porphyry and some of diorite in the volcanic rocks of the Blake River group and in greywacke of the Kewagama group.

BIG BEND MINING CORPORATION, LIMITED

This corporation owns claims A11035 to A11039 in range VI, Joannès township, on the east side of Kinojevis River. Most of the work was done prior to 1934 and the showings have been described by J. E. Hawley (1933, page 71). No work was being done in 1938 and the old trenches were mostly caved or flooded.

The claims are partly underlain by greywacke and conglomerate of the Kewagama group, the conglomerate lying just south of the body of quartz diorite exposed along the railway. The beds curve in strike approximately parallel to the diorite contact and near that rock they are so highly amphibolitized that they are recognizable only in a few places. The amphibolitization decreases away from the diorite. Two northerly trending dykes of quartz gabbro cut greywacke not far east of Kinojevis River.

Most of the many veins are in or close to the quartz diorite. They are irregular veins of quartz and black tourmaline with pyrite and minor amounts of pyrrhotite. One such vein is at the contact of diorite and

amphibolitized sediment in the southeast corner of claim A11039. It strikes north 55 degrees east and dips at 40 degrees to the north. It varies in width to 8 feet and is exposed for 100 feet. Another vein 200 feet to the northeast on claim A11035 contains pyrite and pyrrhotite, has been trenched for 140 feet, and is up to 12 feet wide. There are also lenticular masses of calcite, as wide as 5 feet, along the zone. Other veins lie near the east boundary of the same claim.

The railway grade has been cut in quartz diorite and amphibolitized sediment for nearly 1,000 feet. On the south face of the cut many veins are visible, most of them in the diorite. They consist of white quartz and much black tourmaline with minor quantities of pyrite and pyrrhotite. In several places the diorite is replaced by black tourmaline with very little quartz. Many of the veins are irregular, gently dipping bodies occupying tension cracks subsidiary to several faults that strike approximately north and dip steeply. The writer has no information as to gold content of the veins, except that some are reported to be auriferous. Most of the bedrock to the south of the cut is drift covered. No one vein seems to offer much probability of great continuity; some are so closely spaced as to constitute vein zones that might be more persistent.

BOUSCADILLAC GOLD MINES, LIMITED

This company was incorporated in 1936 to acquire ten claims in eastern Bousquet township, blocks 6 to 15, inclusive, that were originally owned by Graham Bousquet Mining Corporation. Auriferous quartz veins were discovered on the property in June 1924 by P. T. Graham and D. Abrams. After surface work and diamond drilling in 1926, a two-compartment shaft was sunk to 525 feet in 1928 and 1929, and about 1,500 feet of underground development carried out on four levels at vertical intervals of 125 feet. Over half of the development was done on the bottom or 500-foot level. Seven diamond drill holes were bored in 1929. The property lay idle from August 1929 until 1934, when some additional trenching and diamond drilling was done under the supervision of the previous mine manager, J. C. MacPherson. Then followed 2 more years of inactivity until the mine was dewatered late in 1936 by the present company, with Mr. Andrew Walz acting as consulting engineer. Under his supervision about 2,000 feet of new drifting and crosscutting was done and the old workings were resampled. Underground work was again suspended in June 1937, but diamond drilling from the surface, both east and west of the underground workings, was continued until September. Since then the property has been inactive.

The property has been described by Cooke[1] and by MacLean and Bell.[2] The writer received much assistance in his examination from the company's geologist, Mr. W. D. Neeland.

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[1] Geol. Surv., Canada, Mem. 166, p. 264 (1931).
[2] Quebec Bureau of Mines, Ann. Rept. 1929, pt. C, pp. 57-61.

GEOLOGY

The claims completely cover the Cadillac belt of volcanic rocks for 7,700 feet west from the boundary of Cadillac township. On the south there are random outcrops of thin-bedded, argillaceous and siliceous greywacke and phyllite of the Kewagama group (*See* Figure 2). There are no exposures across the contact between these sediments and the volcanic rocks to the north, but several outcrops close to the contact are highly schistose, as if the contact zone had been a locus of shearing. North of the contact the southern 700 to 1,100 feet of the Cadillac belt is agglomerate, porphyritic andesite, pillowed andesite, and a few small bodies of diorite. The southern 400 to 600 feet of this assemblage is mainly agglomerate, but includes in its southern part several flows of pillowed andesite and porphyritic andesite as well as a few diorite dykes. All these rocks are moderately to intensely sheared.

To the north of the agglomerate, but separated from it in at least one place by 20 feet of pillowed andesite, is a band of grey- to brown-weathering, porphyritic andesite that increases in width from about 100 feet at the east side of the property to 300 feet at the west. It is in this rock that the most important mineral deposits have been found. The least sheared phases are distinctly porphyritic, with lath-shaped phenocrysts of albite one-quarter inch and less in length. However, in many places, and particularly in parts of the mine workings, it is sheared and carbonated to a brown or green schist or phyllite, retaining none of the original structures or textures. Brown biotite and ankeritic carbonate are the principal constituents of this altered material. A few small bodies of diorite intrude the porphyritic andesite.

At the mine the porphyritic andesite is bordered on the north by fine-grained, black to grey greywacke. The contact is apparently conformable and somewhat gradational, with a few feet of altered, tuffaceous material in some places along it. In other places it is marked by a narrow, graphitic shear zone. About 400 feet west of the shaft, however, normal, green andesite appears between the porphyritic andesite and the northern greywacke. To the west this lava increases in thickness to over 200 feet at the west boundary of the property and is well pillowed in some exposures. The greywacke to the north is only exposed in a few places. Apparently it attains a maximum width of about 200 feet. In one drill hole it includes a narrow bed of conglomerate, and this rock is known to be more abundant in the adjoining property on the west.

A drift-covered valley crosses the property from east to west, so that there are no exposures for about 800 feet north of the greywacke, except for a small exposure of highly sheared, tuffaceous conglomerate at the west boundary. Two drill holes were driven across the valley during the early development of the property, one northward from the 500-foot level of the mine and one southward from a point on the surface 1,200 feet north of the shaft. The writer has not seen the core, but old company records show about 800 feet of "periodite" beneath the valley, bordered on the south by greywacke and on the north by conglomerate. MacLean and Bell, who may have seen the cores, describe[1] 840 feet of "greenstone

[1] 1929, pp. 58 and 61.

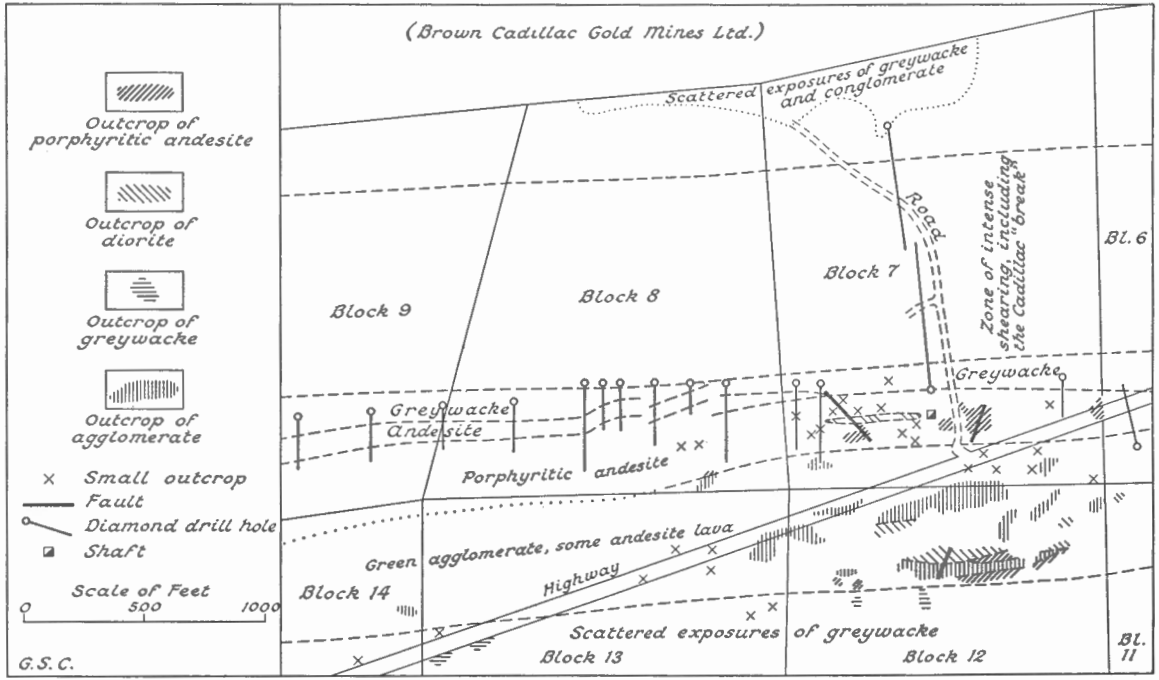

Figure 2. Part of Bouscadillac Gold Mines, Limited, Bousquet township, Quebec.

or basalt including the chlorite-talcose shear zone. The shear zone is not well defined, although much of the rock is extremely altered and foliated. . . . a relatively wide area has been contorted and much altered to schist, but there does not seem to be a localized shear zone within it. Several harder phases of greenstone occur within the sheared zone." It is known that this wide sheared zone must be the Cadillac break, which continues eastward through all the mines but one in Cadillac township and westward across Bousquet township. The two drill holes at Bouscadillac intersected 5 to 10 feet of quartz albitite near the middle of the sheared zone. This is the only intrusive rock other than diorite that is known on the property.

On the property the planes of schistosity are approximately parallel to the bedding of the strata; shearing is more pronounced in the northern half of the porphyritic andesite than elsewhere, except for the zone of the Cadillac break and for some narrow shear zones to the south. The strata are broken by a large number of cross faults, many of which are filled with calcite. One group of these faults strike northeast and their horizontal displacement is left-hand, that is, the southeast side is moved northeast relative to the northwest side. Most of the others strike in the northwest quadrant and their displacement is in the opposite direction or right-hand. Both groups dip to the east from 75 to 85 degrees, and are younger than the veins. Their horizontal displacements are usually less than 1 foot. One northwest fault, 350 feet west of the shaft, shows a displacement of several feet, and another, inferred from the positions of geological contacts 3,300 feet west of the shaft, has an indicated displacement of about 150 feet. The amount of vertical displacement on the faults has not been determined. Underground, a few faults of unknown but probably small displacement strike east, approximately parallel to the bedding of the strata.

MINERAL DEPOSITS

Gold has been found mainly in quartz veins and mineralized shear zones in the sheared porphyritic andesite. The veins are lenticular and narrow, rarely attaining widths of 4 feet. Besides some visible gold they contain small amounts of arsenopyrite, pyrite, pyrrhotite, and a little chalcopyrite. Tourmaline is present in places, but is not abundant. The sulphides are more abundant in the schistose, carbonated wall-rock than in quartz and occur principally as tiny crystals and blebs along the planes of schistosity. In places finely divided brown biotite imparts a distinct chocolate tinge to the mineralized rock, and this mineral is also found in small rosettes in quartz in a few places underground. Sericite is found in the schistose wall-rock and along some fractures in the quartz. Carbonation has proceeded by the formation of calcite and ankerite in the sheared porphyritic andesite and a late generation of calcite fills fissures that cut across the veins.

The original discoveries were known as the No. 1 and No. 2 veins. The latter is at the north contact of the porphyritic andesite 400 feet west of the shaft. It is a rusty zone about 9 feet wide in which there are several lenticular quartz veins parallel to the contact of greywacke on the north. Two other narrow vein zones, with maximum widths of about

5 feet, are exposed in several trenches 60 and 80 feet to the south. They may be continuous for lengths of about 200 feet. The southern of these is presumably the original No. 1 vein on which the shaft was sunk. In 1934 some native gold was discovered in another small quartz vein 160 feet south of No. 2 vein, and there are several other narrow mineralized zones elsewhere in the porphyritic andesite.

UNDERGROUND WORKINGS

The mine workings are almost entirely in porphyritic andesite. Quartz diorite is exposed on the third level for 25 feet north of the shaft, and several crosscuts have been driven north into the greywacke. A crosscut south from the shaft on the fourth level exposes 15 feet of agglomerate, the contact between it and andesite to the north striking due east and dipping 85 degrees southward. The width of the porphyritic andesite on this level is 195 feet, very close to its width of just over 200 feet at the surface. Underground, much of this rock, and particularly the northern 20 or 30 feet, is so highly altered and sheared that no trace of original texture remains. It then is a grey to brown schist or phyllite, with green shades where chlorite is present in quantity. All the more highly carbonated parts effervesce freely in dilute acid. The north contact is essentially vertical to the fourth level. The exact contact between schistose porphyry and greywacke is generally difficult to establish within a few feet; the contact is always schistose and in many places is marked by a narrow, graphitic shear zone.

On the first level, the mineralized zone has been developed over a length of 900 feet, with crosscuts to the north and south. On the second level a crosscut has been driven north to the greywacke contact and the northern 50 feet of the porphyritic andesite has been developed by drifts and short crosscuts for 100 feet east and 350 feet west of the main crosscut. The third level has a crosscut north to the greywacke and a drift for 100 feet to the east along the contact zone. The fourth level has been developed over a length of about 600 feet.

The deposits are narrow veins and lenses of white to dark bluish grey quartz with a variable small proportion of sulphide. Native gold was observed only in two places, in quartz. Sulphides are most abundant along the walls of the veins and in wider zones of the schistose rock where small quartz veins are abundant. Furthermore, in several places there are narrow seams of massive pyrrhotite or pyrite along the schistosity. The vast majority of the veins are vertical and parallel to the schistosity of the enclosing rock, are rarely continuous for more than a few tens of feet, and are only a fraction of an inch to 2 feet wide. There are also a number of narrow veins that lie nearly horizontal, dipping a few degrees to the south or west. They are of the same age and general character as the vertical ones with which they merge in some places.

Thin sections of typical mineralized andesite show a schistose rock largely replaced by carbonate and streaked with brown and white mica. The proportion of tiny, acicular crystals of arsenopyrite varies greatly, as does the amount of disseminated pyrite and pyrrhotite. Quartz is generally present as microscopic veinlets or distributed as tiny granules through the rock, probably entirely introduced at the time of vein forma-

tion. Chlorite is present in some sections. Tourmaline occurs as a few long prisms, parallel to or transecting the schistosity. It is the black, ferruginous variety.

Most of the veins in the mine are in the sheared porphyritic andesite some 20 to 30 feet south of the greywacke contact. However, additional veins and vein zones have been found for 120 feet south of the contact, and on the first level the entire 85 feet north of the shaft is moderately well mineralized. The massive greywacke to the north has not been found to contain any worth-while deposits. MacLean and Bell have reported as follows on the original underground workings: "the zone, where intersected by the north crosscut on the 125-foot level of the mine has a width of 85 feet. Values were found to be fairly consistent to within 5 feet of the faulted contact with greywacke to the north, but are completely terminated at this fault. Careful sampling and assaying showed a zone 70 feet wide which carries an average of $4.00 a ton in gold. Portions of the zone, up to 12 feet in width, carry values appreciably higher than the figures given. Although values were fairly well maintained throughout the length of a drift which was driven for 100 feet to the east of the crosscut on this level, diamond drilling has shown the body to be of limited extent to the east and west of the crosscut intersection. . . . More extensive lateral work, together with diamond drilling, failed to indicate the lateral or the downward continuation of the mineralized body to the lower levels of the mine. Where appreciable values were found below the 125-foot level, they seem to be more or less localized to the fault contact on the north. . . . The quartz vein (No. 1) on which the shaft was sunk narrows to a few inches on the first level."

It is reported that the resampling done in 1937 did not indicate any wide bodies of ore. The best results underground were obtained in the development of a quartz vein followed by a drift from 130 to 320 feet west of the shaft on the first level. The vein varies in width from a mere stringer to about 2 feet and is sparingly mineralized with sulphides. The adjoining sheared porphyry is well mineralized. There is visible gold in the vein about midway along the developed part. The company's consulting engineer stated in 1937 that the average gold content across 3 feet for a length of 110 feet was $5.07 a ton. Below this, on the second level, and 30 feet south of the greywacke contact, a vein that attains a maximum width of 2 feet is exposed in a drift for 110 feet, beginning 195 feet west of the shaft. It contains much pyrrhotite, but the writer saw no gold. No work has been done between the two levels. On the fourth level mineralized rock and a number of small veins have been exposed for widths of about 30 feet south of the greywacke, but no vein can be correlated with that in the two upper levels. Narrow veins of pyrrhotite with some pyrite are more abundant in the western part of the bottom level than elsewhere in the mine and there is less quartz. It has been reported that good values were obtained in drifts at the east end of this level, presumably in some of the numerous small veins exposed there. On the first level there is a little visible gold in a very narrow vein dipping 45 degrees to the south in a crosscut 340 feet west of the shaft. The vein is 115 feet south of the greywacke.

The 1937 drilling probed the north contact of the porphyritic andesite by thirteen holes from 400 to 2,600 feet west of the shaft. The rocks in the cores are mostly so highly metamorphosed that exact identification is

very difficult, particularly near the contact. However, the continuity of the porphyritic andesite for 2,600 feet west of the shaft has been established, though some cross faults of minor displacement are probably present. Quartz veins and associated sulphides occur in the northern part of the porphyritic andesite and in the highly altered greenstone to the north as far as the hole 2,050 feet west of the shaft. Arsenopyrite is present in abundance and some intersections show much chalcopyrite. The company's records show that gold is present in variable amount up to 0·61 ounce a ton in every hole but one. Several substantial widths of quartz were intersected. It may be concluded, therefore, that auriferous mineralization extends more than 1,600 feet west of the present mine workings. Experience in other mines to the east would suggest caution in concluding much as to grade, width, or continuity of individual shoots within the drilled area on the basis of drill intersections at intervals of 75 to 300 feet. Three holes drilled between the mine workings and the east boundary of the property found nothing more than a few narrow widths of very low gold content.

BRAWLEY CLAIMS

Claims A61015 and A61016 in northeast Bousquet township are owned by Jack Brawley, of Amos, and associates. There are no exposures on the claims, but they are between the properties of Thompson Bousquet and Westwood Cadillac Mines. It is reported that some diamond drilling was done on the southern claim in the winter of 1937-38 to probe the belt of rocks in which auriferous deposits had been found on the two adjoining properties.

BROWN BOUSQUET GOLD MINES, LIMITED

Brown Bousquet Gold Mines owns the unsurveyed claims A166 and A232 to A242, inclusive, lying immediately west of Bouscadillac Gold Mines. The property is an old one and prior to 1928 was developed by Montreal Exploration Company. A little prospecting was done in 1932 and 1934; in 1937 a campaign of diamond drilling was completed. Mr. Lloyd Almond was in charge of the 1937 work, under Julius Cohen, consulting engineer.

GEOLOGY

Most of the property is covered by swamp or deep overburden. Limited exposures near the highway and information on adjoining ground indicate that the southern half mile of the claims is underlain by greywacke of the Kewagama group. To the north the Cadillac belt of the Blake River group crosses the property from east to west. The width of these volcanic rocks is about 1,300 feet and there are fairly numerous exposures on the western half of the claims. Grey to green, andesitic agglomerate forms the southern half of the belt, the thickness increasing from about 600 feet on the east to at least 800 feet on the west. The southern contact is not exposed on the property. North of the agglomerate is porphyritic andesite, 450 feet thick, bordered on the north by about 250 feet of greenstone. The latter is pillowed in part, and a single exposure at the north

contact shows andesitic flow breccia in conformable contact with micaceous greywacke. The flow breccia is the north edge of a massive andesite flow over 40 feet thick. A few small exposures of diorite in the greenstone are probably parts of intrusive bodies.

North of the volcanic rocks, along the south side of a drift-filled valley, there are a few small outcrops of greywacke and conglomerate, indicating a thickness of about 300 feet of sediments. All the above strata strike due east and dip vertically. The valley to the north has been shown by the 1937 drilling to be underlain by schists and intrusives of the Cadillac break, to be described in greater detail below.

In the extreme northern part of the property there are a few small outcrops of greywacke of the Cadillac group. It seems probable that similar strata and some beds of conglomerate extend about 1,000 feet south from the north boundary of the property. From 1,000 to 1,500 feet south of the boundary there are five known exposures, three near the east boundary and two 1,000 feet from the west. All consist of highly sheared conglomerate, very different from the normal conglomerate of the region. Small and large pebbles drawn out into thin discs form a large proportion of the rock. Greywacke, felsite, feldspar porphyry, diorite, and a rock rich in biotite, which resembles the porphyritic andesite of the Cadillac belt, are represented in the pebbles. Unusual for the area is the large proportion of green pebbles, now reduced to soft chlorite and biotite schist and greatly elongated. They impart a green hue to the rock and form from 25 to 50 per cent of the whole. The rock is much more fissile than any other conglomerate known to the writer in the region.

DIAMOND DRILLING IN THE CADILLAC BREAK

Some fourteen drill holes put down under the valley have probed an area 300 to 600 feet wide for 1,750 feet from the east boundary of the property. They show that massive greywacke and conglomerate extend about 300 feet north from the edge of the Cadillac belt. North of this is a thickness of over 700 feet of highly schistose rocks cut by irregular, intrusive bodies. The latter are grey to white and include dense, porcelaneous quartz albitite, feldspar porphyry, and quartz-feldspar porphyry. As many as nine bodies from 3 to 50 feet wide were cut in one section of the shear zone, and one body is over 100 feet thick. The only feldspar identified in these rocks is albite, ranging from An_2 to An_{10}. Quartz is present in minor amount in the groundmass of some bodies, as resorbed phenocrysts up to 2 mm. in diameter. Phenocrysts of albite and quartz are in part broken and veined by the groundmass. Very minor accessories include biotite, chlorite, apatite, magnetite, carbonates, rutile, and sulphides. The rocks they intrude are chiefly chlorite and mica schists, partly carbonated and in places talcose or tourmalinized. They are presumably derived from mixtures of greywacke, andesitic lava and tuff, and the schistose conglomerate referred to above. A few harder bands may be tuff, and at least one small, relatively fresh, lamprophyre dyke was cut in the drilling.

In most places the sheared zone is bordered sharply on the south by hard, massive greywacke or conglomerate. The most intense shearing seems to have taken place across a width of 200 feet or less toward the

middle and south side of the zone. However, highly schistose conglomerate is known to extend north of the drilling, and there are, in some holes, considerable widths of harder, less schistose strata within the most intensely sheared sections. It may be inferred, therefore, that the shear zone varies greatly in width and intensity of shearing at different places along its length. No doubt some of the many sections of lost core represent gouge-filled fault planes within the wider shear zone. Some of the quartz albitite is converted to talcose sericite schist and the porphyritic intrusives are fresh and massive or slightly brecciated and silicified. The drilling shows that the intrusives are of very irregular outline, which also characterizes them in most places to the east where the Cadillac shear zone has been explored underground.

MINERAL DEPOSITS

The original showings on the property consisted of quartz veins and several sulphide replacement bodies in and north of the belt of porphyritic andesite. These showings have been described by Bell and MacLean, and what little work has been done on them since has not indicated them to be of any commercial importance. In the 1937 drilling, narrow quartz veins, some of them accompanied by arsenopyrite, pyrite, pyrrhotite, and tourmaline, were intersected at many places. One hole, No. 6, recovered small particles of free gold in quartz with some sulphides at two places, 238 and 241 feet from the collar. The auriferous quartz is in biotite greywacke a few feet south of an 8-foot dyke of dense, white quartz albitite that is also veined by quartz. Samples of the mineralized part of the core without visible gold did not yield commercial assays. Tourmaline is abundant in schist for 1 foot south and 7 feet north of the quartz albitite body. On the north the tourmalinized rock is bordered by a zone of very soft, compact, talc-chlorite schist that probably should be considered as representing the south edge of the main Cadillac shear zone. In other drill holes many of the smaller bodies of porphyry are veined by quartz stringers and moderately well mineralized with pyrite, pyrrhotite, and arsenopyrite. However, most of these sections do not seem to contain an appreciable gold content. The best gold content was found in the lowest intersection of quartz albitite in hole No. 4. A section of core 1·2 feet in length is reported to have assayed $4.55 a ton and 4 feet adjoining this averaged $1.75. Gold was calculated at $35 an ounce. The dense white rock is sparingly sprinkled with finely crystalline arsenopyrite and pyrite.

It may be noted that less than half of the length of the shear zone within the property has been probed by drilling, and that a large part of the rest of the property is so heavily covered by overburden that practically nothing is known of its mineral possibilities.

BROWN CADILLAC MINES, LIMITED

This company owned claims A55932 to A55938 and A62465 to A62467 immediately north of Bouscadillac Gold Mines, in eastern Bousquet township. Surface work and 2,575 feet of diamond drilling in five holes was done in 1937 under the supervision of R. C. Bryden and Dan Paquin. The company went into bankruptcy in November 1938. There are excellent camp buildings on the claims.

The eastern half of the group is high and rocky ground, but the western is low, wet, and almost completely devoid of exposures. Conglomerate of the Cadillac group outcrops on a hill in the south-central part for 500 feet north of the south boundary, but apparently pinches out rapidly to the west. To the north of the conglomerate there are scattered exposures of greywacke for about 3,000 feet west of Cadillac township. The strata are approximately vertical and strike nearly due east. From 600 to 1,000 feet north of the conglomerate there are narrow layers of iron formation, chiefly magnetite, in the greywacke. Two or more narrow dykes of diorite intrude greywacke in the northeast claims and the sediments there for at least 1,000 feet west of the township line are partly amphibolitized, so that they in places resemble diorite. Besides the usual large number of oblique faults of minor displacement there are several bedded shear zones from a few inches to a foot or so across. One of these on the north boundary of claim A55932 displaces the northern end of a small quartz-tourmaline vein 6 inches to the east.

Many quartz veins have been found on the property; several contain tourmaline and some pyrite. Two showed considerable arsenopyrite. One of these is in the middle of claim A62465. A zone from 10 inches to 10 feet wide along the strike of greywacke is exposed for 50 feet, and may be continuous through other exposures for another 110 feet. Thin magnetite beds occur in the greywacke. The strata are vertical and the mineralized zone is defined by two fault planes along which there are thin layers of gouge. The walls show grooves and striations that pitch at 65 degrees to the east. The zone is best exposed in a 12-foot pit at the west end of the stripped area. Across 6 to 7 feet on the north side of the pit there are irregular, flat-lying veins and lenses of quartz, moderately rich in pyrrhotite and with lesser amounts of arsenopyrite, pyrite, and chalcopyrite. The quartz is bluish grey to white and with it are chlorite, green biotite, and small fibrous sheaves of tremolite. The greywacke above and below some of the quartz lenses is silicified and heavily charged with pyrrhotite and crystals of arsenopyrite, particularly for about 3 feet at the north side of the mineralized zone. The intensity of mineralization varies greatly down the walls of the pit. The sulphide impregnation has spread up and down the bedding for short distances from the quartz bodies. The bottom of the pit is much less heavily mineralized in this way than are the walls 3 feet above.

Mr. Paquin reports that grab samples from the pit generally contain some gold, and that one sample assayed $61.90 a ton. A drill hole did not cut the zone about 125 feet below the pit.

Along the south boundary of claim A55932, 180 to 400 feet west of Cadillac township, the greywacke is amphibolitized and intruded by small dykes of diorite. Joint planes in the diorite and greywacke are filled by veins of quartz and tourmaline with some arsenopyrite. The largest vein is 2·5 feet wide, strikes northeast for 20 feet across diorite, and then turns east to disappear under drift. It carries much black tourmaline and irregular small pockets of fine-grained arsenopyrite.

CALDER-BOUSQUET GOLD MINES, LIMITED

Calder-Bousquet Gold Mines owns twenty surveyed claims north of Kiekkiek Lake and straddling the highway. The numbers are A37292 to A37301 and A54650 to A54659. The first ten claims are the old Clement-Manning group, on which a discovery of gold in 1932 attracted considerable attention. In that year they were optioned to Noranda Mines and surface work and diamond drilling was done. The other ten claims, to the west, were worked by M. J. O'Brien interests at about the same time. Both options were relinquished and the whole property was optioned in 1934 by Minefinders, Limited. This company did 3,153 feet of diamond drilling and much surface work before relinquishing their option. In 1936 the present company sank a shaft on the main showing and did a small amount of development work on levels at depths of 70 and 125 feet. Additional work in 1938 consisted of 5,190 feet of diamond drilling and surface work. Mr. E. J. Thompson has been in charge of the recent work.

GEOLOGY

The northern claims are underlain by greywacke of the Cadillac group, the southern by greywacke and conglomerate of the Kewagama group. Between the two lies the Cadillac break and some greenstone of the Cadillac belt. The break has been cut in drill holes on claim A37294 and consists of about 150 feet of serpentine and soft schist, dipping steeply to the north. It is 100 feet wide in another drill hole half a mile to the west. Beyond that it may be cut off for some distance by an intrusive body of porphyritic granite. To the east it probably continues to connect with a drill intersection on Norgold ground. Greeenstone is exposed in two small outcrops on claim A37294, just north of the break, and was cut in drill holes, on the north side of the shear zone. The regional strike of the beds is nearly due west, but the sediments south of the break, particularly on claims A37294 and A54650, are highly contorted, so that for some distance southwest of the shaft their average strike is more nearly southwest. Exposures are poor and details of the structure between the Cadillac break and the known east end of the Kiekkiek Lake fault are by no means clear.

MINERAL DEPOSITS

There are two principal discoveries and a number of others that have received less attention. The main one is at the shaft on claim A37294. In several old trenches 650 feet west of the shaft quartz veins and stringers are typical of the Cadillac type of deposit, except that ankerite and fine-grained pyrrhotite are slightly more abundant than usual. Several of the veins contain pyrite, pyrrhotite, arsenopyrite, and chalcopyrite, and in places the adjoining sediment is replaced by ankerite. Arsenopyrite, as usual, is more abundant in the schistose walls than in the quartz. In one place an area about 15 by 15 feet is well mineralized with irregular veins of quartz and carbonate. This is on the nose of a sharp drag-fold in greywacke and conglomerate, where the strike changes suddenly from west to southwest. A width of 8 to 10 feet on the bend is most heavily mineralized. Some mineralization of this kind is exposed in several trenches for a total length of about 140 feet.

There are no exposures around the shaft, which was flooded at the time of the writer's examination. Material on the dump includes much siliceous, grey to black, argillaceous greywacke, in part replaced by black hornblende and actinolite. There is also massive, black amphibolite that might be intrusive. Vein material is grey quartz and ankerite with an unusual amount of finely intergrown pyrrhotite and lesser amounts of pyrite, chalcopyrite, and arsenopyrite, the latter chiefly as fine needles in the sericitized and biotitized wall-rock. Veins of white calcite cut the quartz and ankerite. Some specimens containing visible gold were found.

Maps supplied by the company show that the shaft was sunk to investigate two lenticular vein zones indicated by drilling to lie just south of the Cadillac shear zone. One was thought to be about 300 feet long and of variable width up to 40 feet. The other, to the northeast, seemed to be about 180 feet long and up to 25 feet wide. L. V. Bell (1936) has reported that a mineralized zone was cut on both levels in the shaft, and that on the 70-foot level a crosscut to the south returned moderate gold values across a fairly substantial width. The results obtained on the second level are not known to the writer, but presumably they were not very encouraging, as the operation was suspended.

Another showing is exposed in trenches in the southeast corner of claim A37301, 4,500 feet east of the shaft. At this place, greywacke and possibly a few beds of tuff are intensely carbonated across widths that vary from a few feet to about 60 feet. The zone follows the strike of the sediments. Associated with the rusty weathering carbonates are flakes of green, chrome-bearing mica. The zone is cut by a few, small, lenticular veins of quartz. Substantial widths, as great as 7 or 8 feet, are well mineralized with disseminated pyrite and arsenopyrite. The zone continues for at least 500 feet on the property, and is known to the east on Norgold ground. Mr. E. J. Thompson says that only a very small amount of gold is found in the mineralized material. Similar material is exposed in a trench to the north, 3,500 feet east of the shaft.

A number of small veins have been found 4,000 feet and more west of the shaft, on claims once developed by M. J. O'Brien interests. None of those exposed seems to hold out much hope of producing an ore-body. In 1938 a drill hole was put down to the west of north from the southeast corner of claim A54659 to pass under a small, southwest-trending valley. The hole was inclined at 35 degrees and was entirely in greywacke. From 207·5 to 214 feet it cut a series of small quartz veins with associated pyrite, pyrrhotite, and chalcopyrite. Core of the first 3 feet is reported to have assayed $11.20 a ton, and the next 4 feet over $7. Drill holes on claim A54653 probed the east end of a body of porphyritic granite, and one of them intercepted the Cadillac break. No valuable mineral deposit was found. A number of trenches to the east show that the granite is well fractured and cut by small and irregular veins of quartz, and small aplite dykes. An included layer of greywacke, a few feet north of the south contact of the granite, is cut by quartz veins and moderately well mineralized with sulphides across widths of 18 inches and 9 feet, respectively, in two trenches 100 feet apart. Arsenopyrite is present. The writer is indebted to Mr. Towsley, who was in charge of operations for the company, for information on the 1938 operations and for guidance in examining

the surface work. The latter also included some trenching and drilling in the southeast corner of claim A54650. At this place several trenches expose an erratic deposit of quartz, arsenopyrite, and other sulphides in greywacke and conglomerate. Widths are substantial, as much as 14 feet in one place, but it is reported that the gold content is low.

CASSELS DUVAL MINES, LIMITED

Cassels Duval Mines, Limited, owns twenty surveyed claims in the north-central part of Bousquet township. The claim numbers are A438 to A442, A57924, A62924 to A62932, A64665, and A66109 to A66111. Cassels Duval Mines also holds an option on the Robert Vaughan claims, Nos. A62099 to A62104, A64705 to A64709, and A66900 to A66903, south and west of the parent property. The discoveries that led to the recent activity were made on claim A62928 in July 1936 by T. G. Duval and W. L. Cassels. Several camp buildings were erected, the discoveries were stripped, trenched, and sampled, and over a dozen holes were drilled within a year, besides which the whole property was prospected and examined by dip needle from a series of survey lines 300 feet apart. In the autumn of 1937 Agaura Explorations, Limited, wholly owned Canadian subsidiary of United States Smelting, Refining, and Mining Company, optioned 52 per cent of the company's stock and took over development under the direction of A. W. Derby and W. H. Graves, jr. Additional surface work and much diamond drilling led, late in 1938, to the sinking of a three-compartment shaft in the north-central part of claim A57924. Early in 1939 levels were established at depths of 285 and 455 feet.

GEOLOGY

The claims are underlain by volcanic rocks of the Blake River group, exposed in outcrops separated by gravel flats and large areas of swamp, and intruded by the Mooshla quartz diorite body on the south. The north contact of the latter passes through the middle of claim A57924, the southern claim of the property. Sediments of the Kewagama group underlie the extreme northeast corner of the property.

The volcanic rocks are chiefly andesite and dacite flows with associated layers of tuff and agglomerate of the same composition. Fragmental varieties were noted chiefly in the southern part of the property. Many flows are pillowed, others are amygdaloidal, a good many exhibit flow breccia at their margins, and several of those over 20 or 30 feet thick are holocrystalline rock of dioritic appearance that might easily be mistaken for dykes. Except near the mine workings and the vicinity of the quartz diorite contact they are massive and remarkably fresh looking on the surface, but microscopic study shows them intensely altered to a mass of secondary minerals, chiefly chlorite and epidote. Less abundant are hornblende, zoisite, magnetite, pyrite, titanite, and carbonate. The quartz content varies from about 5 to 20 per cent. Except in two thin sections of dioritic andesite that contained albite-oligoclase, the original feldspar where not altered beyond indentification is nearly pure albite, An_2 to An_5. The texture of most of the lavas is trachytic; in some, quartz and feldspar are intergrown as micropegmatite. A few hundred feet north of the shaft

there are several exposures of white to rusty weathering quartz porphyry, forming lenticular sheets parallel to the bedding of the lavas. The rock is moderately schistose and contains rounded phenocrysts of quartz, and some of albite, in a sericitized matrix of quartz and feldspar. The phenocrysts seldom attain diameters of over 2 mm. The rusty surfaces are due to the weathering of disseminated pyrite and pyrrhotite. They continue to the east in a zone some 500 feet wide. In the available exposures the writer was unable to prove whether they are intrusive or extrusive. They closely resemble schistose rhyolite flows in other parts of the area and are, therefore, tentatively considered as lava. If intrusive, they are more schistose and, therefore, probably older than the other acid intrusives of the region (*See* pages 20 and 21). The greatest single thickness exposed is 10 feet, but greater thicknesses have been cut in drill holes.

The Mooshla "granodiorite" body is described on pages 24 and 25. Its north contact is not exposed on Cassels Duval ground, but must lie under swamp some 800 feet south of the shaft. The volcanic rocks to the north strike on the average 10 to 15 degrees north of west and dip 70 to 80 degrees to the south. At the mine, however, there is at least one deflexion of strike, from about due east on the west to 20 degrees south of east on the east. This curvature is parallel in a general way to the north contact of the intrusive mass, so far as can be told from the meagre exposures. The dips at the mine are also somewhat flatter than normal, as low as 60 degrees to the south in some places near the deflexion in strike. These facts and the shape on the surface of the intrusive mass suggest that the latter is sill-like and that its north contact may be found to dip southward in approximate conformity with the dip of the adjoining volcanic rocks.

MINERAL DEPOSITS

The shaft is 500 feet south of the north boundary and 720 feet west of the east boundary of claim A57924. It is at the south edge of a timbered knoll of greenstone, on which the auriferous deposits were discovered. The country rock is a series of green flows and pyroclastics, the latter most abundant in the southern 250 feet of the exposures. As mentioned above, the strike swings south of east about the middle of the area and the principal deposit has been found at and southeast of the point of deflexion. The observed dips vary from 60 to 80 degrees to the south. A few narrow sheets of quartz porphyry are exposed at intervals on the north side of the knoll. Otherwise the volcanic rocks were presumably andesite to dacite originally. They are now pale to dark green or grey. A few show recognizable pillows, but many are fine-grained and quite structureless. Their original characteristics are masked by the effects of alteration and mineralization. Much of the rock has been charged with fine-grained, disseminated magnetite, producing massive to poorly layered, speckled types that at first glance resemble fine-grained diorite. In addition, there are many white- to grey-weathering blotches that are due to partial silicification. These alteration effects are more pronounced in the southern part of the exposures; to the north the flows are of fresher appearance and many individual layers range from 5 to 20 feet in thickness, somewhat thinner than to the south. Along and north of the west showing some of the pale green lavas exhibit a peculiar structure. Irregular clusters

of white zoisite crystals and grains, from less than an inch to 5 or 6 inches across, are promiscuously scattered through the rock to produce a striking mottled effect. Presumably, the zoisite formed during the alteration that preceded the formation of the auriferous veins, and, although not restricted to any one flow, the clusters do occur most abundantly in a zone some 40 feet wide that conforms approximately with the strike of the lavas.

The auriferous deposits are narrow veins of quartz that contain variable amounts of chalcopyrite, pyrite, and pyrrhotite. In addition, pyrrhotite is generally disseminated in the wall-rock and is accompanied by a little chalcopyrite. There is native gold in the veins, but it is finely divided and very little is visible to the naked eye. The individual veins are rarely over an inch or two wide and none seen by the writer exceeded 6 inches.

The original discovery is now known as the west showing. It is a zone some 5 feet and less in width, containing one to several narrow, closely spaced veins. The zone is an inconspicuous shear that strikes about 10 degrees south of east and dips southward in conformity with the attitude of the enclosing rocks. It has been exposed in eight trenches for 300 feet east from the northwest end of the hill of greenstone. Samples taken by the company from the trenches indicate a commercial gold content across widths of 2 to 5 feet. Several drill holes have intersected the zone at depth. Other less continuous veins of like character have been found to the north and east of the west vein zone.

The main vein zone is 300 feet southeast of the west showing. It has been developed by trenches, drill holes, and underground workings on two levels from the shaft, over a surface length of 350 feet. Narrow quartz-sulphide veins like those in the west showing are closely spaced in a broad zone that strikes southeast, cutting the strike of the volcanic rocks at an angle of about 25 degrees. At the northwest end of the surface exposures the veins are irregularly curved and many minor "folds" plunge southeast at angles varying from zero to 60 degrees. In this part the zone is bulbous in surface plan, with a maximum diameter of 90 feet. To the southeast the zone narrows to widths of 25 to 40 feet and the constituent veins strike along the vein zone and dip vertically to very steeply north. Most of the widest part of the zone lies within a massive, 60-foot bed of lava. The base or north contact of the flow is sheared and the veins do not extend north of the shearing. It is reported that the average gold content of the zone is $3 to $6 a ton, and that it is greater in some places.

The underground work, done since the writer's examination, has been studied by E. W. Shaw, the company's geologist, to whom the writer is indebted for the following information. It has been established that the northwest end of the main vein zone plunges southeast at approximately 50 degrees, the plunge being determined by the intersection of the near-vertical zone of veins with the south-dipping, sheared, north contact of the massive flow. On the first and second levels the mineralization is most intense and the gold content highest for lengths of about 160 feet at the northwest end of the zone, across widths of 10 feet and more. On the first level the grade is much higher than average within a few tens of feet of the northwest end. To the southeast the intensity of veining decreases gradually and the gold content falls off accordingly. A crosscut to the

south from the east end of the first level encountered a second vein zone 60 feet southwest of the main one and overlapping it *en échelon*. Its width is about 6 feet. On the second level this zone is wider and has been drifted on toward the adjoining Mic-Mac claims, where it is known from diamond drill holes. The west vein zone has been explored for 340 feet on the first level and consists of very irregular, curving quartz veins along a bedded shear in greenstone. It has been followed, without much encouragement, for about 200 feet on the second level.

A few, barren, white quartz veins have been found in and near the main zones. They contain small amounts of calcite, tourmaline, and epidote, and striking black plates of ilmenite. They are later than the auriferous veins.

CASSELS DUVAL SYNDICATE

This syndicate owns sixteen claims in a square block immediately west of the property of Cassels Duval Mines, Limited. The claim numbers are A64911 to A64914, A66459 to A66463, and A66606 to A66612. The claims have been prospected and examined by dip needle along lines run north and south at intervals of 300 feet. A limited amount of stripping and deep trenching has been done.

Exposures are not abundant. Presumably, the claims are underlain almost entirely by lavas and pyroclastics of the Black River group. These strata strike north of west and dip steeply south. The north contact of the Mooshla quartz diorite lies about 300 feet south of the southeastern claim and the porphyritic contact phase extends just on to the property. The general succession within the Blake River rocks may be assumed to correspond fairly closely with that on the property to the east.

The dip needle work indicated a number of magnetic zones, most of them probably caused by concentrations of magnetite along horizons of the volcanic rocks. Several veins of white quartz in the northern part of the property are barren. Most work has been done in stripping and trenching a small area on claim A64911, 1,300 feet north of the south boundary of the property, where the south contact of a body of quartz porphyry has been exposed for a length of 100 feet. The intrusive is bordered on the south by andesite cut by one, small, irregular dyke of the same porphyry. The main porphyry mass, across the exposed width of 10 feet, is traversed by a few small veins of quartz and chalcopyrite. One hundred feet to the east a trench to the south is in pyritic, epidotized andesite, cut by a few small veins of quartz and chalcopyrite and partly replaced in one narrow zone by magnetite. There are also drusy veins of pink and white calcite.

The quartz porphyry is probably a dyke related to the quartz diorite mass to the south. It carries grey to iridescent eyes of quartz and some of albite in a dense, slightly schistose matrix, now altered to sericite, carbonate, and chlorite. Some of the chlorite is pseudomorphic after hornblende and much of it rims disseminated grains of magnetite. The rock weathers pale grey to white and is exceedingly fine-grained.

CLÉRICY CONSOLIDATED MINES, LIMITED

In 1937 this company held and prospected a large block of ground in eastern Joannès township, from the Bousquet boundary to lot 52, range VI, and to lot 56, range VII. They included most of the showings on the old Polson group, including the drusy quartz vein zone in the north-south fault in lot 56, range VI (*See* page 50). Other earlier work includes several drill holes beneath a quartz-veined zone in greywacke in lots 61 and 62, 3,700 feet south of the highway. The large outcrop there is bordered on the south by a steep drop to low ground, and the greywacke is highly contorted, many minor drag-folds plunging at about 45 degrees to the west. Quartz veins of extreme irregularity occur abundantly across widths of 15 feet and more, and carry a little pyrite. The drill holes did not encounter any valuable material, but did cut a zone of pronounced shearing, 15 to 30 feet wide, that must underlie drift at the north edge of the large exposure.

Some drilling has also been done in the past in the southern part of lot 58, where greenstone is cut by dykes of quartz albitite. The drilling is reported to have yielded nothing of commercial importance. Most of the work was done under the supervision of W. J. Hosking, and the writer is indebted to him for records of it.

CLERNO MINES, LIMITED

In 1937 this company prospected most of the ground between lots 47 and 53, rge. VI, Joannès tp. Several drusy quartz veins were found south of the highway, and some veins of the Cadillac type north of the intersection of the highway and railway. The most important of these is a vein zone in lot 56 that was stripped for a length of 120 feet. It is an irregular zone of quartz stringers about 12 feet wide in contorted, partly amphibolitized greywacke, but many of the stringers and veins follow drag-folds in the greywacke and are probably very discontinuous and fairly flat-lying. Mica and a very small amount of sulphides accompany the quartz. It is reported that the zone contains some gold.

DECOEUR-BOUSQUET

This is the name applied to claims A39711 and A40213 to A40217 in western Bousquet township. Work was done on them in 1938 under the direction of W. J. Hosking of McWatters mine. The principal showing is on claim A40215, 800 feet north of Kiekkiek Lake. The claims include part of the old Polson group that extended into Joannès township.

They are underlain by greywacke and conglomerate of the Kewagama group. A large dyke of quartz gabbro passes through their northwest corner. Irregular tongues of carbonate rock extend into the property from the east, where a large area of sediments is carbonated. The main showing consists of a shear zone in greywacke that has been followed by trenching for 650 feet. It is mineralized with quartz and sulphides, including arsenopyrite, and the rocks along it are carbonatized. The old trenches are largely caved, but widths up to about 15 feet of veined and mineralized

rock are reported with narrower widths of more intense mineralization within the wider zone. In 1938 several drill holes were put down to cut the zone. It is stated that encouraging gold values were obtained at the surface, but that the cores from the mineralized shear zone were disappointingly low in gold. The shear zone may be a branch of the Kiekkiek Lake fault, for a depression continues half a mile east-southeast from the trenches to the shore of the lake and there are a few quartz veins along its edge.

Some gold is said to occur in a pit 1,000 feet to the north, on the east boundary of claim A40213. The pit shows 4 feet of quartz stringers in schistose greywacke dipping 45 degrees and less to the north. The host rock is well mineralized with pyrite and arsenopyrite.

DOREVA GOLD MINES, LIMITED

Doreva Gold Mines, Limited, owns a large group of claims in the middle of Bousquet township. The chief development is on claim A36376 between the highway and Bousquet River, half a mile east of the centre line of the township. In 1936 and 1937, following surface work and diamond drilling, a shaft was sunk to 210 feet and about 350 feet of drifting and crosscutting was done from near the bottom. Excellent camp buildings stand on the south bank of Bousquet River and an auto road a mile long connects with the main highway at the township centre line.

The southern half of the claim is high, timbered ground, part of an east-west ridge underlain by conglomerate and greywacke of the Kewagama group. The northern contact of the group is approximately the north side of the ridge where it drops into a small valley. Several exposures of bedded tuff and some of diorite are there visible, the tuff apparently interbedded with greywacke to the south. The writer interprets these exposures as representing the south contact of the Cadillac belt, which is here about 500 feet thick, but poorly exposed. A large outcrop 250 feet south of the shaft consists of pillowed andesite and dacite, and there are three exposures of greenstone 500 feet to the southeast, on the north side of the small valley. The north contact of the belt must lie between the shaft and the oucrop of pillowed lava, and probably is very close to a prospect pit 500 feet south of east from the shaft. At this pit sericitic schist and phyllite are exposed, and small quartz veins are said to be auriferous. On claims to the west there are a few small exposures of schistose and carbonated rocks that presumably were tuffs originally.

The shaft is sunk in a bed of conglomerate about 35 feet thick, exposed for a few feet in a small stream 60 feet west of the collar. A drill hole passed through 70 feet of greywacke north of the conglomerate and penetrated, for 65 feet, a zone of soft sericite-carbonate schist. This zone the writer interprets as the south edge of the Cadillac " break ". Between the conglomerate and the lavas to the south there is at least 170 feet of fine-grained, argillaceous greywacke, in part converted to sericite schist. Carbonaceous layers in the lava to the south are in part converted to graphitic schist. The exact width of the shear zone has not been determined. So far as known the rocks north of it are all fine-grained sediments of the Cadillac group, with several beds of magnetite north of Bousquet River.

The shaft was sunk to investigate a vein zone said to have contained some spectacular native gold at the surface. The original exposures are now covered by debris. At a depth of 150 feet a crosscut runs southeast to the south contact of the conglomerate. Just south of the contact a strong shear zone has been followed by drifts to the east and west for a total distance of 185 feet. The shear strikes north 80 degrees east, is essentially vertical, and varies in width from 5 to 15 feet. The rock in the shear is largely grey and black sericite schist and phyllite, and a well-defined graphitic fault plane marks the south side. The schist is cut by stringers, lenses, and very irregular veins of bluish grey quartz. It is also erratically mineralized with disseminated arsenopyrite, pyrite, and pyrrhotite, and there are small amounts of these minerals in some of the quartz veins. In a brief examination the writer found no native gold, but the management reports that substantial amounts were encountered during the drifting. No average values have been announced. No veins of seeming importance were found in a crosscut 85 feet south from the drift.

The company also owns claims A53067 and A53068, 4,000 feet north of the shaft. On the boundary between them, 1,500 feet north of the river, iron formation occurs in greywacke across a width of 25 feet. In 1936 the showing was stripped and drilled by Robert Vaughan, the previous owner. The iron formation is largely narrow beds of magnetite in greywacke, but the southern 5 feet is particularly siliceous and is cut by irregular, drusy quartz veins. Pyrite fills numerous fractures in this part of the formation and it is reported that some of the material is auriferous.

The old Sagamore property at the east end of the north shore of Kiekkiek Lake is now controlled by Doreva Gold Mines. It was originally known as the Cavanagh group and was developed before 1934 by McIntyre Porcupine Mines. In 1934 an adit was driven north from the shore by Golden Quebec Mines, Limited, and some drifting was done from the adit.

The hill under which the adit was driven is composed chiefly of argillaceous and siliceous greywacke striking due east and dipping steeply southward. Interbedded with the greywacke are narrow beds of conglomerate and several lenticular bands, up to 20 feet thick, of amphibolite. There are also a few exposures of rusty weathering, grey tuff with distinct angular fragments. As pointed out elsewhere, these strata are probably part of the Cadillac belt and they lie not far south of the main Cadillac shear zone. They are broken by faults that strike north 60 degrees west and dip steeply northeast or are vertical. No displacement of more than a few feet was determined, and in each case the northeast side has moved southeast, relative to the northwest. Apparently the vein for which the adit was driven is represented by a narrow shear zone striking north 75 degrees east. Along the shear on the surface are narrow lenses and discontinuous veinlets of quartz. In an alongside these are small amounts of pyrite, pyrrhotite, arsenopyrite, chalcopyrite, ankerite, and white mica The mineralized shear can be traced for 300 feet on the surface. Its western continuation has been developed on Norgold ground to the west without success. The adit is caved near the portal.

CLAIMS OF J. M. GIBEAU

Mr. J. M. Gibeau of Noranda owns claims A58732 to A58752 and A61239 to A61240 in the northwest corner of Bousquet township. The claims are south of those belonging to E. J. Thompson, and extend east from the west boundary of the township. No work was being done on the property in 1937 and 1938 when the writer visited it. L. V. Bell (1930, page 35) discussed part of the property as the Perriard-Continental claims. He describes five quartz veins and stringers in a trench that is still visible about 1,500 feet east of Joannès township and 1,000 feet south of the Thompson claims. The maximum width of quartz in any vein is 3½ feet. Tourmaline and some pyrite accompany the quartz. Bell states that three diamond drill holes had been bored beneath the exposures, that they intersected similar quartz veins and stringers, and that assay results from these were reported as for the most part below $1 a ton in gold. He notes that gold was seen in a specimen from one of the veins. The present writer noted several other quartz veins during routine mapping of the area, most of them in rhyolite. They attain widths of 3 to 6 feet, but are either barren or contain only a little pyrite; some have black tourmaline and albite intergrown with the quartz. About half a mile east of the Joannès boundary the north edge of large exposures of rhyolite is strongly sheared and contains some lenticular veins of this kind, devoid of metallic minerals. Two diamond drill holes have been bored beneath these showings, presumably also to pass beyond them and probe the drift-covered ground to the north.

As can be seen from the accompanying map (Sheet 2), the greater part of the claims is underlain by rhyolite. Narrow widths of rhyolite also occur in a band of andesite some 1,500 feet wide that enters the property from the west and noses out in rhyolite 2,800 feet to the east. As noted on pages 13 and 34, the structure of this part of the area has not been satisfactorily determined.

JOANNÈS DAVIDSON MINES, LIMITED

This company is reported to own twenty unsurveyed claims in ranges VII and VIII in the west half of Joannès township. Surface work and diamond drilling were done on the east side of Davidson Creek, in range VII, in 1937 and early in 1938 under the supervision of W. J. Hosking, to whom the writer is indebted for information on the property.

Near the workings is an area of bush-covered, high ground on which there are scattered exposures of greywacke and conglomerate, in places converted to amphibolite. Some of the beds of arkosic greywacke are garnetiferous. Figure 3 embodies the results of detailed mapping done for the writer by Mr. D. A. McNaughton in 1938, in an effort to unravel the complicated structure.

The mapping suggests that conglomerate and greywacke are folded into an overturned syncline that plunges at about 60 degrees to the northwest. To the southwest the beds strike northeast, parallel to the Davidson Creek fault, and dip to the northwest. A shear zone that varies in width from 2 to 15 feet cuts the northeast limb of the fold. It strikes a little

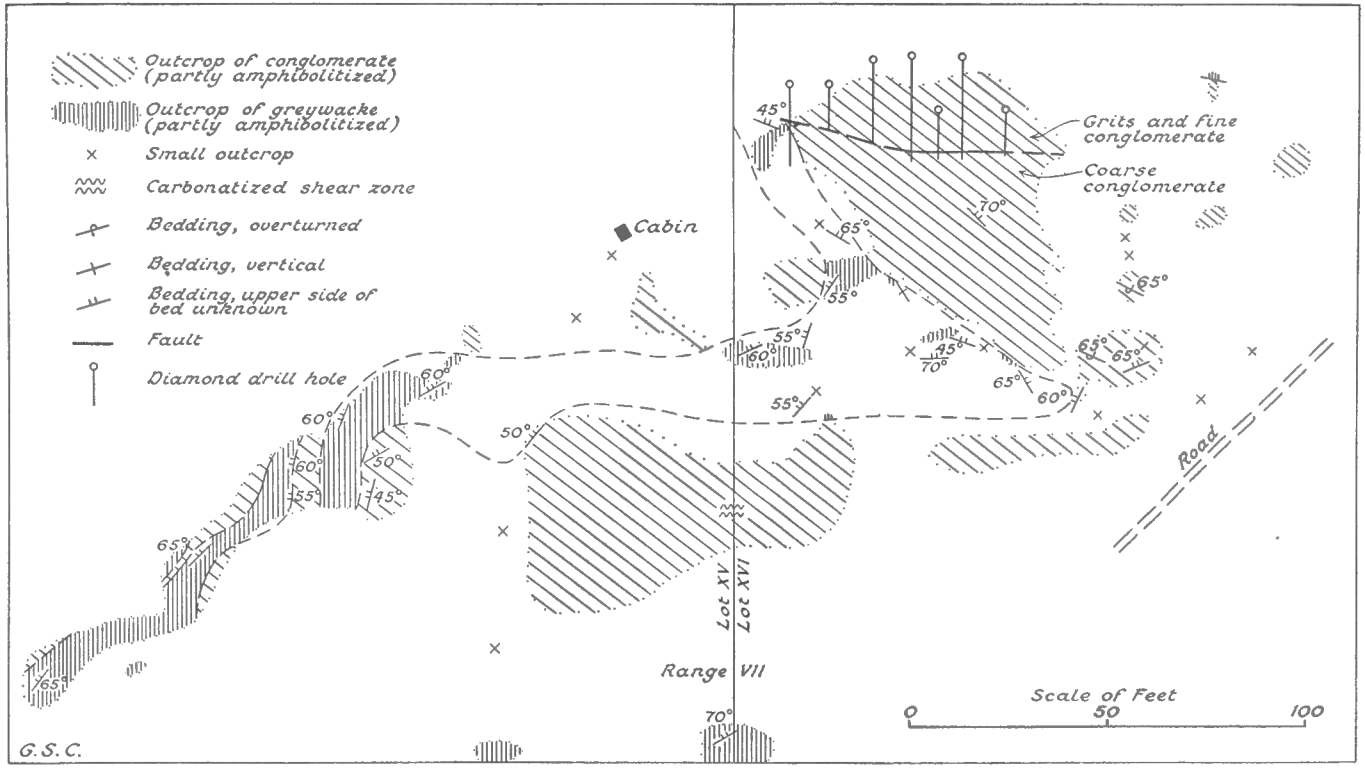

Figure 3. Joannes Davidson Mines, Limited, Joannès township, Quebec.

south of east. It has been explored on the surface by pits and trenches and underground by at least eight drill holes. The conglomerate in the shear is highly carbonated and is cut by a few lenticular and discontinuous quartz veins. Biotite is abundant in the sheared conglomerate and occurs in some of the veins. Tourmaline is less abundant. Around the margins of the veins and disseminated in the carbonate schists are pyrite, arsenopyrite, chalcopyrite, and a little pyrrhotite. The best-mineralized part of the shear extends 250 feet west of drill hole No. 8. Assays varying from 0·04 to 0·20 ounce a ton have been obtained there, across widths of 3 to 6 feet. A sample from the most westerly pit returned 0·30 ounce a ton across 1·5 feet. These results were obtained by the company.

Other quartz veins and carbonate zones that have been found would seem to justify some additional work on the property even if the main showing is of marginal or sub-commercial grade.

JOANNÈS GOLD MINES, LIMITED

This company, successor to Croteau Joannès Syndicate, owns eighteen claims in ranges VII and VIII, western Joannès township, to the north of the Nelson Gold Mines property. A small crew of men was engaged in surface work in 1938. The work was done mostly in the volcanic rocks at the north end of lots 8 to 10, range VII, and a little in the sediments to the north. So far as the writer knows, nothing of importance was discovered. An old pit near the northwest corner of lot 8, range VII, is sunk on a pyritic shear zone, about 4 feet wide, that strikes north 70 degrees east and dips 70 degrees to the north.

MARVA GOLD MINES, LIMITED

Marva Gold Mines, Limited, owns a group of unsurveyed claims west of Warrenmac Mines, Limited, east of the Bousquet centre line and south of Mooshla Gold Mines. The property is underlain by strata of the Blake River group and contains the westward continuation of most of the rocks on the adjoining Warrenmac claims. The northern part of the claims, where would lie any possible extension of the Warrenmac south vein, is heavily drift-covered. On the southern part, in green timber, there are outcrops of acidic lavas and fragmentals on the south and a complex of these with andesite and dacite flows and tuffs on the north. Two zones of quartz veins have been uncovered about 900 feet south of the north boundary and 1,000 feet west of the east boundary of the property. The largest zone is stripped for 250 feet, strikes north 80 degrees east, dips 75 degrees south, and contains lenticular quartz veins from a few inches to 6 feet wide. A limited amount of surface work was done on the claims in 1936 and 1937 by Robert Vaughan.

MIC-MAC EXPLORATIONS, LIMITED

Mic-Mac Explorations owns five claims to the east and south of the Cassels Duval property, in north-central Bousquet township. The claims were purchased as block C of Norgold Mines, Limited, and had been prospected and diamond drilled by that company in 1937. Mic-Mac instituted a diamond drilling campaign in 1938 and continued the work in 1939.

The southern half of the property is underlain by quartz diorite, the northern by andesitic to dacitic lavas and agglomerate in which there are a few narrow sheets of quartz porphyry. One sheet near the east side of the claims is rusty weathering due to disseminated pyrite and is cut by small quartz veins. The north contact of the quartz diorite is exposed in one place, to show the dense, brown to white weathering contact phase cutting and replacing the volcanic rocks to the north over an exposed width of about 100 feet. It is almost impossible to distinguish altered lava from intrusive rock.

It is reported that a narrow shear zone in the quartz diorite 200 feet south of the contact carries a little gold. Several quartz veins and pyritized areas have been found in volcanic rocks to the north, but are not auriferous. Several drill holes were put down in 1937 to probe for possible eastern continuations of the gold-bearing bodies being developed that year on the adjoining Cassels Duval property. Narrow quartz veins with associated pyrite, chalcopyrite, and pyrrhotite were cut in the holes, but no encouraging assays were obtained. Some of the drilling showed that for about 600 feet north of the quartz diorite the volcanic rocks are a mixture of lava and andesitic agglomerate, silicified and dioritized in a most irregular manner to resemble diorite, diorite breccia, and brecciated feldspar porphyry, with intervening masses of green, epidotic andesite and dacite.

The Norgold drilling was completed in September 1937. In the succeeding 12 months much work was done at Cassels Duval. It showed that ore in the south zone of that property, about which practically nothing was known at the time of the Norgold drilling, plunges eastward and should enter Norgold ground at 400 to 500 feet below the surface. The Norgold drilling was too shallow to intersect it. Mic-Mac Explorations, therefore, undertook deep drilling late in 1938. The writer has not had an opportunity to study the core, but the management reports that encouraging results have been obtained. The drilling has shown that a vein zone with substantial gold content across widths up to 20 feet or more does enter Norgold ground about 400 feet below the surface and continues east for at least several hunderd feet. It is apparently the same zone that has been developed on the second (455 feet) level at Cassels Duval and has been followed east there to within 100 feet of the Norgold boundary. The zone lies approximately 500 feet north of the quartz diorite contact.

MONDOUX PROPERTY

This property is reported to adjoin the Big Bend Corporation holdings on the east, and to include lots 10 to 19, rge. VI, Joannès tp. In 1933 Hawley described it as claim R13095. It may include most of the old Harper group. No work was done on the ground in 1938, and Hawley's description of the Harper and Mondoux may be referred to for descriptions of the several veins that had been developed along and south of the present railway grade, for the workings were largely flooded or caved at the time of the writer's examination.

Most of the veins are in outcrops along and south of the railway. To the south there are several narrow dykes of porphyrite in lots 10 to 12. In the same area Hawley has described lenticular veins of quartz and tourmaline with pyrite, pyrrhotite, and a little chalcopyrite and arsenopyrite

in the greywacke walls. Parts of these can still be seen in old trenches. Widths vary from about 2 feet to 10 feet, and one of the veins, on lot 11, has been traced about 300 feet.

On lots 14 and 15, along the railway, there are exposures of hard amphibolite and partly amphibolitized greywacke. The rocks are broken by a number of minor faults and joints, the amphibolite particularly so. Along many of these there are veins of quartz and tourmaline, with some sulphides, and other veins of calcite that have chloritized the amphibolite intensely for several inches from the walls. The joints and faults strike approximately north. At the west end of the exposures a wide exposure in a ditch is intensely carbonated and pyritic. Near the east end a stream flows north under the track and drops over a small fall. Hawley states that a pit near the base of the fall showed a strong shear striking north 65 east and dipping 56 degrees to the north. The northwest wall of the shear was impregnated with tourmaline and the southeast with quartz and pyrite. The pit is no longer visible. Amphibolite on the east side of the stream contains narrow veins of quartz and tourmaline in fractures striking north, nearly at right angles to the reported shear. Other veins occur in some abundance in a large exposure on the railway between lots 11 and 12.

The intense breaking of the rocks and the widespread mineralization all along the railway suggest the presence of a major fault to the north, in low ground devoid of exposures.

MOOSHLA GOLD MINES COMPANY, LIMITED

Mooshla Gold Mines owns a block of fifty-four claims in north-central Bousquet township. Thitry-five claims are west of the township centre line and the remainder east of it. Prior to July 1934, when the Mooshla company was formed, the property was held and developed by Dubuisson Mines, Limited. In 1935 a prospect shaft was sunk to 128 feet on the "A" showing, 300 feet west of the centre line and just north of a large, northeasterly trending diabase dyke. Lateral work was done at a depth of 115 feet. In June 1936, after a year's inactivity, the shaft was enlarged to three compartments with the use of a steam plant installed to replace the previous gasoline compressor. The operation continued to May 1937, the shaft being deepened to 372 feet, and the second and third levels were established at depths of 230 and 345 feet, respectively. At the same time a shaft was sunk to about 55 feet on the " B " showing, half a mile north of the "A" and 750 feet east of the township centre line. Diamond drilling has been done at both occurrences and at other places on the property. Adequate camp buildings and two dwelling houses have been erected near the "A" shaft. D. M. Giachino had charge of most of the development and the writer is indebted to him for maps of the property, and particularly for data on the underground workings, which were flooded at the time of examination in 1937. It is reported that seven and one-half claims in the southeast part of the property were optioned by Howey Gold Mines in 1938. Also that an option was taken on six of the northern claims east of the centre line in 1939 by Mic-Mac Explorations.

GEOLOGY

The property is underlain by rocks of the Blake River and Cadillac groups, and by two igneous masses of quartz diorite and alaskite. All the above are intruded by a large, northeasterly trending dyke of quartz gabbro. So far as known the volcanic and sedimentary strata form a strictly conformable succession, with beds on the south younger than those on the north. The bedding and schistosity dip from vertical to 65 degrees to the south. Their strike varies from due west to about north 60 degrees west, and roughly parallels the contact of the quartz diorite mass, suggesting that the latter is a lenticular, sill-like body that approximately conforms with the bedding of the enclosing rocks.

The nineteen claims east of the township centre line are entirely underlain by intrusive rocks and strata of the Blake River group. The northern exposures are chiefly of andesitic and dacitic lava and agglomerate, the lava predominating. Two thousand feet south of the north boundary of the property, at and east of the centre line, two or more narrow sheets of rusty weathering quartz porphyry are interbedded with the more basic lava. Some horizons of the latter for at least a quarter mile east of the centre line carry veins and disseminations of pyrite and pyrrhotite and outcrop as rusty bands up to 35 feet in width. As the north contact of the quartz diorite is approached the volcanic rocks become more schistose and chloritic, and in some of the few exposures near the contact it is difficult to tell whether one is examining altered lava or a hybrid phase of the intrusive. The exposures in the extreme southeastern corner of the property include dense to porphyritic and amygdaloidal andesite, andesite breccia, tuff, chlorite schist, sericite schist, and porphyritic rhyolite. In all probability the main rhyolite horizon of the Blake River group enters the property from the east some 1,500 feet north of the south boundary of the claims, in a drift-covered area.

The thirty-five western claims of the group are underlain on the north by quartz diorite and alaskite. West of the alaskite there are a few exposures of pyritic andesite and dacite along the south edge of the quartz diorite. To the south is 1,000 feet of low, wet ground and the width of drift increases to half a mile at the centre line of the township. For 3,000 feet south of the drift there are scattered exposures of highly altered rocks. They include rhyolite and rhyolite breccia, dacite, sericite schist, siliceous, fine-grained tuff, and pale grey to green, trachytic lava and agglomerate, both aphanitic and porphyritic. Some of the sericite schist is carbonated and there are intercalations of arkosic to argillaceous greywacke, in places highly schistose, that increase in number to the south. As explained in another part of the report, it is impossible to draw any well-defined contact between the Blake River and Cadillac groups. The outcrops within the Blake River group are too poor to permit of tracing any distinctive horizons if they occur, but in a general way fissile sericite schist is more abundant in the northern part of the exposures, and massive, acidic, volcanic rocks predominate in the southern contact zone. On the southern part of the claims a maximum width of 3,000 feet of the Cadillac group is poorly exposed. Narrow beds of magnetite occur at intervals in the predominant greywacke, which is chiefly impure arkose and quartzite with narrow beds of argillite. The rocks are partly converted to mica schist and phyllite.

The lithology and geological relations of the quartz diorite and alaskite are discussed on pages 24 to 26. The alaskite is younger than the quartz diorite and both rocks are older than the large dyke of quartz gabbro. The only exposure of the alaskite-quartz diorite contact is at the centre line of the township, where the alaskite has intruded the quartz diorite in erratic fashion and by brecciation, alteration, and assimilation has produced hybrid rocks. A short distance west of the township line a narrow parting of chloritic greenstone separates alaskite from quartz diorite. Both rocks are older than the auriferous deposits. A narrow extension runs east from the main mass of alaskite. The rocks composing it are less schistose than in the main body and vary from aplite to white feldspar porphyry. The southern contact of the main mass is drift-covered and for that reason is not accurately located. A drill hole east of the centre line entered bedded tuffs for a few feet at its south end. It is not known whether these rocks are the south wall of the intrusive or whether they are merely part of an inclusion in it.

The quartz gabbro dyke is 200 to 300 feet wide and dips about 80 degrees northwest at the mine. Two narrower dykes, possibly subsidiary to the main one, are known, one at the "B" showing and one in the southeast part of the property. The quartz gabbro is presumably younger than the gold deposits, though this point is not definitely proved at the property.

MINERAL DEPOSITS

The "A" vein is in alaskite. It strikes a few degrees east of north and dips steeply west. Most of the outcrop is now covered by waste rock, but at one place a pencil-thick crack filled with pyrite and pyrrhotite can be seen. The writer was able to examine the vein 12 feet below the top of the flooded shaft. It varies from 1 to 3 inches in width and consists of a massive intergrowth of pyrite and pyrrhotite. The sulphides are frozen to the walls and the latter contain small specks and blotches of pyrrhotite. There is very little quartz in the vein and the only visible gold was in a small eye of quartz in pyrite. Microscopic examination shows that there are small particles of chalcopyrite and sphalerite in the pyrite and of magnetite in the gangue. Many minute specks of gold range in diameter from 0·2 to 0·005 mm. They are chiefly in pyrite, either alone or with specks and veinlets of chalcopyrite. A few are in quartz between the sulphide grains. The high gold content of the sulphides is illustrated by the fact that a piece of the vein assayed 20·07 ounces gold and 10·20 ounces silver a ton. The mineralized wall-rock contains pyrrhotite and some pyrite, much quartz and clear albite, about 50 per cent sericite, and a little epidote and finely divided rutile.

The general type of mineralization is said to be similar on the first and second levels, and different on the third. Specimens from the third level are largely of watery white quartz with irregularly distributed pyrrhotite, pyrite, and chalcopyrite, and some spectacular concentrations of native gold. Branching from the main vein are veinlets of pure white albite with specks of chalcopyrite. Albite and calcite are intergrown with the quartz and pale yellow garnet has formed in the vein and in the wall-rock close to the vein. The wall-rock is speckled and seamed with pyrite and pyrrhotite and holds a few needles of tourmaline.

The writer is indebted to D. M. Giachino for information on the underground workings. The vein was traced for 80 feet on the surface, northward from the quartz gabbro dyke, and the vertical shaft sunk 25 feet north of the south end. The shaft entered the dyke at about 50 feet and remained in it to the bottom. The vein was found on the first and second levels and followed for lengths of 90 and 85 feet, respectively. It is about the same as on the surface—from an inch to several inches of sulphides with very little quartz. On the south it pinches out entirely just north of the gabbro dyke. Several very narrow veins were found to the east and west of the main vein on the second level, but were developed only for short distances at the north end of the workings. It is said that the best part of the main vein is generally 5 to 10 feet north of the gabbro contact, and that widths and gold content decrease gradually to the north and rapidly to the south.

On the third level the vein was traced for 80 feet. At the north end it bends sharply northwest and dies out within 25 feet. Other narrow veins were found to the east and west. If the main vein is the same as that on the two upper levels, the westward dip has flattened from an average of 85 degrees above the second level to 69 degrees below it. In view of the dissimilarity of the vein material on the third level and the position of the vein on that level, it seems possible that there are two veins instead of one.

A report to the shareholders in 1937 stated that the following average assays had been determined by Mr. Giachino:

First level—$34.95 across 34·4 inches for 72 feet.
Second level—$32.18 across 31·5 inches for 56 feet.
Third level—$94.73 across 37 inches for 75 feet.

A winze sunk 32 feet below the third level was reported to have indicated $14.84 across a width of 3 feet. It is said that the bulk of the gold is in the narrow veins, but that there is some gold in the mineralized wall-rock.

Some gold has been found in drill cores and surface samples of quartz-sulphide veins and replacements along the sheared contact between alaskite and quartz diorite 300 feet north of the shaft. Purple fluorite was noted in one core section of a small auriferous vein.

In June 1939 the company announced plans to dewater the shaft and continue development, at the same time attempting to extract some 4,000 tons of ore that were estimated to contain from $21 to $36 a ton of gold. The mining width was set at about 2 feet.

The " B " veins are half a mile northeast of the " A " vein and 500 to 1,000 feet east of the centre line of the township. They have been explored by trenches, several diamond drill holes, and a prospect shaft to a depth of 54 feet, with a short drift from the bottom. The veins lie within the main mass of quartz diorite. The main vein strikes northwest and dips 70 to 75 degrees to the northeast. A second follows a narrow quartz-porphyry dyke striking north 60 degrees east. The first has been found at intervals for a total length of about 1,300 feet, the second for 100 feet. The mineralization consists of white quartz and some ankerite accompanied by pyrite, chalcopyrite, and some pyrrhotite. In some places there is much black tourmaline. Along the main vein the quartz diorite is sheared to

chlorite schist and contains narrow inclusions of greenstone, in part impregnated with sulphides. A narrow diabase dyke cuts northeast across the main vein in one place and small sulphide seams in the vein zone stop abruptly against it. The vein fissure does not cut the diabase. The maximum width of the main vein is 4 feet, but the average is much less, probably not much over a foot. Although some samples have yielded over an ounce of gold a ton, the average content has been found to be too low for mining.

The " E " vein is a narrow sulphide zone in alaskite 1,500 feet southeast of the " A " vein. It has been exposed for 150 feet and two drill holes have been put down beneath it. Other quartz veins and mineralized shear zones have been found on the property, in quartz diorite and in the Blake River rocks.

NELSON GOLD MINES, LIMITED

Nelson Gold Mines, Limited, owns about 1,200 acres in western Joannès township. The property includes most of lots 1 to 11, range VII, and a part of lots 12 to 14 north of the Teck-Hughes holdings, as well as those parts of lots 6 to 7, range VI, that cover the area between Kinojevis River and Davidson Creek. O'Neill Thompson Gold Mines adjoins on the south and west. Surface exploration was done on the property in 1937 and 1938.

The claims are largely drift-covered, but are underlain by rocks of the Blake River and Cadillac groups. The Davidson Creek fault passes through the southeast corner of the property. Mineral deposits have been found in four principal places. Six hundred feet south of the north boundary of lot 8, range VI, a quartz vein is exposed in a trench. It is in highly sheared, contorted, and in places brecciated, greywacke and carbonate rock at the edge of an irregular body of highly altered diorite. The latter body is 55 feet wide from north to south and dies out in a blunt nose on the east, a length of about 80 feet to the west of the nose being exposed. The vein zone of grey quartz with a little pyrite follows erratically around the south and east contact of the diorite. Where exposed in the trench for 140 feet it varies in width from 1 foot to 7 feet. In addition, over 50 per cent of an area 10 by 20 feet in the southwest end of the trench is lenticular quartz stringers. One or two shallow pits have been sunk on the vein. Gold content reported by the company is erratic. Four samples assayed between $15 and $19 a ton, but many others assayed from nil to $2.

Another small deposit is 50 feet south of the north boundary of lot 10, range VI. Arkosic greywacke on the north is underlain by about 7 feet of dense, felsitic rhyolite and rhyolite breccia, presumably a narrow flow but possibly an intrusive sill that pinches out within 120 feet to the west. The rhyolite is underlain on the south by 50 feet of soft carbonate-serpentine rock, possibly derived from diorite or a more basic intrusive, though a faint banding preserved within the body in one or two places resembles bedding. The rhyolite and overlying sediment that is silicified near it strike due east and dip 50 degrees to the north. The rhyolite is fractured and veined by stringers of grey quartz and for not over 25 feet at the west end is also well mineralized with fine-grained arsenoyprite across a width of about 1 foot. Samples by the company are reported to have shown a very low gold content.

Three hundred feet to the south, beside Davidson Creek, there are several exposures of conglomerate, greywacke, and greenstone, in part altered to carbonate. There is also one small, plug-like body of rhyolite similar to that to the north. The structural relations of these rocks are complex and obscured by drift. In the writer's opinion this area should be stripped in an attempt to elucidate the geology. Any information that could be obtained would be of value in appraising the potential value of ground to the south, under heavy overburden, and close to the Thompson Creek and Davidson Creek faults.

In lot 12, 2,400 feet north of range VI, a zone up to 23 feet wide in argillaceous greywacke is replaced by carbonate and veined by lenses of quartz and ankerite that contain some pyrite. It is exposed in trenches for 55 feet, and no important gold content is reported. A 5-foot dyke of lamprophyre cuts the sediments to the north of the zone. The zone follows the bedding in sediments that strike due east and dip 55 degrees to the north.

A wide, chloritic shear zone just north of range line VI-VII and 3,300 feet east of the Rouyn boundary contains some pyrite, but has not been found to be auriferous. It is in sheared, dacitic lava.

NORGOLD MINES, LIMITED

Norgold Mines holds a large number of claims in Bousquet township. Group A is north of the west end of Kiekkiek Lake and includes claims A36373, A37365, and A40285 to A40288. Group B is a mile to the north and includes claims A57360 to A57373. Group C is optioned to Mic-Mac Explorations, Limited, and is described as such elsewhere.

Group A is part of the old Clement-Manning holdings, the remainder now belonging to Calder-Bousquet Gold Mines, Limited. The Clement claim, A36373, was developed by Noranda Mines in 1932. Norgold assumed control in 1933 and did additional work. In 1936, after some diamond drilling, a prospect shaft was sunk. One more hole was drilled in 1937.

Kiekkiek Lake, at the south side of the property, is presumably underlain by greywacke of the Kewagama group. To the north is a width of 550 feet of conglomerate. For about 600 feet north of that there are numerous exposures of chloritic and carbonated schist with some definitely tuffaceous layers holding clearly visible angular fragments. To the north there is deep overburden for 1,000 feet to outcrops of siliceous greywacke on the highway at the northern edge of the property. All the strata strike nearly due east and dip close to vertical.

Two diamond drill holes have probed beneath the southern part of the drift-covered area. They intersected greywacke and, 700 feet north of the north contact of the main conglomerate, a strong shear zone that is presumably the Cadillac " break." The shear zone is 75 feet wide and consists of soft, talcose, chlorite schist with layers of mica schist and chloritic, micaeous greywacke for a few feet on each side. There are a few small quartz stringers in the shear zone, which strikes north 85 degrees east. In the outcrops south of the shear zone a few minor faults strike due east to slightly south of east and their north sides are offset to the east. They are probably subsidiary to the main shear.

The prospect shaft is on a narrow vein zone in greywacke 400 feet south of the Cadillac "break." The zone strikes north 75 degrees east. Grey quartz with associated ankerite and very small amounts of sulphides occurs in a vertical fissure as discontinuous, lenticular masses from an inch to 2½ feet wide and rarely over a few feet long. The fissure has been traced for 700 feet and the quartz veins in it are known to contain native gold. A deposit of this kind would have to be exceedingly rich before it could be exploited with success. If projected east across a narrow, drift-filled valley the fissure continues, without offset, as the main lead on the adjoining Sagamore (Doreva) claim.

Seven hundred feet west and 200 feet north of the shaft another mineralized zone has been stripped for a length of 90 feet. A lenticular quartz vein from 3 inches to 3½ feet wide lies in a carbonated zone in schistose greywacke and conglomerate. Small amounts of pyrite and arsenopyrite accompany the quartz. The vein dips 80 degrees to the south. A similar zone is exposed in a trench 1,100 feet to the west and continues beyond that on the Calder-Bousquet property. Two drill holes between the exposures on Norgold ground are reported to have intersected the same zone. Although the mineralized zone is apparently persistent, and where exposed contains encouraging amounts of quartz and sulphides, only very low gold assays are reported.

A number of large quartz veins, barren or with meagre sulphides, lie in conglomerate south of the two main showings.

So far as the writer knows nothing of commercial interest has been found on group B. A very large part of the area is drift-covered. Sporadic trenching has uncovered some small quartz veins and a few narrow beds of magnetite, in the southern part of the group.

O'NEILL THOMPSON GOLD MINES, LIMITED

This company owns claims R10996 to R11005, inclusive, in the big bend of Kinojevis River in Joannès township. Originally known as the Thompson claims and later as Thompson Joannès Gold, Limited, the property was developed under option by Noranda Mines in 1932 and 1933. The option was dropped after extensive surface work and some 3,300 feet of diamond drilling, distributed in ten holes. Operations by the present company and its predecessor syndicate continued from August 1934 until late in 1936, and work was concentrated on auriferous quartz veins on claim R11005. A two-compartment shaft was sunk to 175 feet and levels established at 80 and 160 feet. A small test mill erected in 1936 treated 25 to 35 tons a day from July to October and recovered some gold. Operations were suspended late in the year, but the mine was kept pumped out until 1938. The camp buildings are 3,000 feet northeast of the shaft on the bank of Kinojevis River.

GEOLOGY

The principal features of the general geology of the property have been discussed on page 15 and in the part of this report that deals with structure. The main structural element is the Thompson Creek fault, marked by a wide belt of soft schist that underlies the valley of Thompson

Creek (*See* page 41). The fault strikes east and dips about 60 degrees to the north. Conglomerate and greywacke with a few tuffaceous beds are exposed across narrow widths to the north and south of the fault and are bordered on the north and south, respectively, by greater thicknesses of volcanic rocks of the Blake River group. Near the fault the strata dip north at about the same angle as the fault. The second structural feature that is of economic importance is the contact between sediments and volcanic rocks on the south side of the fault. This contact, as determined by the writer, is from 250 to 500 feet south of the fault. It is the same contact that continues east for 2 miles beyond the property to McWatters mine, and along and near which are the ore deposits of that mine and of the East Rouyn property. Across the O'Neill claims there are veins and replacements near the contact, and the type of mineralization is similar to that at McWatters. It is to be noted that the location of the contact does not agree with that shown on previous maps of the area. The contact zone is sheared and carbonated in most places, and it is difficult to differentiate between sediments and volcanic rocks in such cases. However, small pebbles can generally be recognized along the southern edge of the sedimentary band, and to the north of the contact zone there are several exposures of coarse conglomerate. Therefore, it is possible to determine the contact within a few tens of feet at most. A faint banding is generally present in the sediments also, and this is not so in the altered, dense, volcanic rocks to the south. As can be seen from examination of the maps, much of the contact zone is drift-covered, so that its exact location is in doubt in several places.

The third feature of economic importance is the occurrence of diorite in the volcanic rocks (*See* page 24). One of the two main showings on the property is in diorite on claim R11004. The extensive areas of volcanic rocks on the property have not yet been proved favourable to the occurrence of mineral deposits. A northerly trending dyke of quartz gabbro that passes through the claims is apparently offset about 1,100 feet to the east on the north side of the Thompson Creek fault. The important Davidson Creek fault passes through the southeast corner of the property.

MINERAL DEPOSITS

Two principal deposits have been discovered, one a replacement deposit in quartz diorite on claim R11004, the other, known as the No. 1, in the southern part of claim R11005, 1,500 feet to the west. Several other deposits of lesser importance have been exposed at the surface.

The replacement deposit has been described in some detail by Hawley (1933, page 68). He examined it when the work was being done by Noranda Mines in 1933, and since then no work has been done on the deposit. The old workings are partly caved and little information that could be added to Hawley's description was obtained by the writer. On the accompanying maps the outlines of the quartz diorite do not agree exactly with those established by Hawley. The writer's ideas on the origin of that rock have been given on page 24. Hawley's description of the replacement body is as follows:

"Some remarkable gold values were obtained in a replacement body in the quartz diorite sill, 140 feet stratigraphically below the top. The boundaries of the deposit are irregular and difficult to define. The main

body has a lenticular shape, with its maximum width of 35 feet near the southwest end. It narrows towards the northeast and disappears after a length of 170 feet. Several smaller, but highly irregular, mineralized bands occur above the main one, on the northwest. In these deposits, the dark, brownish-green, carbonated diorite, with "eyes" of bluish quartz, has been altered to a light grey rock mineralized heavily with fine pyrite and arsenopyrite. The alteration follows joint planes striking and dipping in many different directions, though the more completely altered zone strikes northeast, parallel to the margin of the sill, and dips northwest with it.

"The alteration, or replacement, consists in the early development of albite and additional graphic intergrowths of quartz and albite, which cut and invade original quartz phenocrysts. Minute crystals and aggregates of pyrite and arsenopyrite are present in the matrix, and, with their development, chlorite and a brown secondary biotite disappear. The magnetite of the less altered sections of the diorite may be represented in the sulphide zone by fine, platy to feathery crystals of specularite. The formation of the sulphides, and of ferriferous carbonates, is the dominant alteration, though some quartz has been introduced, both early with albite or alone, and later as narrow seams filling fractures in pyrite. The relation of the gold to other minerals as present has not been determined. It seems most closely related to arsenopyrite.

"The sulphide zone is covered with a dark red, shallow gossan from which free gold may be panned readily. Grab samples of the sulphide ore are said to assay as high as $95 per ton in gold, and in channel samples taken in the trench across the widest portion, 35 feet, values between $5 and $6 per ton are reported. A sample taken by the writer gave $3.80 across seven feet which is low compared with assays reported over similar widths elsewhere in the deposit.

"Three holes were drilled beneath the zone, over a length of 100 feet. The one drilled below the widest surface showing encountered the zone at a depth of 60 feet, where it had narrowed to 6½ feet. In the other holes only a small sulphide mineralization and stringers of quartz were found."

Vein No. 1 is the name applied to the original vein on claim R11005 on which the shaft was sunk. The vein can still be partly seen in a stripping just east of the headframe. For 45 feet at the east end of the exposure it strikes 10 degrees south of east and dips about 50 degrees to the north. To the west it bends sharply west of north for 15 feet along the schistosity of the enclosing rock and then swings southwest for 30 feet to the southeast corner of the shaft-house. The maximum width of 4 feet of quartz and mineralized schist is at the sharp bend at the west end of the 45-foot length. The average width is under 1 foot. Other veins and lenses said to have been found to the north and west are now covered with rock on the dump. The enclosing rock is a grey to green schist that contains small, rounded pebbles of quartz porphyry, felsite, greywacke, and a few of vein quartz. This the writer interprets as sheared greywacke and pebble conglomerate, though in the past it has been termed tuff. The vein matter consists of quartz, tourmaline, and ankerite, with pyrite the chief metallic mineral. The veins underground also contain small amounts of pyrrhotite and arsenopyrite, and some galena is reported. Native gold

is said to have been found at the surface and still can be seen in some of the veins in the mine. The nearest exposures along the vein zone are in a trench 200 feet southwest of the shaft. The same rock, with shards of bright green, chrome-bearing? chlorite and remnants of crossbedding, is traversed by a very erratic vein zone for about 35 feet. The veins follow a zone of shearing in the sediment and a lenticular mass of quartz, tourmaline, and ankerite, 3 feet by 3 feet, is exposed in a pit at the west end. In a few other trenches to the south and southwest, greenstone is carbonated across widths up to several feet. The south contact of the sediments lies under drift about 50 feet south of the shaft, and about 20 feet south of the southwest trench.

Other veins are exposed along the same contact, notably on the south side of the railroad grade from 825 to 1,100 feet east of the shaft. One of these, now exposed for 3 feet at the south edge of the railway ballast, is 3 feet wide and consists of dark grey to white quartz with black tourmaline and a little ankerite. Pyrite is sparingly present. The showing is said to have been followed for 60 feet to the west under the present tracks and to have attained a width of 8 feet in one place. It is also said that free gold was present in considerable abundance. The vein is approximately on the contact of sediments and greenstone. Immediately to the east the contact swings southeast into a depression the southern edge of which displays intense shearing, suggesting that a northeast striking fault of some magnitude underlies it.

From 1,700 to 2,000 feet west of the shaft a few trenches expose up to about 40 feet of carbonate schist cut by some quartz-tourmaline veins. These occurrences are at and north of the same contact, and in one trench pillowed dacite is exposed 100 feet south of the contact. Conglomerate is exposed in parts of two trenches north of the contact.

Assay plans of the underground workings showing the principal veins were kindly supplied to the writer by J. M. Cormie, geologist for McWatters mine. Other information was supplied by E. E. Claudet and Albert Thompson, respectively, consulting engineer and manager at the property. With this help the writer and his assistants mapped the workings. The sedimentary-volcanic contact, just south of the shaft on the first level, dips north at about 65 degrees, bringing it 35 feet to the northwest at the second level, 80 feet below. The contact is masked by alteration and mineralization, so that it is difficult to establish. For about 60 feet north of the contact pebble beds are present at intervals in the altered, phyllitic to schistose sediments. To the north the rocks are grey to greenish, bedded greywacke, carbonated along a few narrow zones. On the second level a thickness of about 180 feet of these rocks continues to the Thompson Creek fault, broken only by a single 12-foot horizon of agglomeratic conglomerate situated about 25 feet south of the fault. This horizon contains rounded to angular pebbles of felsite. For 45 feet on the second level the fault is a zone of soft schist evidently derived in part from the destruction of conglomerate, for several round pebbles of feldspar porphyry up to 8 inches in diameter were extracted from the schist. A zone of gouge 5 inches thick at the face of the crosscut strikes north 77 degrees east and dips 45 degrees to the north. The south edge of the fault zone is sharply defined and dips north at 60 degrees. There 18 inches of quartz is on the north side of

another narrow zone of gouge. Some drag-folds in the schist at the south suggest that the north side has moved up relative to the south, but others indicate that the north side has moved down and to the east, at an inclination of 40 degrees. In all probability there have been several periods of movement, in different directions. As previously noted, a diabase dyke appears to be offset about 1,100 feet to the east on the north side of the fault.

The strata south of the fault are broken by a large number of faults of minor displacement. Most of them strike northeast and dip at moderate angles to the southeast. Those on which the offset could be determined are thrust faults, and several have displaced veins a few inches to one foot. A few of the veins lie in minor normal faults dipping north with the bedding of the strata.

Normally, the schistosity in the sediments is not strong and it strikes and dips about parallel to the bedding. At the east end of the second level, however, within about 30 feet of the gabbro dyke, the rocks are much more fissile and the schistosity strikes northeast, about parallel to the dyke. The dip is steep to the west, also about parallel to that of the dyke. Bedding planes are not recognizable in this part of the mine. The rocks are altered to chlorite and sericite schists and are much carbonated, so that it is difficult to tell whether they should be classified as sediment or volcanic. The suggestion is that the dyke has been intruded along a fault or shear zone.

The principal veins and replacement bodies are shown on Figure 4. Except for a few of the smaller veins they are all extremely irregular and quite discontinuous. The average gold content is low, not high enough to constitute ore. In the volcanic rocks the mineralization consists chiefly of quartz-ankerite veins and replacements with little or no pyrite, and a few barren veins of quartz and chlorite. In the sediments to the north the veins and irregular bodies contain much more tourmaline on the average and more pyrite. Pyrrhotite is not abundant. The large mass 70 feet northwest of the shaft is reported to have yielded some small pockets of native gold and to have contained some galena, but its average value is probably not over $3 a ton. One or two of the small stringers have yielded assays of several dollars a ton. It is noteworthy that the veins in the far east end of the level strike east of north with the schistosity. The vein zone farthest northeast contains a small amount of scheelite. All the veins in this end of the mine are cut by calcite stringers. The small thrust fault that cuts the gabbro at the east end of the drift offsets the contact of the dyke 10 inches and the fault, and small tension cracks running off from it, are filled with narrow veins of quartz, calcite, epidote, and fibrous actinolite. They presumably represent a period of barren vein formation that is later, and probably much later, than the auriferous veins.

On the first level the deposits are similar to those on the second level. None of them can be satisfactorily correlated with those on the second level, unless it be assumed that irregular bodies northwest of the shaft on the two levels occur in a more or less vertical zone, though the individual bodies dip to the northwest. Thirty feet north of the shaft a curving quartz stringer from 1 to 4 inches wide that dips about 20 degrees to the west can be traced for a total length of about 65 feet. Wherever exposed it contains small grains of native gold scattered at random in the fractured

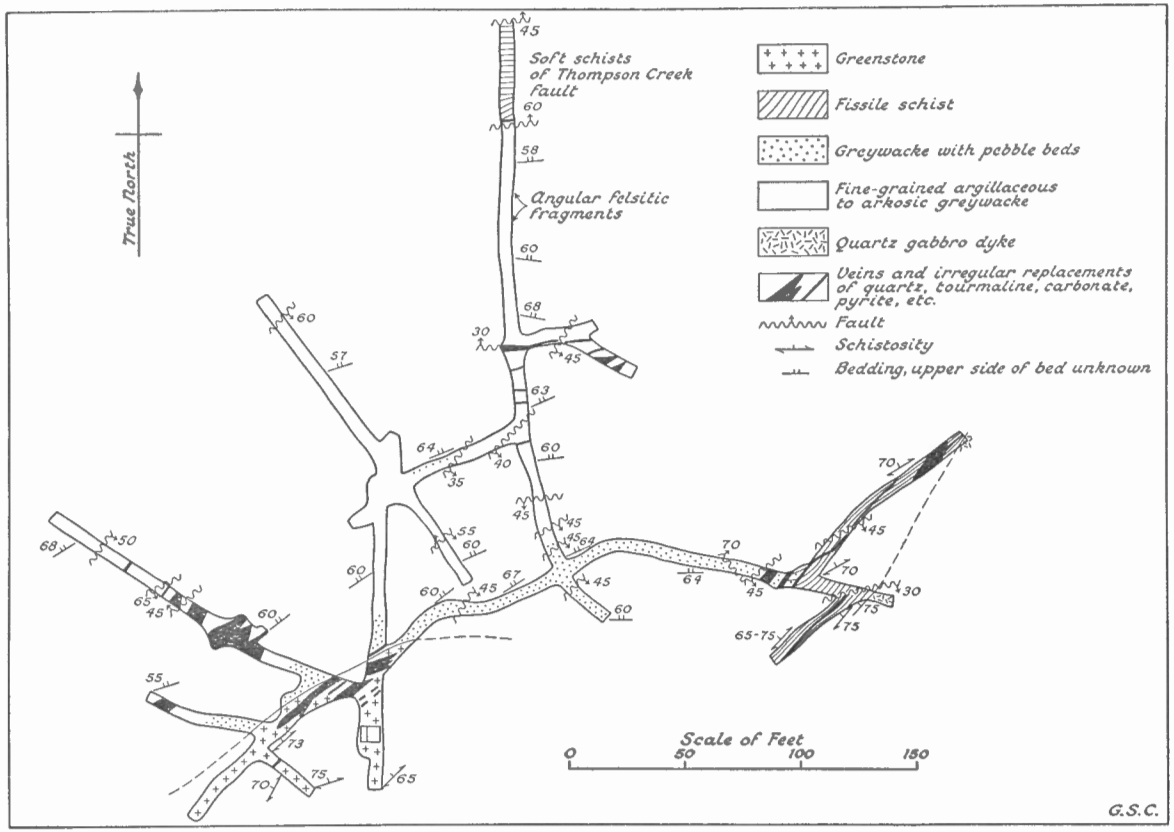

Figure 4. Plan of second (160-foot) level, O'Neill Thompson Gold Mines, Limited, Joannés township, Quebec.

quartz. It is possible that small, high-grade stringers like this are later than the larger bodies of quartz and have effected some enrichment of the latter where they cut them. Most of the " ore " that was put through the mill came from an irregular quartz-tourmaline mass 50 feet northeast of the shaft. It was cut in a drift for about 30 feet and had a maximum width of about 10 feet, being lenticular in plan with a blunt east nose. It was stoped out to about 50 feet above the level and it is reported that the gold content decreased rapidly at that height. A raise was continued to the surface and shows that quartz and tourmaline continue up to the vein that is exposed on the surface east of the shaft. The downward continuation of this body was not found on the second level and it hardly seems likely that it could be missed by the closely spaced tunnels there.

The quartz-tourmaline veins and replacements on the property are similar in type, if not in size and gold content, to those mined at McWatters mine to the west. Studies by the staff of that mine and by the writer show that at each property they occur along and near the same contact. As much of this contact zone is drift covered for a length of over 4,000 feet on O'Neill ground, and very little drilling has been done, it seems obvious that the possibility of finding ore-bodies has by no means been exhausted. Sharp bends or " drag-folds " in the contact are said to exist at the ore-bearing parts of both the properties to the west. A minor bend in the contact exists at the O'Neill shaft. For nearly 2,000 feet to the west the exact path of the contact is not known. One other feature on the property that should not be forgotten is that the analogous sediment-volcanic rock contact to the north of the Thompson Creek fault has not been systematically explored. In a few exposures along it the rocks are carbonated.

PROPERTY OF A. PAQUIN

A. Paquin of Rouyn controls a group of claims in western Bousquet township and did some surface work on them in 1937. The showing is 1,500 feet north of Kiekkiek Lake and 5,500 feet east of the Joannès boundary. Early in 1937 it was developed by Ventures, Limited, or Beattie Gold Mines, and the writer is indebted to Mr. Banfield of that organization for a map showing the results obtained; also to Mr. Paquin for guidance on the property.

A gold discovery was made at the southeast corner of claim A59886, on the southwest edge of a large area of drift-covered ground. It is an irregular zone of quartz veins and mineralized rock exposed at intervals in trenches for 500 feet. It is doubtful if there is a continuous lead for the entire length; more probably there are several zones more or less *en échelon*. The host rock is conglomerate and the most interesting exposure is in a large stripping at the east end. The conglomerate there is contorted so that the dips vary from steep to the south to about 20 degrees to the north. Apparently the showing is on the crest of a sharp bend or drag-fold, with the strata striking west and southeast from the point of curvature. A pronounced shear zone strikes north 35 degrees west in the middle of the stripping and dips 60 degrees to the east. East of the shear, the con-

glomerate is cut by quartz-ankerite veins across a width of 15 feet, and is mineralized with arsenopyrite, pyrite, a little pyrrhotite, and chalcopyrite. This is probably at the crest of the drag-fold, and ground to the east is drift-covered. Thirty feet to the west, and to a lesser extent between, there is similar mineralization across narrower widths. Free gold is present in some of the quartz stringers. A sample weighing 300 pounds from across 15 feet at the east end of the stripping is said to have averaged 0·25 ounce of gold a ton, and one of 50 pounds across 5 feet returned half an ounce. Elsewhere erratic high assays have been obtained, but the average of those taken is low. To some extent along the showings, and to a much greater extent on exposures within a few hundred feet to the south, the sediments are intensely carbonated.

SCOTT CHIBOUGAMAU MINES, LIMITED

This company owns three claims and a fraction in northeast Bousquet township, southeast of the property of Thompson Bousquet Gold Mines. The claim numbers are A39756 to A39758, inclusive. Surface work was done on the claims in 1937 under the supervision of Mr. Croteau.

The southern part of the property is low and drift-covered, but is underlain by sediments of the Cadillac group. The only exposure of these rocks is on the west boundary of the west claim. To the north of the sediments there is about 1,200 feet of acidic lava and agglomerate with some andesite, hard, brittle rocks typical of the southern part of the Blake River group. These are bordered on the north, in the extreme northern corner of the group, by a maximum width of about 300 feet of softer tuffs and sericite schist, the eastward continuation of the horizon in which the auriferous deposits at Thompson Bousquet have been found. Exposures of the Blake River group are limited to about a dozen natural outcrops and several trenches.

A carbonated, schistose zone 13 feet wide is exposed in a trench just south of the northeast corner of claim A39757. It is practically devoid of sulphides or quartz. To the south, in the harder, acidic rocks, trenching has exposed several quartz-tourmaline veins of substantial width. Some of them contain pyrite, but at the time of examination no important gold content had been discovered. The most encouraging deposit is in several trenches 400 feet from the north boundary of claim A39756, and consists of lenticular veins of quartz and tourmaline, with some pyrite, that range in width from 2 to 6 feet. They have been exposed in four trenches for a length of 300 feet, but probably no one vein is continuous for anything like this distance. Nine hundred feet to the south acidic lava is impregnated with pyrite across a width of 33 feet in one trench. One thousand feet to the east of this some old pits just south of the property expose rhyolite replaced by pyrrhotite and pyrite and cut by veins of quartz and tourmaline. Both these showings of sulphide lie within about 100 feet of the south contact of the Blake River group.

SUDBURY CONTACT MINES, LIMITED

Sudbury Contact Mines controls thirty-four surveyed claims in the western half of Bousquet township, between the highway and Bousquet River and extending a mile west and 4,000 feet east of Norman Lake. The original holdings are twenty claims on the west, Nos. A37966 to A37970, A38970 to A38983, and A46684. They were known as the Mahley group, and have been explored by trenches, pits, and several diamond drill holes. The Hamba group, claims A59889, A59890, and A60095 to A60099, lies to the east, and except in the extreme north and south the claims are drift-covered and undeveloped. The property was enlarged in 1938 by the purchase of the seven intervening claims, Nos. A67277 to A67283, inclusive. On these claims a single outcrop on the east shore of Norman Lake has been trenched; otherwise they are heavily drift-covered except for a hill of greywacke at the north boundary. Norman Lake is shallow, but is spring fed and is one of the few clear water lakes in this part of Quebec.

The property is underlain by strata of the Cadillac, Blake River, and Kewagama groups. A large dyke of quartz gabbro strikes northeast across the claims. Greywacke with a few small pebble beds, striking nearly due east and dipping within 10 degrees of vertical, underlies the northern half. The Cadillac belt, poorly exposed, apparently decreases in thickness from east to west from about 1,400 to 600 feet. Most of the rocks within it are highly metamorphosed. Some old strippings at the northeast corner of Norman Lake are in highly altered, massive to schistose, andesitic lava with poorly preserved pillows at the east end. The exposure is probably close to the north edge of the Cadillac belt. Many exposures west of Norman Lake consist of andesitic agglomerate and tuff with some narrow widths of carbonated, porphyritic andesite. On claim 38983 agglomerate, tuff, and pillowed andesite are exposed in trenches just west of the large gabbro dyke. Here also is at least one band of carbonaceous and graphitic slate, 7 feet wide and heavily charged with pyrite, in a sheared zone along which there are narrow, lenticular quartz veins.

The next exposures of any size are 2,000 feet to the west, in trenches along and near the No. 1 vein. The rocks are massive to schistose tuff and pillowed andesite with two narrow layers of diorite just north of the vein. A single outcrop of greywacke 250 feet north of the vein marks the northern limit of the volcanic rocks. It is on the south side of an east-west depression, 300 feet wide, that is bordered on the north by exposures of greywacke of the Cadillac group. The southern part of the Cadillac belt is exposed in several old pits and trenches along a small creek valley 400 feet south of the No. 1 vein. The rocks are grey, fine-grained, and highly carbonated, but in one place they are definitely porphyritic and in another a few deformed pillows were identified. Some narrow shear zones are graphitic. On the north face of the hill to the south, sedimentary and volcanic rocks are intercalated so that the actual contact beween the Cadillac belt and the Kewagama group can only be determined arbitrarily. Greywacke and conglomerate of the Kewagama group underlie the southern part of the property, the northern conglomerate band thinning, presumably, from about 1,200 feet on the west to only a few tens of feet at most at the east boundary of the property. The conglomerate is not exposed east of Norman Lake.

Although there are many quartz veins in the sediments of the Cadillac and Kewagama groups, the only deposits that have seemed to merit even preliminary development are in the Cadillac belt on claim A37970. The No. 1 vein, about the middle of the claim, has been stripped for 600 feet. It is a moderately sheared zone from a few inches to 10 feet wide, along which andesite is carbonated and penetrated by lenticular quartz veins. In the quartz and wall-rock are small quantities of pyrite and arsenopyrite. The zone follows a curving, easterly course and swings north to strike north 65 degrees east at the east end. It dips steeply to the south. One hundred and twenty-five feet from the east end of the stripping a flooded prospect shaft is said to be 20 feet deep. At the shaft collar there is a 5-foot width of closely spaced, lenticular quartz veins. To the west of the shaft the width of the zone varies greatly, and no single quartz vein is continuous. At the extreme west end, 450 feet from the shaft, 6 feet and less of carbonated, black, carbonaceous sediment is interbedded with the lavas, and is in part schistose and sparingly mineralized with quartz and sulphides. East of the shaft the vein zone pinches to two narrow veins 1 to 2 inches wide and then swells to 3 feet of quartz and mineralized rock. It is reported that the vein zone contains only a small amount of gold.

Old pits on the No. 2 vein, 400 feet south of No. 1, are now almost completely caved. Narrow quartz veins and moderate amounts of pyrite, arsenopyrite, and pyrrhotite occur in sheared and carbonated rocks with some graphitic seams. Individual veins seem to be small and discontinuous, but similar material has been found at intervals for a length of about 600 feet. The showings are near the south contact of the Cadillac belt; the narrow east-west valley and the sheared rocks suggest a fault or shear zone along the valley bottom.

In 1937 a drill hole was collared in greywacke 600 feet east of the No. 3 post of claim A37969 and 166 feet north of the claim line. It was drilled south at an average inclination of 40 degrees and its length of 808 feet was sufficient to completely cross the depression north of the No. 1 vein. The following information was supplied by D. M. Giachino, engineer for the company. At 125 to 275 feet from the collar the drill intersected a highly sheared zone, including two zones of soft, talc-chlorite schist 25 and 40 feet wide, respectively, at the north and south, separated by 50 feet of greywacke and biotite schist. For the last 58 feet the hole was in andesite. Between the andesite and the shear zone is greywacke and two beds of conglomerate, one 120 feet south of the shear and another, 40 feet wide, immediately north of the andesite. The writer interprets the shear zone as the main Cadillac break. The conglomerate beds between it and the Cadillac belt are in accord with conglomerate at the same horizon on the Brown Bousquet property to the east. There were several narrow quartz veins in and south of the shear zone, and some accompanying arsenopyrite. The highest gold assay obtained from the core was $1.75 a ton across 5 feet in the northern conglomerate.

It is worthy of note that the Cadillac belt and the important shear zone to the north lie in the property for a length of over 2 miles. Only a very small part of this length has been explored to date.

TECK-HUGHES GOLD MINES, LIMITED

Teck-Hughes Gold Mines controls three unsurveyed claims in range VII, Joannès township, R12855 to R12857. They lie on either side of Davidson Creek a mile above its mouth. The discovery of gold in a quartz vein on the west side of the creek led to considerable excitement in 1934. The vein was exposed by trenches and test pits, one of which was deepened as a prospect shaft. The operation was suspended in the autumn. In 1938 three short drill holes were put in to intersect the vein at shallow depth.

The rocks at the shaft are arkosic to argillaceous, slaty greywacke, striking north 70 degrees west and dipping steeply to the north. Two hundred feet to the southeast they are intruded, in irregular fashion, by a dyke of quartz gabbro that is in places intensely fractured and crushed, probably by movement along the nearby Davidson Creek fault. A second gabbro dyke 600 feet southwest of the shaft is exposed only at one place. The sediments come into contact with trachytic lava about 700 feet northeast of the shaft.

Most of the old workings are completely caved, but the vein is visible in a trench for 30 feet east of the shaft. It strikes due east in massive arkosic greywacke south of a bed of slaty argillite, and does not continue in the latter. The vein consists of grey to watery quartz with intergrown ankerite, grain size averaging about one-quarter inch. Pyrite is more abundant in ankerite and wall-rock than in quartz, and there is a small amount of arsenopyrite, chiefly in the wall-rock. Small fragments of included rock are altered to carbonate and pale green mica.

Maps supplied by the company show that the vein was traced continuously in a trench for 60 feet, and that it probably continues for another 70 feet through two other pits. In this distance its width would average about 2 feet or less. For a further 70 feet to the west there are lenticular stringers and some cross veins on the line of strike. Several assays, ranging from $8.20 to $84 a ton in gold, are shown on the map across widths of 13 to 26 inches, in a length of about 120 feet near the middle of the workings. It is reported that 115 pounds of ore extracted from a pit west of the shaft assayed 35 ounces in gold a ton. There are a few lower assays, and the east and west ends apparently were not highly auriferous. Presumably, the values were calculated with gold valued between $20 and $35 an ounce. It is reported that two small veins were cut in the 1938 drilling, but that their gold content was almost negligible.

Another quartz-veined zone and some carbonated rock have been exposed in trenches 600 feet northeast of the shaft, near the contact of sediments and volcanic rocks.

BOUSQUET RAPIDS CLAIMS OF E. J. THOMPSON AND ASSOCIATES

E. J. Thompson and associates control thirty claims west of the lower reaches of Bousquet River and south of Chassignolle Lake. During 1937 and 1938 a small crew of men was engaged in prospecting and trenching, and in 1938 some diamond drilling was done. The claim numbers are A59622 to A59626, A59713 to A59717, A60198 to A60202, A61298 to A61307, A61493 to A61495, A61551, and A61552.

The claims are underlain by volcanic rocks of the Blake River group and by sediments of the Kewagama group. A few exposures of quartz syenite on the south shore of Chassignolle Lake are probably parts of a body of large size. The few known dykes of feldspar porphyry to the south may be offshoots of the main mass. Most of the property north of the Blake River group is covered with swamp or deep drift. The trend of the contact between the Blake River and Kewagama groups swings from nearly due west to northwest in crossing the property from east to west.

Two main discoveries have received most of the development, but as yet no commercial deposits have been proved. A few encouraging gold assays have been obtained from a pyritic replacement body in greenstone on claim A59626, not far north of the wagon road leading west from Bousquet rapids. The lead strikes north 80 degrees west and dips south at 80 to 85 degrees. It has been exposed in trenches for a length of 450 feet and varies in width from a few inches to 2 feet. The chloritic greenstone is, for these widths, heavily charged with finely crystalline pyrite and is converted to pale grey, quartz-sericite schist. At the widest exposure the foot-wall is a pyritic, chlorite schist and the hanging-wall schist is charged with fine-grained pyrrhotite for 6 inches from the "vein". For 3 feet farther south the chlorite schist is impregnated with tiny magnetite crystals, besides being partly carbonated. There is also a marked development of tremolite in rosettes up to an inch across. There is a little chalcopyrite and sphalerite in the pyritic zone. A body of porphyritic andesite with one-eighth inch feldspar phenocrysts in a green, epidotic groundmass lies about 8 feet south of the vein and is up to 40 feet wide. Similar rock is exposed north of the west end of the exposures. It is interpreted as a flow by the writer. Similar rock is found alongside the O'Leary Malartic north vein 4,000 feet to the west. Another, somewhat leaner, pyritic zone has been exposed 200 to 450 feet to the east and a little south of the first, and similar material outcrops on a small scarp 2,000 feet to the east, at the sharp bend in Bousquet River. At the latter place there is 1 to 2 feet of pyrite with pyrrhotite and quartz in schistose greenstone.

Quartz-tourmaline veins and siliceous replacements have been found in greenstone and tuff near the north edge of the Blake River group. Several widely spaced trenches near the middle of the property have exposed one of these for 500 feet. It consists of pyrite, some pyrrhotite and chalcopyrite, and quartz tourmaline veins, across maximum widths of 10 feet. Similar material is found in a pit a quarter mile to the east along the strike of the strata. Some narrow flows of rhyolite occur near the showings. The mineralized zone is on the south side of a large swamp and, presumably, very close to the south contact of the Kewagama group.

At and south of the south contact of the Kewagama group, on the old wagon road from Bousquet rapids to Chassignolle Lake, there are several small veins of quartz, tourmaline, and ankerite. At least one small porphyry dyke cuts the north part of the Blake River group, and some of the rocks are well tourmalinized.

THOMPSON BOUSQUET GOLD MINES, LIMITED

Thompson Bousquet Gold Mines owns fourteen claims, A57823 to A57825, A61480 to A61487, A62354, and A74469, in northeast Bousquet township, east of Bousquet River. Surface work with a small crew began early in 1937 and continued until the autumn. The principal discovery was made in July, and it was probed by several diamond drill holes in the late autumn. Prior to July much work had been done on other showings developed in years past by other companies. The writer examined the property in July and September 1937, before surface work had been completed and before any diamond drilling had been done. He is much indebted to Mr. M. C. H. Little, consulting engineer, for information on all the work done by the company.

GEOLOGY

The claims cover an almost rectangular area a mile from east to west and 4,000 feet from north to south. They are entirely underlain by strata of the Blake River group. Striking north of west through the middle of the property is 500 to 600 feet of rocks that are chiefly rhyolite flows, in part converted to quartz-sericite schist. Intercalated with the rhyolite are minor widths of dacite, trachyte, greenstone, and tuff. North of this band is a maximum width of 2,300 feet of andesitic lavas with a few small bodies of diorite. Particularly near the south contact of this assemblage there are a few narrow flows of rhyolite and dacite. For about 600 feet south of the rhyolite band there is a group of mixed volcanic rocks, predominantly green to grey andesite and dacite flows and tuffs, but including some rhyolite, trachyte, and beds of green agglomerate. They are cut by a few small lamprophyre dykes. For 500 feet to the south, as far as scattered exposures persist, the rocks are highly schistose. They vary in colour from dark green to pale grey and white and are chiefly sericite schist, chloritic phyllite, and chlorite slate. Originally they were probably andesitic to rhyolitic tuff and related thin flows. In the northern half there are thin layers of pseudo-amygdaloid. Considerable widths are carbonated and pyritized and a few mud seams are evidence of faulting in the broad schistose zone. For 400 to 500 feet at the south side of the property bedrock is deeply buried in clay. This area is probably underlain by more massive, acidic lava and agglomerate, the contact between these and the schists to the north being gradational.

Except for local bends and contortions, the beds and the schistosity strike a few degrees north of west and dip 80 to 85 degrees to the south.

MINERAL DEPOSITS

The principal deposit is in chloritic slate and schist 800 feet south of the main rhyolite horizon and 900 feet north of the south boundary of the property. At the time of examination the mineralized zone had been exposed in seven trenches for a length of 800 feet. Green, greenish grey, and light grey slate and schist are interlayered in the trenches. On the north is sericite schist and bands of pseudo-amygdaloid. One trench to the south of the auriferous zone exposes pyritic sericite schist. Most of the rocks are partly carbonated.

The mineralized zone is up to 100 feet wide and has no well-defined walls. Most of the best gold values have been found in green, chloritic horizons. Mineralization consists of seams and disseminations of pyrite along cleavage planes, layers of schist or slate, and small fissures that cut the planes of schistosity at small angles. The sulphides, therefore, impart a pronounced banded appearance that accentuates the original colour banding of the strata. Most of the pyrite is in crystals and grains from $\frac{1}{32}$ to $\frac{1}{4}$ inch in diameter. Casual examination gives the impression that there is practically no quartz in the deposit but closer study shows that many of the narrow seams of pyrite contain tiny eyes and lenses of quartz and albite. Some layers an inch or two across consist of almost equal proportions of pyrite and dark grey quartz, in a chloritic base.

The mineralized zone weathers to a brown gossan that would not ordinarily be considered a likely host for gold, and the freshly blasted, pyritic material looks hardly more promising. However, the company sampled the trenches systematically to depths of 6 feet, with interesting results. For example, in trench 2, 125 feet east of the west boundary of claim A57824, thirty-three consecutive channel samples across a total width of 87 feet yielded assays of 70 cents to $10.50 a ton, gold at $35 an ounce. Four consecutive samples, each 30 inches long, at the north end of the trench, returned $6.65, $10.50, $6.30, and $6.65. The writer took only two samples, in each case chipped from the sides of trenches blasted 3 to 6 feet deep in bedrock. The first was across 8 feet near the south end of trench 1, 110 feet east of trench 2. It assayed 0·56 ounce of gold a ton, whereas the company results across the same width are given as $3.15 a ton. The second sample was taken across the 10 feet in trench 2 that returned the four assays quoted above. The result was 0·12 ounce gold and 0·03 ounce silver a ton.

In May 1938 Mr. Little informed the writer that diamond drilling and trenching had defined a body 1,300 feet long and 60 feet wide that averaged $3.05 in gold a ton, or $2.50 a ton if some erratic high assays are reduced. He also stated that higher gold content is indicated across narrower sections in and south of the main zone.

Other discoveries of less importance have been made. One hundred and fifty feet south of the east end of the main zone a zone has been exposed almost continuously for 225 feet. It lies in carbonated chlorite and sericite schist, and the schist is partly to completely replaced by fine-grained pyrite with a little chalcopyrite and a few grains of pyrrhotite. Small veinlets of brown sphalerite cut the pyrite body, and, particularly along the south side, there are narrow veins of dark grey quartz that carry a little pyrite and muscovite. The width of the sulphide body varies from 2 to 6 feet, and for 100 feet at the east end it branches to form two bodies, up to 5 feet wide, separated by 10 feet of barren schist. The mineralized bands, being carbonated and sericitized, weather white to buff, in marked contrast to the adjoining green or grey schists. The zone strikes a few degrees north of west, approximately parallel to the schistosity of the rocks. It is reported that some samples have yielded $5 to $8 in gold a ton, across widths of 5 feet and less.

Several other showings on the property were sampled in 1937, with discouraging results. A group of lenticular quartz veins is exposed on

claims A61486 and A57824. They lie at and just north of the south contact of the main rhyolite horizon and continue for about 1,300 feet. The quartz is accompanied by tourmaline, muscovite, and in some places by small quantities of pyrite and chalcopyrite. Probably no one vein is continuous for the whole 1,300 feet.

Six hundred feet north of the No. 3 post of claim A61486 a quartz vein from 10 to 12 feet wide is exposed for 90 feet in rhyolite. It carries a little pyrite.

There are a large number of old trenches and two test pits across claim A57825, 600 feet south of the main rhyolite horizon. They expose a series of quartz veins with some pyrite in sericite and chlorite schist. One of the test pits near the west boundary of the claim is said to have shown native gold.

WARRENMAC MINES, LIMITED

Warrenmac Mines, Limited, was incorporated in 1938 to assume control of a property previously held and developed by O'Leary Malartic Mines and Warren MacLean. The eight claims of the group, Nos. A56951, A58413, A58731, A58861, A58862, A59109, A59110, and A61755, are immediately west of the property of Westwood Cadillac Mines. Surface work between 1934 and 1938 resulted in the development of two mineralized zones. In 1938 additional trenching was done and a campaign of diamond drilling was started in the autumn. Bousquet River passes through the southeast corner of the property and trails from Bousquet Rapids and from Mooshla mines lead to the workings.

The claims are underlaid by volcanic rocks of the Blake River group that strike north 75 degrees west to north 85 degrees west and dip 70 to 80 degrees to the south. There are a few exposures in the northern part of the property, chiefly at the west end, and more numerous ones in high, timbered ground in the southern part. Between these a width of about 1,200 feet across the property is low ground, covered by clay and drained by a small stream.

There are a few small exposures of the main rhyolite horizon of the Blake River group in the northern part of the claims. The horizon is probably about 600 feet thick and greenstone and chlorite schist are intercalated with the rhyolite. To the south, at the western end of the property, there are outcrops of greenstone, agglomerate, carbonated and sericitic tuff, and porphyritic andesite, near the North vein. The porphyritic andesite is along and south of the vein and in one place is at least 90 feet wide. It fingers in and out of the schistose rocks along the vein zone in a very irregular manner and is evidently a porphyritic phase of the enclosing lavas.

The exposures for about 800 feet from the south boundary of the property are chiefly hard, massive, siliceous lava and agglomerate. A few of the outcrops of rhyolite show well-preserved pillows, and there are large exposures of aphanitic to porphyritic trachyte and of rhyolite and trachyte breccia. To the north of these massive rocks the strata rapidly become softer, thin bedded, and more schistose. Along the strike of the South vein they include chlorite and sericite schist, carbonated and in part silicified. Included with these are bands of pseudo-amydaloid and a few dense, hard layers of basic lava. The assemblage

is very similar to and is undoubtedly the westerly continuation of the schistose and slaty horizon at the Westwood and Thompson Bousquet properties. Judging by what is known to the east, the drift-covered ground to the north should be underlain by strata similar to and in part more highly schistose than those exposed along the strike of the South vein.

The South vein is exposed in a series of trenches, now mostly caved and flooded, along the south side of claim A58861. It is a pyritic carbonate zone in white to green sericite and chlorite schist. Accompanying veins of dark grey quartz contain pyrite, chlorite, muscovite, and some black tourmaline. The zone strikes north 80 degrees west and dips 70 to 80 degrees to the south. In some parts there are veinlets of sphalerite and small amounts of chalcopyrite. In one of the western trenches dark brown garnet is developed in tiny seams along the schistosity. The width of the mineralized zone is not now fully exposed, but in places it is as great as 25 feet. Assay plans supplied to the writer by W. A. Hastie, secretary of the company, show that a section in the middle of the southern part of claim A58861 is auriferous for a length of 380 feet. The samples taken in a number of closely spaced trenches across widths varying from 5 to 22 feet varied from a trace to $17.15 in gold a ton. The erratic results make it almost impossible to estimate any average grade or width. Some low values were also obtained from trenches 150 feet to the west and from others 360 to 420 feet to the east, on the strike of the mineralized zone. The intervening ground to the east is drift covered.

Two thousand feet west of the main showing, and approximately on its strike, a pyritic carbonate zone has been exposed in several trenches for a length of 300 feet. The zone varies up to 5 feet in width. There are at least four, narrower, pyritic zones within 200 feet to the south. The southernmost is exposed for 21 feet and consists of narrow quartz veins in pyritized, siliceous, sericite schist across an average width of 12 inches. This and the zones to the north have been found to contain some gold. From 250 to 500 feet east of the northern zone some exposures of schist are garnetiferous, and adjoining layers are altered to pseudo-amygdaloid. Epidote and clinochlorite accompany the garnet.

The North vein is on claim A58731, 1,400 feet north of the west end of the South vein. It is a rusty shear in highly altered and sheared greenstone, tuff, and porphyritic andesite. The strike is due east, the dip 70 degrees to the south, and the average width about a foot. It has been stripped for a length of 240 feet. Pyrite is the most abundant mineral. Chalcopyrite is present and there are small lenticular veins of quartz and tourmaline along the shear zone. The displacement along the shear is probably negligible, for it is developed *en échelon* along the strike of the strata, the ends of the constituent shears overlapping slightly and lying up to 5 feet apart. The company's assay plan of the surface workings indicates a very erratic distribution of gold. Several channel sections assayed from $22 to over $100 a ton across widths of 1 to nearly 3 feet. Native gold can be panned from the rusty outcrop.

It has been reported that diamond drilling was done in 1938 to explore the north and south vein zones and that other drilling probed the central, drift-covered part of the property.

WASHINGTON GOLD MINES, LIMITED

Washington Gold Mines, Limited, owns seven claims, R3008 to R3014, inclusive, in range VIII, Joannès township, Quebec. This area consists of the south halves of lots 24 to 29, inclusive, and all of lot 30. Officials of the company report that the seven adjoining lots to the south, in range VII, were staked in 1938 and added to their holdings.

The best access to the property is by a wagon road that goes north 2 miles from the main highway to the line between ranges VII and VIII, and thence 1 mile east to the camp buildings on the southern part of lot 24, range VIII. Trails lead east and northeast from the camp to the several surface showings that have been developed. A transmission line from Noranda to Bourlamaque crosses the northern part of lot 30, range VIII.

The property was owned originally by Notre Dame Gold Mines, Limited. Two quartz veins of some interest were discovered in 1927 and buildings were erected. In 1928 surface work was followed by an electrical survey and diamond drilling. It is reported that eight holes, aggregating 3,000 feet, were drilled during the latter part of that summer and that operations were suspended in the autumn. Some prospecting was done in 1936, under the supervision of A. V. Hannam, and the present company was incorporated in December of that year. During 1937 one of the old log buildings was renovated and a small crew of men was employed in trenching and the sinking of test pits. The property was inactive in 1938.

GEOLOGY

The principal outcrops are on the claims in range VIII and on the northern part of those in range VII. The southern two-thirds of the latter range is largely covered by a swamp. Lots 24 to 28, range VIII, are chiefly on a high, bush-covered ridge that slopes gradually down to the northwest and drops abruptly eastward into swamp on lots 29 and 30. The ridge in range VIII is rough terrain with bare or moss-covered and timbered rock knolls projecting above a smaller proportion of irregularly distributed swamp and low, bush-covered ground.

The property is underlain chiefly by greywacke of the Cadillac group. At the north end of lot 30, range VIII, there are several exposures of massive and pillowed andesite, agglomerate, and tuff. These exposures are near the southern edge of the Blake River group, and the contact between these rocks and the younger Cadillac group to the south must cross lot 30 about 1,000 feet south of range IX. The only intrusive rock found on the claims is a dyke, or two dykes, of quartz gabbro. It follows a curving, northerly course and is about 100 feet wide. The greywacke is a white to grey weathering rock, varying from argillite to arkose and quartzite. The argillaceous beds are darker, softer, and generally more schistose than the others. In range VII the greywacke is locally amphibolitized. The regional strike of the sediments is nearly due east, but on the property the beds are highly contorted so that, with few exceptions, there is a tremendous variation in the strike in any area of outcrops 100 yards or so across. The average dip is northward at about 65 to 80 degrees, with local extremes of 55 degrees and vertical,

and a few southern, dips. The sediments are uniformly fine-grained so that there are no distinctive key horizons, such as conglomerate or quartzite, to use in solving the details of the contortion. Determinations of the upper sides were made at only three places on the property and, in view of the intense contortion, the details of which are unknown, these have little regional significance. However, at the cabins, beds of arkosic greywacke strike north of east and are overturned so that they face south while dipping 55 degrees to the north. Locally the greywacke is schistose or phyllitic; the most pronounced regional schistosity strikes north of east and dips 65 to 75 degrees northward.

The quartz gabbro is known to cut greywacke and greenstone. It is also younger than some of the quartz veins in the sediments. Similar dykes in other parts of the region are known to cut granitic intrusives that invade the sedimentary and volcanic rocks and may be of Keweenawan age.

MINERAL DEPOSITS

There are two types of quartz veins on the property. The first, and probably the older, consists of lenticular veins of dark grey to bluish, vitreous quartz that generally contain small amounts of white feldspar and mica and no metallic minerals. These veins follow fissure or bedding planes in the sediments and their predominant strike is nearly due east.

The second type has been developed by the company. They are veins and vein zones of milky white, coarsely crystalline, and often drusy, quartz mineralized erratically with chalcopyrite, a small amount of pyrite, and, in some places, minute amounts of sphalerite and galena. A small percentage of ankerite, white mica, and chlorite accompanies the quartz in some places. Not uncommonly the quartz has entered brecciated zones in greywacke and has surrounded fragments, forming a vein breccia; in other places the greywacke alongside a vein is silicified and irregularly replaced by the quartz. The veins pinch and swell, and the wider mineralized zones are generally formed by several closely spaced stringers branching from one to the other. The percentage of chalcopyrite in a vein varies greatly; considerable lengths are apt to be essentially barren whereas adjoining parts a few feet long are liberally spotted with specks and small masses of the sulphide. Occasionally vugs are filled with chalcopyrite that is in part crystalline. In places chalcopyrite occurs in the inclusions of greywacke or in the wall-rock an inch or two from the vein proper.

The recent surface work has been concentrated on stripping and the sinking of a number of shallow test pits. The greatest amount of work was done on lot 23, 400 feet east of an old blacksmith shed, where a zone of quartz veins strikes north 60 degrees east in a sheeted zone that cuts obliquely across the strike of the strata. The predominant dip of the quartz veins is 70 degrees to the north. The vein zone is exposed for a length of 150 feet. It ends on the west, but may continue eastward through an old, caved trench and under drift. Two large pits and a stripped area on the east half of the exposure show brecciated and sheeted greywacke, veined and replaced by quartz, across widths that vary up to 5 and 10 feet in the two pits. The quartz is irregularly but well mineralized with chalcopyrite and some pyrite. To the west the vein narrows to a mere stringer that is essentially barren. The vein zone has been probed by old

drill holes about which the writer has no information. Reports of the recent work do not indicate that any appreciable gold content has been proved on the surface.

Two hundred feet west of the blacksmith shed there are two pits, partly caved, on two other veins. The southern pit exposes an easterly trending zone about 5 feet wide that is veined by white quartz stringers similar to those of the eastern occurrence and contains a few small pockets of chalcopyrite and pyrite. One hundred feet to the north another pit shows a vein zone 3 feet wide, mineralized with chalcopyrite and pyrite, that strikes due east and dips 60 degrees to the north. Two other pits to the west of these are caved and flooded. In the easterly one some quartz stringers dipping 65 degrees northward can still be seen. There are many other quartz veins on the property. None of those seen by the writer carry more than a few specks of sulphides and most are barren.

WESTWOOD CADILLAC MINES, LIMITED

Westwood Cadillac Mines, Limited, owns twelve claims and a fraction in northeastern Bousquet township, at the rapids in Bousquet River. The claim numbers are A56592, A56593, A58409 to A58412, A61496, A61497, A73642, and A74667 to A74670. The first intensive work on the property was done in the winter of 1933-34 when it was under option to J. H. C. Waite from E. J. Thompson and associates. Four diamond drill holes were put down after a campaign of deep trenching. After the option was dropped, the property was obtained by O'Leary Malartic Mines, Limited, and additional surface work was done in 1936. In October of that year the Westwood company assumed control and operations continued intermittently through 1938, with F. N. Bidgood as mine manager and J. M. Cohen as consultant. After more surface work and much additional diamond drilling a prospect shaft was sunk to 210 feet in 1938 and about 800 feet of drifting and crosscutting was done from the bottom. Late in 1938 several holes were drilled from the underground workings.

GEOLOGY

The claims cover the southern half of the Blake River group for a length of nearly 4,000 feet, and extend 3,000 feet south over fine-grained sediments of the Cadillac group. All the strata strike nearly due east and dip vertically to 75 degrees south. Planes of schistosity parallel the bedding.

The contact between the Blake River and Cadillac groups is exposed only in a trench at the extreme northwest corner of claim A74670. A width of 103 feet of porphyritic hornblende diorite is exposed in the trench. Hornblende crystals attain a maximum length of three-eighths inch and the rock contains about 2 per cent quartz besides remnants of altered albite (An_6) and a little magnetite and epidote. This rock is bordered on the south by 18 feet of banded, pale green tuff. To the south of this there is 50 feet of banded, argillaceous greywacke striking north 84 degrees west and dipping 80 degrees south. The tuffs and sediments are conformable. On the north of the diorite is 17 feet of fine-grained, grey to green, tuffaceous sediment with the same attitude as that to the south and

bordered on the north by a few feet of andesitic tuff. Low, clay-covered ground borders this on the north, in which direction the nearest outcrops are 800 feet away. These outcrops consist of rhyolite, trachyte, and related agglomerate with cherty fragments up to 4 inches in length. Such rocks are typical of the southern part of the Blake River group in the western part of Bousquet township.

Massive, in part amygdaloidal, andesite and some diorite of the Blake River group are exposed at the north edge of the property in a trench and along the north bank of Bousquet River below the rapids. For about 800 feet to the south bedrock is deeply buried in clay, except at the north boundary of the northwestern claim where a trench exposes 150 feet of schistose rhyolite. This, and a drill hole put out to the north from the underground workings, show that a thickness of about 500 feet of sheared rhyolite, with intercalations of trachyte and greenstone, underlie the clay-covered terrain. The north edge of these rocks must lie only a few tens of feet south of the greenstone exposures at the rapids. The south contact is known from the drill hole to lie about 160 feet north of the mine workings. South of the clay flats an area of high ground about 1,200 feet from east to west and some 500 feet wide is exposed by a number of trenches and has been probed by drill holes. The exposures in this area, chiefly in the northeast corner of claim A58411, are of thin-bedded, grey to green tuff, in places altered to pseudo-amygdaloid (*See* page 11). The rocks are altered to chloritic and sericitic schist and phyllite and are moderately to completely carbonated. On the extreme northeast corner of the high ground a trench exposes 60 feet of andesite lava and flow breccia. These rocks are the direct western continuation of similar strata on the Thompson Bousquet property. They are broken by a number of northeasterly striking faults with very small displacements. It would appear that the band of carbonated schist and phyllite is some 900 feet thick, and that it is bordered on the south by about 1,100 feet of volcanic rocks in which much harder acidic lavas and pyroclastics are abundant.

The four southern claims of the property are underlain by the normal, fine-grained greywacke of the Cadillac group. A few layers are definitely tuffaceous and there are narrow beds of magnetite at intervals from 1,200 to 2,400 feet south of the north contact of the group. A dyke of quartz gabbro up to 300 feet wide intrudes greywacke in the southern part of the property and sends off some irregular apophyses of diabase into the adjoining sediments. The dyke strikes north 30 degrees east and was intersected for 34 feet at the collar of a 1934 drill hole 45 feet northwest of the No. 2 post of claim A58411. It either stops there or, more probably, is deflected sharply eastward, as it does not pass through trenches northeast of the claim post.

MINERAL DEPOSITS

Gold has been found in a number of quartz veins and pyritic replacement bodies in the carbonated strata 1,000 feet south of the river. The original discovery is a mineralized zone that outcropped 300 feet south of the northeast corner of claim A58411. It strikes north 85 degrees west, dips vertically, and has been traced 200 feet by closely spaced trenches. At its extreme east end the lead is only a 10-inch width of quartz and

carbonate, with practically no pyrite; but in the next trench, 30 feet to the west, it has swelled to 5 feet of carbonate-sericite schist, with a little talc, heavily impregnated with pyrite and in parts completely replaced by it. A little chalcopyrite and a few veins of sphalerite up to an inch in width are also present. The country rock is pyritic, grey to greenish grey schist. Ten feet west of this trench the mineralized zone splits into two parts and the southern branch continues at least 80 feet south of west, cutting across the schistosity at a small angle. The northern branch continues west for 170 feet, varying in width from 1 to 3 feet, and is mostly pyrite, but includes a few small quartz veins with little pyrite. Though some visible gold has been found in the zone and some sections have yielded high assays, the gold content is said to be erratic and too low on the average for a successful operation. There are other, narrow, discontinuous zones of pyrite and veins of quartz, ankerite, and tourmaline to the north and south. Some have been found to contain gold.

The North vein was found in trenches on the north edge of the hill, 200 feet west of No. 1 post, and just south of the north boundary of claim A58411. Most of the trenches are caved. A plan supplied by Mr. Bidgood shows that gold assays of a trace to $11.20 a ton were obtained for a length of about 180 feet. The best remaining exposure is in a trench about the middle of the vein zone. It shows sericitic and chloritic schist for a width of 25 feet. The mineralization consists of exceedingly irregular veins and masses of quartz with much black tourmaline, in streaks and patches, and scattered spots and bunches of coarsely crystalline pyrite. Chalcopyrite, ankerite, and white mica are present in minor amount. On the south, at the contact with more massive tuff beds, a width of 5 to 8 feet is well mineralized in this manner. After 5 feet of barren schist another 5 feet on the north is veined by several, closely spaced, irregular stringers, and from 6 to 8 feet north of this another 2 feet of schist is similarly veined. Three trenches, 48, 63, and 93 feet to the east, show maximum widths of 2 feet of similar material at the south edge of the mineralized zone and nothing of importance to the north. Twenty-five feet to the west a trench exposes 7·5 feet of quartz, tourmaline, and pyrite at the south side of the zone and very little to the north. In the schist of the northern part of the zone there is a width of 1 to 3 feet of pyritic carbonate that does not continue for over 25 feet. It is identical with material in the pyritic zone to the south. The general strike of the vein zone is north 80 degrees west.

About sixteen drill holes were put down to probe the north vein at depth. Free gold was found in a narrow section of core from the first hole, in pyritic carbonate, but nothing resembling the quartz-tourmaline zone of the surface was encountered. Other holes disclosed similar pyritic schist at about the same horizon and a prospect shaft was sunk to investigate.

The main crosscut from the bottom of the shaft is largely in structureless to thin-bedded, altered tuff like that in the trenches above. There are many quartz-carbonate lenses, a few, small, pyritic, carbonate zones, and several irregular veins of quartz, tourmaline, and pyrite. The most promising of these was followed by the east drift south of the shaft. Sampling is said to have shown erratic gold content for the length of 40 feet.

Sixty-five feet north of the shaft the rocks become intensely sheared, to soft, generally pyritic, grey to green chlorite and sericite schist with much introduced carbonate. The main "vein", followed by drifts to the east and west, is at the contact of soft, white to pale green schist on the south and darker, chloritic schist and phyllite. In places the latter rock exhibits a texture resembling diorite, but is altered beyond exact determination. A fault of unknown displacement follows the contact. The "vein" is a pyritic carbonate zone from an inch to about 2 feet wide. Lying in pyritic schist, it is accompanied by small lenses and granules of quartz. Much finely divided rutile in the wall-rock is probably of hydrothermal origin. The only gold seen by the writer occurs as tiny specks and veinlets in a one-half inch, lenticular quartz vein in pyrite accompanied by a little chalcopyrite and sphalerite. Native gold or high gold assays are reported to have been obtained for 18 feet west and 51 feet east of the main crosscut, where the backs have been taken down. The width of the auriferous material averaged about 4 inches, and the gold is said to have been associated with an unusual amount of chalcopyrite. Gold content to the east and west was erratic, though the pyritic zone continues strong to the east face of the drift. The main zone dies out 50 feet west of the main crosscut, but another narrow quartz-pyrite zone was found a few feet to the north and was followed by a drift for 80 feet to the west. It lies along a fault for most of this distance.

Provided its southward dip of 75 to 80 degrees is maintained, the vein developed underground would reach the surface well to the north of the north vein exposed in trenches.

The drilling done in 1938 did not encourage development at depth. Native gold was found in the intersection of a quartz vein in schistose rhyolite 370 feet north of the underground workings. Three other holes from underground returned interesting assays from a zone of substantial width some 50 feet southeast of the short east drift south of the shaft. Only some very irregular veins were found in the main crosscut where this zone should cross it.

A number of quartz veins have been found in greywacke in the southern part of the property, but none has been found to contain gold in substantial amount. In the northwest corner of claim A74669 chloritic greywacke is cut by small, gently dipping quartz veins that carry small amounts of biotite, pyrrhotite, pyrite, and chalcopyrite. The greywacke adjoining some of these veins is partly replaced by beautifully developed arsenopyrite crystals that attain a maximum length of over an inch. In other places to the south the sediments are tourmalinized.

OTHER MINERAL DEPOSITS

Many other showings were observed in the area, and a few may be briefly described.

In the northwest corner of Bousquet township, 3,000 feet west of the northwest corner of the Norgold group of claims, there are six old trenches, now partly flooded. They expose highly altered rocks that may have been tuff, andesite, and greywacke originally, near the contact of the Blake River and Cadillac groups. the foliation strikes south of east and dips

vertically or very steeply to the south. Small, steeply pitching drag-folds suggest that the structure may be intricate, but no recognizable horizons that would facilitate correlation between the different trenches were found. The rocks are partly carbonated and are cut by small quartz veins. In the third trench from the west a width of 25 feet is mostly quartz and carbonate, with much fine arsenopyrite in the altered wall-rock. There are lesser amounts of pyrite, pyrrhotite, and chalcopyrite. The next trench to the east, 40 feet away, shows only 2 feet of quartz-veined rock, on the north edge of 40 feet of flooded trench where the main zone might pass. The other trenches do not show any significant mineral, though they also are partly flooded. A sample across 6 inches of the more concentrated arsenopyrite in the main showing is said to have assayed $9 in gold, but much lower values were obtained elsewhere. Several holes have been drilled beneath the trenches at some time in the past. The writer was unable to establish the ownership of the showings.

During 1938 W. Mayrand of LaMotte prospected the area extending some 3,500 feet south of the above-mentioned trenches. In two places, 1,400 and 2,700 feet west of the southwest corner of claim A57366, the rocks are brecciated and silicified, and in part replaced by carbonate, garnet, and chlorite. Pyrite and some pyrrhotite occur with the other minerals. The west showing of this material is 110 feet wide, and the east one about 20 feet. So far as the writer knows no gold content has been proved. The two showings may be part of a single mineralized horizon, striking north 80 degrees west, or they may have no direct connection. The complexities of the local geology are referred to on page 15.

Early in 1938 Mr. R. Peterson did some prospecting in range X, Joannès township. He discovered a zone, 10 feet wide, of quartz and tourmaline in lot 37 about 800 feet south of the north boundary of the township. It lies a short distance east of a dyke of quartz and was only exposed in one trench when the writer saw it. Five hundred feet to the west some very old trenches are now largely caved, but judging by float and a few exposures they also showed good widths of quartz.