CANADA
DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH
BUREAU OF GEOLOGY AND TOPOGRAPHY

GEOLOGICAL SURVEY

MEMOIR 233

CLÉRICY AND LA PAUSE MAP-AREAS, QUEBEC

BY
J. W. Ambrose

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

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INTRODUCTION

La Pause map-area extends from 48° 15′ to 48° 30′ north latitude and from 78°30′ to 78°45′ west longitude. Cléricy map-area extends from 48°15′ to 48°30′ north latitude and from 78°45′ to 79°00′ west longitude. Together they cover an area of about 400 square miles, and include parts or all of Destor, Aiguebelle, Manneville, Dufresnoy, Cléricy, La Pause, Rouyn, Joannès, and Bousquet townships.

Field work, except in Rouyn, Joannès, and Bousquet townships, and in a small area around Lake Dufault in Dufresnoy township, was done as for publication on a scale of 1 mile to 1 inch. In Rouyn, Joannès, and Bousquet townships the field work was plotted on a scale of 1,000 feet to 1 inch, and around Lake Dufault on a scale of 800 feet to 1 inch.

The examined parts of Bousquet, Joannès, and Rouyn townships cover the area between Cadillac township, described by H. C. Gunning in Memoir 206, and Noranda district, mapped in detail by M. E. Wilson. The north halves of Joannès and Bousquet townships were examined by Gunning, and described by him in Memoir 231, now in press. The northeast quarter of Rouyn township was examined by the writer. Because it forms part of the series of areas mapped in detail from Malartic to Noranda, this part, named the Lake Routhier area, is published separately. It is drawn to the same scale as the other areas mapped in detail, i.e., 1,500 feet to 1 inch, and accompanies this report. It includes both the eastern extension of structures from the Noranda district and the westward extension of structures from the Joannès district, and is, therefore, of considerable interest to prospectors.

The Lake Dufault area adjoins the eastern boundary of the detailed geological maps of the Noranda district and the northern boundary of the Lake Routhier area. The Lake Dufault area is of economic interest because it forms the eastern extension of the igneous complex in which was found the 'Lower A' ore-body on Waite-Amulet and Lake Dufault ground, just west of Lake Dufault.

All townships within Cléricy and La Pause map-areas, except Aiguibelle and Bousquet, are subdivided. Colonization roads make travel relatively easy within Destor, Dufresnoy, Cléricy, and Joannès townships. Manneville and La Pause townships may be reached via Kinojevis River and Lake La Pause, or from the main highway just south of the district between Noranda and Val d'Or. Branch roads from it lead to the Arrowhead, Cassels-Duval, and Mooshla mines. Thriving settlements, with post offices and general stores, are located at Davangus, Cléricy, and Mont-Brun, and each is connected by an all-weather road to the main highway between Noranda and Macamic.

Unfailing courtesy and kindly assistance were given by those of the mining fraternity with whom the writer came in contact, by the officials of the Quebec Department of Lands and Forests in charge of colonization, and by the colonists themselves. The writer wishes to thank particularly Mr. W. C. Martin for stimulating discussion of many problems. Independent mapping was done, as assistants on the parties, by Gordon N. Fasken in 1937 and 1938, by Norman R. Snively in 1938, and by J. M. Harrison in 1939. Junior asssitants included J. A. Boileau, J. B. Bussey, and J. G. Runnells.

PREVIOUS WORK

M. E. Wilson made reconnaissance surveys over large parts of this district prior to 1918. Earlier work is adequately summarized in his reports on the Kewagama Lake map-area, and on Timiskaming County, Quebec. In 1924 W. F. James and J. B. Mawdsley mapped the Clericy area, which included both the present Clericy and La Pause map-areas, on a scale of 1 mile to 1 inch. In 1930 L. V. Bell reported in detail on the geology of the Bouchard-Collier claims and vicinity, and in 1923 H. C. Cooke reported on certain of the mineral deposits and prospects within the area. In 1931 Cooke, James, and Mawdsley collaborated in a report on the geology of the Rouyn-Harricanaw region. In 1937 and 1938 H. C. Gunning mapped the northern parts of Joannès and Bousquet townships, and H. M. Bannerman examined, for the Quebec Bureau of Mines, a small area in and somewhat beyond the extreme northwest corner of Clericy map-area. The writer is indebted to Dr. Bannerman for information concerning the geology in this part of the area.

W. C. Gussow joined the writer's field party late in June 1938, and was in charge of field work within that area during the remainder of the season. The writer's field work therein covered three field seasons; La Pause map-area was mapped in 1937; part of the Clericy area and the northeast corner of Rouyn township were examined in 1938; most of the 1939 field season was used in completing the examination of the Clericy area, and in mapping in detail the east half of Lake Dufault and immediate vicinity.

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Map 328A: The Rouyn-Bell River Area, Abitibi and Témiscamingue Counties, Quebec; Geol. Surv., Canada, Pub. 2404 (1936).

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PHYSICAL FEATURES

The area covered by Clericy and La Pause map-areas falls naturally into three physiographic divisions: the northern range of the Abijevis Hills; the central lowland; and hilly country in the south and southwestern parts of the area.

Abijevis Hills cover most of the southern halves of Destor, Aiguebelle, and Manneville townships. They consist entirely of volcanic rocks and constitute one of the most rugged areas in this part of the Canadian Shield. The highest hills are found around La Haie and Macnamara Lakes, where vertical cliffs of 150 feet are common, and the total relief approximates 500 feet. The ridges trend east and west. In Destor township they break up into isolated knobs that decrease gradually in elevation towards the western margin of Clericy map-area. East of La Haie Lake, though the ridges are somewhat lower, the range persists to the eastern edge of La Pause map-area.

The central lowland is a clay-covered plain, with here and there a few outcrops of bedrock protruding through the surface mantle. The bedrock underlying the plain is made up of sedimentary and volcanic rocks folded into a westerly plunging anticline. As the sedimentary beds that flank the fold approach one another towards the west, the width of the lowland decreases from about 12 miles on the eastern side of La Pause map-area to less than a mile in Destor township at the western edge of Clericy map-area. This lowland is being settled and should, when cleared, be comparable as farming country to that around Amos and Senneterre. The lowland is interrupted near the juncture of the Clericy, Dufresnoy, Destor, and Aiguebelle township lines by a prominent group of hills underlain by a stock of syenite.

The hilly country in the south and southwest parts of the map-area is similar to, but with generally lower relief than, Abijevis Hills. The northwestward extension of these hills around Dalembert Lake has been named the Camac Hills. The hills, more or less isolated in areas covered by glacial drift and clay, are formed mostly of volcanic rocks, sharply folded and cut by several fairly large bodies of intrusives of various types. The highest hill in southwestern Clericy township, with a relief of some 400 feet, is part of a dyke of resistant diabase. Another commanding group of hills just south of Dufresnoy Lake is formed mainly of dykes of gabbro. Areas underlain by granitic rocks are in most cases somewhat lower than their surroundings.

A large delta-esker, one of the system recently figured by J. T. Wilson[1], crosses La Pause map-area from north to south along or near the town-

[1] Wilson, J. T.: Glacial Geology of Part of Northwestern Quebec; Trans. Roy. Soc., Canada, Sec. IV, pp. 49-59 (1938).

ship line that divides Aiguebelle, Cléricy, and Joannès townships from Manneville, La Pause, and Bousquet townships. It is a broad ridge of sand and gravel about 2 miles wide, with very gently sloping sides. The depth of debris in the esker is undoubtedly variable, but where it crosses Abijevis Hills all but the highest peaks are buried; the debris must be 350 to 400 feet deep in the valleys. The surface is pitted with kettle-holes and dotted with large boulders. Perfectly preserved north-facing sets of beach lines cross the esker near the southern edge of Cléricy and La Pause townships. The beaches are formed almost entirely of wind-blown sand, and the sand-plain south of the beach lines is dotted with well-preserved dunes.

Wave-cut beaches are also to be found at a much higher elevation in several places on the sides of Abijevis Hills. These beaches, with terraces 25 to 50 feet or so wide, are covered with well-rounded pebbles and cobbles of volcanic rocks to 6 inches in diameter. The elevations were not determined accurately, but they are roughly about 1,500 feet above sea-level. The hilltops, which project 75 to 150 feet above the beaches, are crowned with heavy drift and probably were islands when the lake that cut the beaches existed. J. T. Wilson has described a very similar situation around Plamondon Hill, 50 miles north in Mistawak area[1], and the approximate elevation of the shoreline there is 1,500 feet. This correspondence suggests that both the Abijevis beaches and those around Plamondon Hill represent the upper limits of Lake Barlow-Ojibway. More accurate determinations of elevations in both places might give information regarding relative changes of level since the lake disappeared.

The height of land between James Bay and Ottawa River waters follows Abijevis Hills. The southern and much the greater part of the area is drained by Kinojevis River, a broad, sluggish stream with an average gradient of less than a foot per mile. Most of its course lies in the clay-mantled lowland, but south of Cléricy its course is in a pre-glacial valley cut deep in bedrock. However, neither in the lowland nor in the valley has the river cut through the surface clay except for short stretches.

GENERAL GEOLOGY

GENERAL STATEMENT

The rocks of Cléricy and La Pause map-areas are early Precambrian in age. They consist of a succession of volcanic and sedimentary strata that from oldest to youngest have been subdivided into four groups, as follows: a volcanic group of unknown thickness, overlain with apparent conformity by a sedimentary group nearly 2 miles thick, followed conformably by a volcanic group that ranges from 5,000 to 16,000 feet thick, and this in turn by an uppermost sedimentary group of unknown thickness. These groups have been named, respectively, the Malartic, Kewagama, Blake River, and Cadillac groups, and have been shown to be areally continuous with the type sections for these groups in Cadillac and Malartic townships.[2]

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[1] Op. cit., p. 57.

[2] Geol. Surv., Canada, Memoirs 206 and 222.

The lowermost three groups of this succession were classified as Keewatin by James and Mawdsley in 1924[1], and the uppermost, or present Cadillac group, was placed in the Timiskaming.[2] In 1931 Cooke, James, and Mawdsley retained "Keewatin" for the volcanic rocks of this area, but classified the Cléricy band of sedimentary rocks tentatively as Timiskaming.[3] The Cléricy band, a layer of sedimentary rocks that extends diagonally across Cléricy and La Pause map-areas from northwest to southeast, is now known to be areally continuous with that part of the Kewagama group exposed on the north limb of the Cadillac-Malartic syncline. It lies between and separates the Malartic from the Blake River volcanics. It cannot, therefore, be classified as Timiskaming. In fact, if Keewatin and Timiskaming were to be retained as stratigraphic names in these map-areas, the most logical division would be that adopted by James and Mawdsley in 1924, for it has the virtue of placing all the volcanic rocks, albeit with a 2-mile thickness of interbedded sedimentary rocks, in the Keewatin, and of restricting Timiskaming to the principal conglomerate-bearing group, the Cadillac. However, as Gunning and Ambrose have shown, this leads to such serious complications elsewhere that it seems advisable to drop the terms Keewatin and Timiskaming altogether and to use local names with no regional connotation beyond the area mapped. This usage is followed in this report; the group names, as defined in Memoir 222, are used because the stratigraphic units so designated are areally continuous from Malartic through La Pause and Cléricy map-areas.

Table of Formations

Proterozoic (Late Precambrian)

Keweenawan (?): quartz diabase and olivine diabase

Archæan (Early Precambrian)

Albite and quartz-albite porphyry; minor albite granite; felsite; granodiorite grading to quartz diorite and to granite; alaskite; aplite; lamprophyre

Aegirine-augite syenite

Olivine gabbro and periodotite; pyroxenite; serpentine

Diabase; quartz diabase; gabbro; quartz gabbro

Diorite and quartz diorite

Cadillac group: greywacke, slate, bedded chert; stratified tuff; beds of magnetite and iron formation

Blake River group: andesite, dacite, and rhyolite; related pyroclastic rocks; minor greywacke

Kewagama group: greywacke and some slate; interbeds of andesite and dacite; minor conglomerate, in part agglomeratic

Malartic group: andesite and dacite; some rhyolite; related pyroclastic rocks

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[1] Geol. Surv., Canada, Sum. Rept. 1924, pt. C, pp. 105-109.

[2] For a more complete review of the history of classification *See* Gunning, H. C., and Ambrose, J. W.: The Keewatin-Timiskaming Problem in the Rouyn-Harricanaw Region, Northwestern Quebec; Trans. Roy. Soc., Canada, 3rd ser., sec. IV, vol. 33, especially pp. 41-44 (1939).

[3] Geol. Surv., Canada, Mem. 166, pp. 60, 61.

MALARTIC GROUP

DISTRIBUTION AND THICKNESS

The Malartic group occupies a roughly triangular area in the central lowland. The group appears in the central part of a westwardly plunging, faulted anticline, so that the area occupied by the rocks of the group tapers westward from a width of 8½ miles on the east boundary of La Pause map-area to a pointed tip that just crosses the east boundary of Clériсy map-area. As a consequence of structural interpretation, a narrow continuation of the group is shown north of the Kewagama group across Clériсy map-area. If the large strike fault assumed there as the north boundary of this narrow strip should lie south of the position indicated on the map, for example, along the north boundary of the Kewagama group, all but a tiny triangular tip of the Malartic group near the east margin would be eliminated from Clériсy map-area.

The thickness of this volcanic pile cannot be determined, as the bottom is unknown. Even the thickness exposed within the area can only be guessed, for the anticlinal axis that falls within the group can be placed only within wide limits. A rough approximation from information available across the southern and best exposed limb of the fold suggests 16,000 feet as a possible maximum thickness, with the bottom unknown. In the Malartic area the group is known to be at least 10,000 feet thick.[1]

DESCRIPTION

The largest area of good exposures of rocks of this group is east of Kinojevis River, in range VII, Clériсy township. Good exposures of smaller extent occur south of Lake Patris in ranges III and IV, La Pause township. Elsewhere exposures are small, scattered, and poor.

Andesites and dacites altered to greenstones form the bulk of the group. Many of the flows show the familiar pillow structures; breccias and tuffs are common. With them are associated some fine- to coarse-grained diorites and granodiorites, which may be either extrusive or intrusive.

Thin sections show that the rocks are now composed of secondary minerals, with albite, quartz, epidote, chlorite, actinolitic amphibole, and carbonates the most common. A curious feature, noted by several authors in descriptions of similar altered flows, is that in spite of the almost complete destruction of the original minerals, the gross features of structure, such as pillows, and even delicate ophitic and variolitic textures, are sufficiently well preserved in unsheared rocks to be readily recognized.

Rhyolite breccias and tuffs, with some interbeds of siliceous sedimentary rocks and possibly some rhyolite flows, are exposed in Clériсy township east of Kinojevis River on range line VIII-IX along the sides of a diabase dyke. They are not known elsewhere within the group; their position suggests that they lie near the upper part of the group, and outcrop just across the nose of the anticline. The rocks, like the more basic varieties of volcanics, are now composed almost entirely of secondary albite, quartz, sericite, chlorite, amphibole, and epidote.

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[1] Mem. 222, p. 7.

Clastic sedimentary rocks, in addition to those associated with the rhyolite tuffs noted above, were observed interbedded with volcanic rocks in lots 20 and 21, range IV, La Pause township, on mining claims held by the La Pause Gold Mining Corporation, Limited. Thin beds of black, siliceous slate, a little greywacke, and one or two beds of conglomerate in which all the pebbles are of volcanic rocks, are interbedded with chloritic tuffs and breccias. The clastic sedimentary rocks occur through a stratigraphic thickness of 400 feet, of which at least 90 per cent is of strictly volcanic origin. The small extent of these sedimentary strata, their stratigraphic associations, and the character of the conglomerates all indicate that there were small temporary basins on the surface of the lava field with intermittent sedimentation.

RELATIONS OF THE MALARTIC GROUP TO THE KEWAGAMA GROUP

Structural observations, listed under "Structure", show that the Malartic group occupies the central part of a plunging anticline. It comprises the oldest rocks exposed in the area, and is overlain on both flanks of the fold by sedimentary strata of the Kewagama group.

The contact between the two groups is exposed in only one place, on the south limb of the fold in lots 57 and 58, across range line VI-VII, Clériey township. There it can be followed, in spite of short, drift-covered stretches, for 1,700 feet. Elsewhere along the south limb outcrops are too few, even where most numerous, to locate the contact within 1,000 feet or more, and over most of its length of 24 miles in these areas its position can only be approximated.

The well-exposed contact noted in lots 57 and 58 is near the south side of a series of strike ridges formed on pillowed and massive flows, with some breccias and tuffs. The volcanic rocks are intruded by several varieties of granitic dykes and serpentine. Many reliable determinations on pillows in these ridges show that the flows face southwest; their dips range from 65 degrees southwest to vertical, and the average is probably between 75 and 80 degrees. The actual contact, where exposed, is between pillow lavas of the Malartic group and a conglomerate-bearing member of the Kewagama group. The succession from north to south (lower to upper) near lot post 57-58 is as follows: andesitic pillow lavas with long axes of the pillows parallel to the contact and with tops south; 40 feet of conglomerate or breccia composed of angular to rounded fragments of greenstone and felsite in a matrix of coarse, chloritic greywacke; 20 feet of coarse, chloritic greywacke free of pebbles; 100 feet of alternating beds of conglomerate and greywacke 1 to 15 feet thick; normal greywacke. The upper conglomerate beds are composed of squeezed pebbles of greenstone, felsite, quartz-feldspar porphyry, and feldspar porphyry. A few pebbles of sugary quartz and two of dark blue chert or very fine-grained quartz were observed. Elsewhere in this section a layer of well-bedded tuff 15 feet thick is exposed within the Kewagama strata 100 feet above the contact with the underlying volcanics, but its contacts with the adjacent sedimentary beds are not visible.

The conglomerate-bearing layer can be followed through nearly continuous exposures for 2,000 feet southeast of lot post 57-58. It outcrops

again in lot 60, rge. VI, Cléricy tp., and 2½ miles farther southeast, in lot 9, rge. IV, La Pause tp., another outcrop of conglomerate is probably to be correlated with this layer. Northwest of lot post 57-58 the conglomerate-bearing layer can be followed for 4,500 feet, but it there disappears under drift and does not appear again at the contact exposed on the east shore of Kinojevis River in range VII, Cléricy township. West of the river, in lots 28 and 29, range IX, a dyke of feldspar porphyry, believed to be near the contact, carries inclusions of conglomerate. Again in lot 16, rge. X, Cléricy tp., an outcrop presumably near the same contact is composed of greywacke with beds to 10 feet thick of conglomerate. Pebbles in this latter conglomerate are squeezed, and all noted are of felsite.

Thus a conglomerate-bearing layer, up to 150 feet thick, is exposed in several places at or near the contact between the two groups for 14 miles. The pebbles are almost exclusively of volcanic rocks, and the chloritic matrix probably had much finely divided, basic, volcanic detritus. These features suggest that the contact is an erosional unconformity, but the presence of the interbedded layer of chloritic tuff in the overlying sediments and the complete lack of any angular discordance between the strata of the two groups indicate, first, that no period of folding intervened between Malartic and Kewagama time, and second, that volcanism persisted even after deposition of Kewagama sediments began. It may be supposed, therefore, that an irregular surface on a lava field was first smoothed off, that the coarse detritus accumulated over considerable areas of this smoothed-off surface to form the conglomerate-bearing layer at the bottom of the Kewagama group, but that minor volcanic outbursts persisted even after sedimentation had begun.

KEWAGAMA GROUP

DISTRIBUTION AND CORRELATION

The Kewagama group consists mainly of sedimentary rocks. It overlies the volcanic rocks of the Malartic group and is overlain by those of the Blake River group. The strata of the group outcrop on both flanks of the main faulted anticline. Along the southwest flank they form a band ½ mile to 3 miles wide, which strikes diagonally across both La Pause and Cléricy map-areas from Chassignolle Lake on the southeast to the Davangus highway on the northwest. This band was formerly named the "Cléricy band of sediments".[1] It extends southeast and east beyond the limits of La Pause map-area across Bousquet, Cadillac, and Malartic townships along the north flank of the Malartic syncline. It ends in the northwest corner of Cléricy map-area against the Destor fault.

The correlation of the "Cléricy band" with the Kewagama group in the north limb of the Cadillac-Malartic syncline is of fundamental importance in any interpretation of the geology of the district. Outcrops in the critical area south of Chassignolle and Kewagama Lakes[2] are referred to by Gunning and Ambrose,[3] as follows: "The beds dip steeply south or are vertical; the strike near the east side is due west, but about the middle it changes gradually to northwest. Outcrops at either end are satisfactory,

[1] 1924, pp. 107-109.

[2] Geol. Surv., Canada, Map 612A, Bousquet-Joannès, Sheet 1.

[3] Gunning, H. C., and Ambrose, J. W.: The Timiskaming-Keewatin Problem in the Rouyn-Harricanaw Region, Northwestern Quebec; Trans. Roy. Soc., Canada, 3rd ser., sec. IV, vol. 33, pp. 23, 24 (1939).

but there is a gap in the middle of over 3 miles bridged by only two small areas of outcrop. The situation of these outcrops, the gradual change in strike, the proven continuity of the Blake River group to the south, and the apparent though less certain continuity of the Malartic group to the north all lead to the conclusion that the Kewagama strata of Cadillac Township must be correlated with the Clériсy band.

"The importance of this correlation is clear. First, the Clériсy band is a continuation of a single, south-facing band of strata, the Kewagama group, and is thus itself a single south-facing band and not a down-folded syncline of sedimentary rocks as previously supposed. This conclusion has been fully confirmed in Clériсy Township by determinations of top by means of pillow lavas under the band, by gradation in grain size, cross-bedding, and stream-channelling within it, and again by pillow lavas over it; with one dubious exception, they all face south. The Clériсy band, consisting of some 10,000 feet of sedimentary strata, thus actually lies between and separates two volcanic series."

On the north limb of the anticline sedimentary rocks outcrop in a strip that trends west, and which narrows from 1½ miles wide on the east side of La Pause map-area to 1,500 feet wide near its western termination against the Destor fault in range X, Clériсy township. The eastern extension of this part of the group is not certainly known, but James and Mawdsley found outcrops of sedimentary rocks along the strike at least as far east as Ste. Raphael on Kinojevis River.[1]

Structural determinations show that this formation faces north and lies on the north limb of the main anticline. Although the presence of a fault of large displacement near the south flank of the fold throws some doubt on correlations of the strata of the limbs, the petrographic similarities between the sediments composing the layers on either limb, the similarity of the stratigraphic succession on either limb, and the present structural interpretation all point to the probability that the two sedimentary bands are both parts of the Kewagama group.

Both lie within the central lowland. Exposures along the southwestern limb are small and scattered in La Pause map-area, except along Clayhill Rapids and in lots 56 to 60, rge. VI, Clériсy tp. In Clériсy map-area, several fair-sized hills, mostly burnt bare, and a few smaller but clean exposures along colonization roads, serve to demonstrate the continuity of the band. On the northern limb exposures near the east side of the map-area are limited to a small hill in lot 36 and a tiny exposure in lot 26, both on range line IX-X, La Pause township. West of lot 22 in the same township outcrops are more numerous, and in lots 10 to 15, range X, a nearly complete cross-section can be observed. Other good exposures are found in Clériсy township along the flanks of a diabase dyke in ranges IX and X, east of Kinojevis River. West of the river exposures are poor, and as the group apparently includes more and more volcanic material

[1] James, W. F., and Mawdsley, J. B.: La Motte and Fournière Map-Areas, Abitibi County, Quebec; Geol. Surv., Canada, Sum. Rept. 1926, pp. 61, 62, and Map 189A.

towards the west, the boundaries are placed with increasing difficulty and uncertainty in that direction. The limits shown, especially west of Caste Lake, may be seriously misplaced.

THICKNESS

The thickness of the group on the south limb is difficult to estimate with accuracy because of marked variations in dip within short distances along or across the strike, and because minor contortions result in duplications of beds. Thus if the average dip near Chassignolle Lake be taken as 60 degrees southwest, the thickness there is 3,500 feet. On the other hand, in the northwest quarter of Cléricy township, where the exposed width is about 15,000 feet, the beds are overturned and dip 60 to 80 degrees northeast. If 70 degrees be taken as an average, and possible duplications be disregarded, the calculated thickness is about 14,500 feet.

The thickness of the group on the north is similarly difficult to determine. The greatest outcrop width is 11,000 feet and dips range from 70 to 80 degrees north, so that a thickness of 10,500 feet may be possible. At the western end of this band, where its boundaries are uncertain because of the intercalated volcanic materials, the thickness is doubtful, and about all that can be said is that sedimentary beds are interbedded with volcanic materials through a stratigraphic thickness of some 1,500 to 2,000 feet.

DESCRIPTION

The Kewagama group in La Pause and Cléricy map-areas consists chiefly of argillaceous to arenaceous greywacke. Bedding is well developed, and gradation from coarse-grained, arenaceous bottoms to fine-grained, argillaceous tops in beds ½ inch to 6 inches thick is common. Crossbedding is uncommon, and only one or two instances of minor stream-channelling or scour were observed. Sorting of the sediments is excellent. Clastic quartz grains in the coarser greywackes average between 1 and 2 mm. in diameter; in the finer varieties they are about one-tenth that size. Growth of the quartz grains due to metamorphism is, in general, negligible. They are, for the most part, subangular to well-rounded, detrital grains.

Thin sections of greywackes from both limbs of the anticline show them composed of a remarkably uniform, simple suite of minerals. Quartz, albite (An_{3-5}), biotite, chlorite, and epidote in various proportions are invariably the main constituents. Many of the quartz grains have sutured margins, but some are clearly detrital. Many of the albite grains, on the other hand, are charged with poikilitic inclusions, and have deeply sutured borders. Few of the large quartz grains are free of strain shadows and many are cracked and broken, whereas those of albite, though generally flecked with sericite, show little or no effects of mechanical deformation. These features suggest that whereas quartz is an original, little changed constituent, albite has formed within the rocks as a result of metamorphism, some time after deposition.

Biotite, as well, has formed since the beds were deposited. Nearly all the flakes lie parallel to the schistosity, but some are grown across the planes of schistosity and are themselves undeformed. Chlorite and sericite, and probably epidote as well, are of similar late origin.

Conglomerate beds occur at or near the base of the Kewagama group on both limbs of the fold in La Pause map-area. The discontinuous conglomerate-bearing layer along the north contact of the southwestern limb has already been described. Conglomerate beds are found on the north limb at the south end of a ridge of granitic rock in lot 13, rge. IX, La Pause tp., along the flanks of the large diabase dyke east of Kinojevis River in range IX, Cléricy township, and a mixture of conglomerate and breccia is exposed on the colonization road across lot 48, rge. IX, Cléricy tp.

The conglomerate in lot 13, rge. IX, La Pause tp., carries squeezed pebbles, 6 inches or less in intermediate diameter, of greenstone, coarse-grained diorite, quartz-bearing granitic rocks, andesite porphyry, and felsite. Along the diabase ridge three beds of conglomerate are exposed, the largest of which, with interbedded greywacke, is 100 feet thick. Pebbles of feldspar porphyry, quartz-feldspar porphyry, greenstone, felsite, and quartz were observed, but none of granitic rocks.

The greywackes and conglomerates change little, if at all, in composition in 8 miles along the strike, from the east side of La Pause map-area to the outcrops along the diabase dyke. However, outcrops ½ mile west of this dyke, along the east bank of Kinojevis River, indicate that a great change takes place in that short distance to a mixed assemblage of basic tuffs, breccias, conglomerates, agglomerates, and greywackes. West of the river pillow lavas and massive flows appear also, and at least half of the group is of volcanic origin. Although there are small exposures of argillaceous greywacke on the south shore of Caste Lake and along the flanks of the north-south diabase dyke in lots 35 and 36, rges. IX and X, Cléricy tp., the outer limits of the group are quite uncertain. No outcrops of the group were found west of this dyke, and the westward extension of the sediments into Cléricy map-area is assumed.

About the middle of the Kewagama group in lots 40 to 43, rge. II, Destor tp., beds of conglomerate with many unusual characteristics occur through some 1,500 feet of section. The conglomerate beds range in thickness from rows of pebbles ½ inch to 6 inches in diameter, in coarse greywacke, to beds 200 feet thick. In the thick beds sorting is very poor, with fragments, sharply angular to subrounded, which range from pebbles ¼ inch in diameter to boulders and blocks 4 feet across.

Good exposures of the thickest bed of conglomerate appear in bare outcrops just south of the Beattie tramway, in lots 40 and 41, rge. II, Destor tp. The proportion of fragments to matrix is high, in many places over 90 per cent. The most remarkable feature of these conglomerates is that 90 per cent or more of the fragments are of felsite and feldspar porphyry. The felsite is a white-weathering, acidic, dense rock with a few tiny phenocrysts of feldspar. The feldspar porphyry carries phenocrysts of feldspar 1 cm. long in a medium-grained matrix of quartz, feldspar, and chlorite. The matrix of this conglomerate is variable, and ranges from fine-grained, highly chloritic, sheared material to coarse, chloritic greywacke. Other types of fragments are rare, but a few of banded red and black jasper, one or two of quartz, and one of a granitic rock were discovered.

The beds of conglomerate are interbedded with greywacke of various types. In particular, some thick, poorly sorted conglomerates are overlain,

underlain, or both, by thin-bedded, argillaceous greywackes. Thus, conditions of sedimentation changed abruptly. The conglomerate is of unusual composition, as the pebbles consist almost entirely of two types of volcanic rock, many of them sharply angular or poorly rounded. These facts, taken together, suggest that deposition of fine-grained greywacke was interrupted from time to time by heavy falls of volcanic material, which was then partly reworked by water action.

Conglomerates and agglomerates occur in the upper 2,000 feet of the Kewagama group on the southwest limb of the fold, outcropping on the hill on the Dufresnoy-Clericy township line, range VIII-IX, and again in lots 4 and 5, rge. VIII-IX, Clericy tp. On the township line an agglomerate or conglomerate bed 30 feet thick consists of angular to subrounded fragments 6 inches across of andesite porphyry, a few of pink feldspar porphyry, and felsite. One block of rhyolite 18 inches across and one or two fragments of scoria were seen. This agglomerate bed grades northward (downward) into an agglomerate with only white-weathering felsite fragments 2 inches or less across in a highly chloritic matrix. The coarse agglomerate is overlain by 4 feet of coarse, chloritic greywacke. The greywacke is succeeded to the south by 80 feet of pillow lava, followed successively by 100 feet of agglomerate, some 400 feet of agglomerate and coarse greywacke, and a lens of massive and pillowed dacite. This part of the section may be the thin southeast end of a lens of volcanic rocks extending some 2½ miles northwest and widening to about 1,000 feet. The flows and agglomerates are succeeded in turn by about 500 feet of well-bedded, argillaceous greywacke, which must lie close to the upper, drift-covered contact of the group.

Two tiny outcrops of volcanic rocks in lots 13 and 14, rge. VIII, Clericy tp., lie in the upper part of the group about 2 miles to the southeast of the lens mentioned above, and may be part of another smaller lens.

Agglomerate in lot 19, rge. VII, Clericy tp., about 1,000 feet north of Kinojevis River is identical in appearance and composition with the coarse agglomerate described above. On the south shore of the river, in lot 17, a similar agglomerate with sharply angular fragments of felsite and feldspar porphyry 1 to 2 feet across is exposed. This rock must be very near the upper contact of the group. Again in lot 20, range VI, tuffs and breccias are interbedded with greywacke.

Thus as the Kewagama period drew to a close normal sedimentation was interrupted from time to time by deposition of volcanic material. It will be recalled that the Kewagama sedimentary layer exposed on the north limb thins to the west, and in place of 11,000 feet of normal greywacke with a few beds of conglomerate there appear some 1,500 feet of interbedded volcanic and clastic rocks. On the basis of the volcanism, it may be that the upper 2,000 feet of the Kewagama group on the south limb is correlative with this 1,500 feet on the north limb. On the south limb, however, a thick series of sediments lies below the volcanic and sedimentary mixture. If the suggested correlation is made, it follows that while the lower sediments on the south limb, free of volcanic material, were accumulating, no deposition occurred farther north. The Kewagama group would, therefore, be unconformable on the Malartic group in this part of the north limb. In addition, large-scale irregularities in the surface

of the Malartic lava field are suggested by the increase in thickness of the Kewagama group from 1,500 feet at its western end on the north limb to some 11,000 feet 5 miles east.

RELATIONS OF THE KEWAGAMA GROUP TO THE BLAKE RIVER GROUP

The Kewagama group, composed mainly of sedimentary rocks, is overlain by the Blake River group, composed mainly of volcanic rocks. The contact between the two groups is exceptionally poorly exposed, even for this country. It was observed in only three places, in an overall length of contact of 42 miles.

Gunning describes an exposure of the contact on the old road from Bousquet River to Chassignolle Lake. There, banded, tuffaceous greenstone is bordered conformably on the north by arkosic and argillaceous greywacke.[1]

The second locality is in lot 28, just north of the Bousquet-La Pause township line, where the contact was exposed in a trench. Well-bedded, strongly sheared greywacke is overlain by schistose greenstone, which, farther south, can be seen to be pillowed. The beds dip 60 to 70 degrees south, face south, and are apparently in structural conformity. The third place is in lot 24, rge. VII, Cléricy tp., where a narrow strip of coarse, massive greywacke is exposed on the northeast flank of a hill of pillowed andesite. Attitudes in both types of rock are parallel to the contact.

The contact can be approached closely in one other place, on the north limb of the fold, in lot 8, rge. X, La Pause tp. There, a low, moss-covered knoll about 300 feet in diameter has small exposures of well-bedded, schistose, argillaceous greywacke cut by a dyke or dykes of pink feldspar porphyry on the south side, and on the north side, similarly small exposures of coarse- to fine-grained andesite and serpentine. The actual contact is not exposed.

Throughout the area no discordance in attitude between the beds on either side of the contact, other than that caused here and there by small contortions, was discovered.

Much better evidence as to the relationships of the two groups is furnished by the stratigraphic section. The upper 2,000 feet of the Kewagama group contains numerous beds of agglomerate and tuff, and even flows of pillowed andesite and dacite, all interbedded with typical greywacke. Thus, there was an overlap of the two depositional processes, a strong indication that the Blake River group was deposited on the Kewagama group without any appreciable time gap. The two groups may, therefore, be regarded as conformable.

BLAKE RIVER GROUP

DISTRIBUTION

The Blake River group, mainly of volcanic rocks, occupies almost all the southwest half of Cléricy and La Pause map-areas. In addition, all the rocks north of the northern exposures of the Kewagama group are

[1] Gunning, H.C.: Bousquet-Joannès Area; Memoir 231, in press.

correlated with the Blake River group, so that altogether it occupies considerably more than half of the two areas.

In general, rocks of the group form the hills that flank the central lowland, Abijevis Hills on the north and Camac Hills with their southeastward extension on the southwest. All the volcanic rocks in the Lake Routhier and Dufault Lake areas belong to the group. This correlation places all the volcanic rocks around Noranda, from the main volcanic-sedimentary contact south of Pelletier Lake to Duparquet Lake, 20 miles to the north, in the same group.[1] Furthermore, if correlation of the rocks of Abijevis Hills in this group is correct, it takes in a large part of the volcanic rocks in this whole region.

THICKNESS

The thickness of the Blake River group in the northern part of the area cannot be determined, for there the upper part of the group and the overlying Cadillac group are missing. The minimum thickness is estimated to be about 20,000 feet. In the south, where it lies between the Kewagama and Cadillac groups, fair estimates of its thickness are possible. In the southwest corner of La Pause map-area, south of Chassignolle Lake, it is about 5,000 feet thick. The thickness increases rapidly westward. Five miles west, just east of the La Pause and Bousquet western township line, the estimated total surface width is 3 miles. All structural observations in this section show that the flows dip 70 degrees to vertically and face south. The thickness thus indicated is about 15,000 feet. Farther west the width of exposure increases as the northern contact with the Kewagama group diverges from the southern contact with the Cadillac group, to reach an astonishing maximum of 20 miles, as noted above.

This great increase in exposed width is doubtless due in part to a continued thickening of the volcanic pile, for near Noranda Wilson estimates the stratigraphic thickness of volcanic flows at not less than 20,000 feet. This increase is responsible for only a part of the width of exposure, however, for west of the La Pause-Bousquet township line strata of the Blake River group are folded and faulted in several places, with consequent repetition of beds. The greatest thickness of the group can be taken on the east to be about 15,000 feet, with a gradual increase westward to about 23,000 feet.

DESCRIPTION

The Blake River group is made up of andesite, dacite, rhyolite, and related pyroclastic rocks. Beds of clastic sedimentary rocks large enough to be mapped are found only in one place, in lots 41 to 43, rge. IX, Dufresnoy tp.

A four-fold lithological subdivision of the group was attempted in Cléricy map-area. In La Pause map-area the group is similarly subdivided, but the lowermost division is absent, except possibly for a very small area represented by one outcrop at the western margin of the map-area just north of the Cléricy-Aiguebelle township line.

[1] *See* Geol. Surv., Canada, Map 328A.

The lowermost division, an agglomerate with fragments mostly of basic lavas, with interbedded rhyolite tuffs and some greywacke beds, is exposed in two places along the south side of Abijevis Hills in Aiguebelle township, and may well be continuous between the exposures. One exposure is in the southwestern corner of Aiguebelle township, about 1½ miles north of the south boundary; the other just west of and crossing the north-south centre line of the same township.

The first-mentioned exposures are the best. The agglomerate is in contact on the south with pillowed andesite in which the pillows, though poorly developed and squeezed, appear to face south. This outcrop is separated across the strike by 100 feet of drift from a 30-foot width of agglomerate or breccia with fragments 3 inches or less across, of white-weathering felsite in a chloritic matrix. The northern 10 feet of this outcrop is strongly sheared and pyritized. The agglomerate is succeeded on the north by small exposures of interbedded, cherty, rhyolite tuffs and coarse, arkosic greywacke, for a total estimated width of 1,000 feet. These are overlain by pillowed andesites that face north. About 1,500 feet east. near the south contact of the layer, a very coarse agglomerate makes up a knoll some 500 feet long and 200 feet wide. The agglomerate is a heterogeneous collection of angular, undeformed blocks of all shapes and sizes up to 14 feet on a side. Blocks are of diorite, andesite, dense felsite, bedded tuffs, both acidic and basic, chloritic lamprophyre, rhyolite, coarse gabbro, serpentine, ropy lava, and one of pillowed lava with several pillows intact in the block. No granitic, jasper, or quartz fragments were found. Individual agglomerate beds are 100 feet or less thick, separated by beds of massive, coarse, chloritic greywacke 10 to 30 feet thick. The bedding strikes 20 to 30 degrees south of east, and dips vertically or very steeply north or south. James and Mawdsley considered, on the evidence of mud cracks, that the strata are in ascending order from south to north.

The agglomerate is overlain on the north by about 800 feet of interbedded greywacke and rhyolite tuff in beds 2 inches to 3 feet thick. Gradation in grain in 3-inch greywacke beds suggests that they face north. They are overlain in turn by pillowed andesite, which also faces north. The complete lack of any repetition of beds across the section makes it appear unlikely that they are folded into an anticline. If the andesite near the south contact does face south it must be faulted into position.

The agglomerate exposed just west of the north-south centre line contains a similar mixture of angular blocks of basic volcanics, bedded tuffs, some round objects that might have been bombs, and blocks of felsite and rhyolite. None of the blocks observed were over 2 feet across. No beds of either greywackes or tuffs are exposed in this section, but blocks of both occur in the agglomerate. Pillowed andesites, facing north, overlie the pyroclastic assemblage. The south contact is not exposed, but the width across the strike of the agglomerate is about ½ mile. The southernmost outcrops are strongly sheared and carbonatized, and may lie within or near an east striking shear zone, possibly a branch of the Destor fault. The agglomerate beds either pinch out eastward, or are cut off against this fault, for they do not extend any appreciable distance into La Pause map-area.

The volcanic rocks, which comprise the remainder and by far the greater part of the group, are divided lithologically into three types. First, and in general lowermost, a thick series of andesites, dacites, and related pyroclastic rocks; second, rhyolites and rhyolite breccias, most abundant in the southwest corner of Clèricy map-area and predominant in Lake Routhier area; and third, acidic pyroclastic rocks, in part well bedded. The divisions as mapped are not entirely clean cut, for some rhyolite flows are included with andesites and dacites, especially near the axis of the Abijevis syncline in the northern parts of the areas. Likewise, some andesites and dacites occur with the rhyolites and rhyolite breccias, and flows of massive rhyolite occur within the acidic pyroclastic rocks. Nevertheless, within each subdivision as mapped one or two rock types, as noted, greatly predominate.

When these rock types are separated their distribution relative to one another serves to emphasize the structure and, in addition, indicates that the stratigraphic succession changes from place to place within the map-areas. Andesites and dacites, i.e., volcanic rocks of intermediate to basic composition, greatly predominate in the Abijevis syncline. They are well exposed in the southwest part of Aiguebelle township, and are estimated to be 19,000 to 20,000 feet thick, with the top unknown. Rhyolites appear, with few exceptions, only in the upper part of the exposed section, and at least some of it is intrusive. One of the exceptional occurrences of rhyolite low in the section is found on the MacCormack claims in lots 23 to 25, rge. II, Malartic tp.

The succession that occupies most of the southwest half of the combined map-areas is much more varied. Intermediate to basic types form the base of the series in contact with the Kewagama group, and at their greatest development, in southwest Clèricy township, are about 23,000 feet thick. This thickness decreases rapidly, both southeast and northwest, to about 4,000 feet.

Rhyolite flows appear about the middle of this succession on the north limb of the Clèricy syncline. At Clèricy and northwestward younger rhyolites occupy the centre of the syncline and are about 2,000 to 2,500 feet thick, with the top missing. On the south limb of this fold the central rhyolite thickens to occupy some 5,000 feet of section, with about 3,000 feet of andesite exposed below them to the presumed crest of the next succeeding anticline. Southwest again from this anticlinal axis rhyolites and rhyolite breccias, with the addition of acidic pyroclastics, increase in thickness to attain their maximum development in Routhier Lake area. Andesites and dacites appear in only a few isolated flows intercalated with the rhyolite flows. Wilson[1] estimates the total volcanic pile in Noranda area to be about 23,000 feet thick, with rhyolite and rhyolite breccia forming about 40 per cent of the whole.

Pyroclastic volcanic rocks occupy the upper 2,000 feet of the Blake River group in the southeast corner of the area, the whole group there being about 6,000 feet thick.[2]

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[1] Wilson, M. E.: Personal communications.

[2] *See also* Gunning, H. C.: Mem. 206, pp. 7-8.

Westward the width across the strike occupied by outcrops of pyroclastic rocks increases to about 6,000 feet just east of Davidson Creek fault, but there may be some repetition due to folding or faulting. West of Davidson Creek fault rocks of this character are exposed as far as 1 mile west of Dufault Creek. There they are interbedded with massive rhyolite flows and finally wedge out completely. From Davidson Creek fault again they can be traced northwestward along the southwest contact of the Clericy granodiorite about to the Joannès-Clericy township line. In this direction again rhyolite occupies an increasing amount of the section, with the last known outcrops of these pyroclastic rocks appearing on the east bank of Kinojevis River in lots 25 and 26, rge. III, Dufresnoy tp. Pyroclastic rocks of the same type outcrop as well in a small area near the northeast bay of Dufault Lake, in lots 35 to 40, rge. III, Dufresnoy tp. (Lake Dufault area).

The andesites and dacites occur in both massive and pillowed flows. Pillowed andesites with round nodules $\frac{1}{8}$ inch to $\frac{1}{4}$ inch in diameter are exposed along the north shore of Rouyn Lake (Routhier Lake area) and in a series of low ridges that trend southeast from the northeast bay on Trémoy Lake. A few nodules are composed of fibres of feldspar in radial or sheaf-like arrangement, and are probably variolites. Amygdaloidal lavas are quite common, and some of the amygdules, filled with quartz and calcite, are an inch in diameter. Flow breccias and pyroclastic breccias and tuffs are as common here as elsewhere in similar volcanic successions, but are of relatively minor volume. In striking contrast to most of the ancient lavas, the andesites and dacites in the Abijevis syncline are remarkably fresh.

As in most volcanic assemblages of this character, intrusive diorites can be distinguished in well-exposed areas, but where exposures are discontinuous or poor, fine-grained, intrusive diorite ordinarily cannot be distinguished from coarse-grained, extrusive andesites. Because of this practical difficulty, no attempt was made to map intrusive diorites separately from andesites and dacites with which they are associated. It seems probable they are quasi-contemporaneous with the flows.

Rhyolites and rhyolite breccias are best displayed in Lake Routhier area, north and northeast of Trémoy Lake. Typical massive rhyolites weather light grey or creamy grey, and are somewhat darker on fresh surfaces. They are aphanatic to fine grained, and commonly contain scattered crystals of white feldspar 2 or 3 mm. long, and round grains of quartz 1 mm. or so in diameter. The feldspar is invariably albite (about An_3) more or less charged with particles of sericitic mica and specks of clinozoisite, epidote, or carbonate. Dark minerals include chlorite, or rarely actinolite, and a little biotite. The groundmass consists ordinarily of finely divided quartz, albite, and carbonate. Indistinct, wavy lines, visible only on clean weathered surfaces, are probably flow structures. Spherulitic and amygdaloidal varieties are not uncommon. No ellipsoidal rhyolites were observed.

Columnar structures are developed in several thick rhyolite flows north of Trémoy Lake and are described in the Lake Routhier report.

Chloritization of rhyolites is widespread, and commonly most intense near dykes or masses of meta-gabbro or meta-andesite. Examples of all stages of chloritization are to be found on the Guardian Gold property.

In the first stage, hard, light grey or yellowish weathering rhyolite becomes softer, quite dark on fresh surfaces, and acquires a marked greenish tint on weathered surfaces. An indistinct mottling by dark green, irregular patches of highly chloritic material in the lighter rhyolite is common. In more advanced stages the rock becomes much darker green and notably softer, and contains only scattered remnants of recognizable rhyolite. In the final stage nearly every indication of its original rhyolitic character is obliterated. The rock is fine grained, dark green, and weathers almost black. The last remaining clues as to its origin are rare, irregular, light-coloured fragments of rhyolite and a few scattered quartz phenocrysts in the uniform, dark green rock. Aside from the unreplaced fragments and quartz grains, the rock cannot be distinguished in hand specimens from altered andesite.

Pyroclastic rocks form the upper part of the Blake River group in the southern and southwestern parts of the map-areas. They include some rhyolite breccias and tuffs and some flows of massive rhyolite, but the predominant rock is a breccia composed of fragments of quartz-feldspar or feldspar porphyry in a matrix that carries numerous relatively large grains of quartz and feldspar and so has itself a porphyritic appearance. Some fragments of siliceous felsite are commonly present, and here and there form the majority, but the groundmass remains generally uniform throughout. Fragments range from single crystals $\frac{1}{8}$ inch long to blocks 5 feet across. Sorting is very poor, but, remarkably, some of the blocks are well-rounded. The rocks are waterlain in part, as shown by bedding in tuffs associated with the coarse breccias in outcrops on the narrow isthmus between Rouyn and Routhier Lakes and elsewhere. In some exposures, notably in those on ground held by the Continental Copper Company, no large fragments are present, and bedding is poorly developed. As a consequence, the scattered crystals of feldspar and quartz set in a uniform grey matrix make the rock strongly resemble a porphyritic lava. It is, however, nearly always possible to discover some traces of bedding, or a few tiny angular rock fragments, even in outcrops of most uniform appearance.

The fact that these waterlain breccias and tuffs form the upper part of the Blake River group shows that sedimentation began before the period of volcanism closed, a feature that suggests an overlap with the succeeding period of Cadillac sedimentation. In this connection, an outcrop on the southeast shore of Rouyn Lake, on and just north of range line VI-VII, is most informative. The outcrop is about 75 feet across the strike. The lowermost rocks exposed are typical acidic, pyroclastic breccias, with rounded and angular fragments to 4 inches long in a grey, pseudoporphyritic matrix. The coarse breccia is about 60 feet thick; it passes upwards into a bed 15 feet thick, of the same composition as the matrix of the breccia. Bedding planes within this tuff or fine breccia are marked by thin films of black, argillaceous material. The films thicken to about an inch in the upper part and divide the rock into well-marked beds a few inches thick. The argillaceous material is identical with that that makes up, with very fine-grained, siliceous sediments, the Cadillac group on Rouyn Lake.

RELATIONS OF THE BLAKE RIVER GROUP TO THE CADILLAC GROUP

The Blake River group of volcanic rocks is overlain along the southern margin of Cléricy and La Pause map-areas by sedimentary rocks of the Cadillac group. The contact is not exposed in Joannès township, but in Bousquet township the exposures are somewhat better. This section was examined in detail by H. C. Gunning,[1] and the reader is referred to his report for detailed information thereon. In summary it may be said that the two groups appear conformable, a conclusion in agreement with that drawn from the outcrop on Rouyn Lake, and supported by the evidence that sedimentation was well under way before Blake River volcanism ceased.

CADILLAC GROUP

DISTRIBUTION

The Cadillac group outcrops in a narrow strip along the south side of Cléricy and La Pause map-areas, from about the middle of Bousquet township to the Davidson Creek fault. West of the fault the group outcrops again in two narrow synclines, one in range VIII, Joannès township; the other the Rouyn Lake syncline. The westernmost exposure in the range VIII syncline is on the Joannès-Rouyn township line 1,850 feet south of range line VIII-IX.

In Lake Routhier area, sedimentary rocks of the Cadillac group are exposed in the centre of Rouyn Lake syncline. They first appear on an island in Rouyn Lake due east of Mercier Landing. The synclinal axis trends northeast and east, and plunges gently east. As a consequence, the width of exposure of these sediments increases gradually to about 4,500 feet across the point that forms the east side of Lake Routhier. Exposures around the lake shores are good, and a few can be found in range VII, Rouyn township, as far east as lot 54. Between there and the Rouyn-Joannès township line no exposures of sedimentary rocks were discovered. This stretch, though fairly high ground, is a nearly impassable tangle of windfall and small softwoods and hardwoods. Outcrops may be present, but the undergrowth is so heavy that one might pass within a few feet of an exposure and not see it.

THICKNESS

The maximum thickness of the group in Lake Routhier area is about 1,800 feet. This is only a small part of the thickness known in Joannès township, where the maximum thickness, with the top missing, is 6,000 feet.

DESCRIPTION

Rocks of the Cadillac group exposed in Cléricy and La Pause map-areas are, for the most part, typical greywackes. They range from argillaceous to arenaceous, and are, in general, well bedded. The beds dip steeply, or are vertical. Stratigraphic top can be determined here and there by grain gradation within single beds, and, much less commonly, from crossbedding.

[1] Gunning, H. C.: Bousquet-Joannès Area; Geol. Surv., Canada, Memoir 231, in press.

Westward from Davidson Creek fault the sedimentary rocks gradually include more and more argillaceous material. Slaty and argillaceous greywackes are exposed in a small island just northwest of the big bend in Kinojevis River. Greywackes on the mainland north of there are fine grained and in part argillaceous. On the east shore of Lake Routhier, coarse to fine greywacke, massive to well bedded, makes up most of the exposures. In addition, a few pebble beds 2 inches to 18 inches thick are found, the pebbles, ¼ inch or less in diameter, being of cherty or felsic material. Slates as well form beds several feet thick. They weather black or dark grey and have well-developed cleavage. Westward again, on the isthmus between Rouyn and Routhier Lakes, on the southern shores of Rouyn Lake, and on nearby islands, the Cadillac group is made up of beautifully bedded, silty slates. Individual beds 3 inches to 1 foot or so thick consist of black, slaty material in the bottom half or two-thirds, and this grades upwards into white weathering, exceedingly fine-grained chert or siliceous silt. A striking feature is the development of fractures in the upper siliceous parts of individual beds, most of which die out in the lower, slaty parts. Only those fractures on which appreciable movement has taken place cut across from one bed into another.

INTRUSIVE IGNEOUS ROCKS

Intrusive igneous rocks in great variety are exposed in Clériсy and La Pause map-areas. They appear in sills, dykes, and small stocks, or in bodies of undefined shape. Precise classification is difficult, for with rare exceptions they are wholly composed of secondary minerals. The names applied are field classifications, modified where possible by microscopic examination. In composition they range from dunite, peridotite, and pyroxenite, to siliceous granite, alaskite, and aegirine syenite. A large number of intrusives of intermediate to basic composition, diorite, quartz diorites, diabase, and gabbro, in part quartz-bearing, were included in a single group in mapping Clériсy and La Pause area, although the group doubtless includes rocks of different ages. In fact, in Lake Dufault area, where more detailed examination was made, it was possible to separate the group into three on the basis of relative ages, and at least the youngest of these sub-groups contains intrusions of two or more ages. Somewhat similar grouping of the acidic intrusions was found necessary. Although many varieties are present, the bodies are isolated and relations between them cannot be established. One exception to the group is made for a stock of aegirine syenite, because of its distinctive petrographic character.

DUNITE, PERIDOTITE, PYROXENITE, AND SERPENTINE (CLÉRICY MAP-AREA)

A large body, possibly a composite dyke, of peridotite, pyroxenite, and gabbro, serpentinized in part, is exposed in the extreme northwest corner of Clériсy map-area. This body was mapped in detail by H. M. Bannerman for the Quebec Bureau of Mines in 1938.[1] To avoid duplication, the writer confined himself to cross-traverses by his assistants, and to a brief visit to that part of the intrusive in which there is a deposit of asbestos.

[1] Bannerman, H. M.: Lepine Lake Area, Destor Township, Abitibi County; Quebec Bur. Mines, Geol. Rept. 4, pp. 15-18.

The dyke, or sill, strikes about east where it crosses the western boundary of the area in range V, Destor township, and swings 20 degrees north of east to leave the area just east of the north-south centre line of the township. At the west margin it is about 4,500 feet wide, at the east about 1,500 feet. In general, its strike is parallel to that of adjacent flows.

The intrusion is divisible in most places into two parts, a southern part of peridotite, or of peridotite and olivine-bearing pyroxenite in alternating layers, and a northern part of quartz-bearing gabbro. The peridotite is a medium-grained, very dark green to black rock that weathers light grey or brown and has a rough surface. It is cut by numberless veins and lenticles of antigorite and fibrous chrysotile, with both cross-fibres and slip-fibre. In section the olivine is recognizable only because the crystal forms are preserved in meshwork of grains of iron ore, embedded in an uncommon variety of chlorite, probably clinochlore. A few crystals of strongly altered pyroxene, possibly diopside, occur in some specimens. Other minerals include mats of fibres of antigorite or chrysotile, much black iron ore in grains, flaky masses of antigorite, grains of coffee-brown picotite, one or two flakes of biotite, and a few colourless or very faintly green grains of an isotropic mineral, possibly pleonaste.

Gradations in composition from rocks containing 90 per cent olivine and 10 per cent pyroxene, to those containing 10 per cent olivine and 90 per cent pyroxene are complete. In the pyroxene rich rock the pyroxene is in euhedral to subhedral crystals to 2 mm. long, almost completely altered to chlorite (penninite?). Material interstitial to the pyroxene crystals consists of flaky antigorite and chlorite. A few grains of picotite and much black iron ore are present. In addition, a colourless or very faintly red, isotropic mineral with high relief was tentatively identified as garnet.

Dykes of pyroxenite cut chloritized peridotite near the road in lots 37-38, rge. V, Destor tp. The pyroxenite closely resembles that gradational into peridotite elsewhere.

Quartz gabbro forms two large parts of the intrusive, one extending from the western margin of Clericy map-area to lot 36, range V, the other extending from lot 31 to the west margin of the map-area. Relations between these several types of ultrabasic to basic rocks were not investigated by the writer, but Bannerman concludes (page 18) that the evidences ".....warrant the assumption that the several rock types in the main body of these basic and ultrabasic rocks originated from a common source perhaps a single magmatic intrusion."

SERPENTINE (LA PAUSE MAP-AREA)

Serpentine crops out in bodies of undefined shape in La Pause township on islands in Chassignolle Lake, in lots 41 and 42 on range line IV-V, on the east shore of La Pause Lake near the east-west centre line, and in a dyke or dykes cutting volcanic rocks on the south side of a large outcrop in claims of the La Pause mine, lot 18, range III. In Manneville township, south of Kinojevis River, a ridge of serpentine intrusive into rhyolitic lavas extends from lots 14 to 17, range I. In Clericy township a serpentine dyke cuts pillow lavas near the south end of lot 57, range VII. Serpentine is

exposed in two or three places along the east shore of Kinojevis River in ranges VII and VIII. In range X, lots 58 and 60, tabular bodies of serpentine are enclosed in granite. No definite criteria as to relative ages between the granite and the serpentine were obtained, but apparently the serpentine bodies are thin remnants of country rock rather than a dyke.

The serpentine is characteristically dark green or almost black, weathering dark to light grey. In thin section it is seen to be composed of variable amounts of antigorite, tremolite, chlorite, talc, calcite, and specks of black iron ores. Here and there rounded aggregates of antigorite and black iron ores are reminiscent of the form of olivine grains. The rocks were probably derived from peridotites and pyroxenites. No mineral deposits of economic importance are known to be associated with any of these serpentines.

INTERMEDIATE TO BASIC GROUP OF INTRUSIVE IGNEOUS ROCKS

Diorite, quartz diorite, diabase, and gabbro, in dykes and irregular masses, are widespread in both Cléricy and La Pause map-areas. The practical difficulty of distinguishing them from lavas of basic to intermediate composition, except where exposures are good or detailed examinations can be made, is such that many more are doubtless present than are mapped. This is particularly true in Abijevis Hills and in the range of hills that extends from Cléricy to the southeast corner of Cléricy township.

In La Pause map-area gabbro forms a dyke 120 feet wide that intrudes sheared volcanic flows across the La Pause-Bousquet township line in lots 24 and 25. Northwest along the strike an isolated outcrop of similar rock is exposed near the north end of lot 10, rge. I, La Pause tp. In lots 52 and 55, rge. III, Cléricy tp., gabbro appears in a dyke about 500 feet wide, where it is cut by a dyke of younger (Keweenawan?) diabase. The same type of rock outcrops near the north ends of lots 39 and 41, rge. IV, Cléricy tp.

In lots 18, 20, and 23, La Pause township, gabbro is exposed, cut by a dyke of albite porphyry. Diorite is exposed along the north flank of a rhyolite ridge in lots 22 to 25, rge. II, Manneville tp.

In Cléricy township intrusive rocks of this group are best displayed around Lake Dufault and in the northeast corner of Rouyn township. They are there subdivided into three subgroups on the basis of relative age, diorite, coarse diorite and quartz diorite, diabase and gabbro dykes, in part quartz-bearing. With the possible exception of one dyke of diabase they are probably older than granodiorite of the Dufault stock. Evidence indicates they were emplaced after the volcanic rocks that they intrude were folded.

Rocks of this group are prominent in burnt-over ridges between Dalembert and Dufresnoy Lakes. They form dykes or sills that strike in general parallel to the flows of sheared andesite into which they are intruded. The largest dyke in this section is 1,400 feet wide, and can be followed along the strike through almost continuous exposures for 2 miles. Still larger bodies occur just west of the west edge of the sheet in ranges VII and VIII, Dufresnoy township. The thick dyke has chilled margins against the lavas; within 8 to 10 feet from the walls the grain increases to

a maximum of ⅓ inch. The rock is massive and consists of about equal amounts of amphibolitized pyroxene and albite, both charged with granules of epidote, chlorite, and sericite.

AEGIRINE SYENITE

Aegirine syenite forms an oval stock 1½ miles wide and 2 miles long across Cléricy-Dufresnoy township line in ranges IX and X. Its edges extend into the southeast corner of Destor and the southwest corner of Aiguebelle townships. Dykes of similar rock cut mixed volcanic and sedimentary strata in lots 4 and 5, range line VIII-IX, Cléricy township.

The stock is composed of two main types of rock, an early aegirine syenite characterized by large, tabular crystals of flesh-coloured feldspar, and a later, even-grained, quartz-bearing aegirine syenite. The tabular crystals of feldspar in the early aegirine syenite are up to 2 inches across and ¼ inch thick, and are arranged parallel to one another to form books several inches wide. They are of microcline intergrown with albite in exceedingly irregular patterns and hold inclusions of quartz, titanite, and aegirine-augite. Around the margins of some of the larger crystals there is a fringe of small, clear, well-twinned, anhedral to subhedral crystals of albite. The mafic mineral is aegirine-augite, in euhedral crystals pleochroic from sea-green to yellow. Zonal structure is apparent in some of the crystals, with colourless interiors surrounded by wide, green, pleochroic rims. Many exceptionally large grains of apatite, and a few grains of an unidentified mineral, possibly eudialite or melilite, are present. Aegirine-augite forms, in general, less than 10 per cent of the rock, but ranges in some segregations and clots to 40 per cent.

The early coarse aegirine syenite is cut not only by the quartz-bearing aegirine syenite, but by dykes composed of pale green aegirine-augite, biotite, minor microperthite, and apatite, and by still younger dykes of coarse-grained aegirine syenite, rich in mafic constitutents. In these younger dykes, all the tablets of feldspar are oriented parallel to the walls of the dykes.

The latest, quartz-bearing aegirine-augite syenite has a granitic texture and is of medium grain. It is composed of microcline, 60 per cent; albite, 25 per cent; quartz, 10 per cent; aegirine-augite, 5 per cent; and accessory titanite, biotite, and zircon.

The suite of rocks in this stock appear to resemble very closely in mineral composition and texture some syenites and syenite porphyries described by H. C. Gunning[1] from Boischastel township, and noted by Bruce[2] as occurring near Aldermac mine, Quebec. The rocks are like those described by J. J. O'Neill[3] at and near the Beattie mine. Both the syenite and bostonite porphyry there contain large tabular phenocrysts of orthoclase and microline, which have marked parallel arrangement in so-called lath-porphyry dykes. They are not reported to contain aegirine-augite, possibly because of more extensive alteration than those in Cléricy township.

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[1] Gunning, H. C.: Syenite Porphyry of Boischatel Township, Quebec; Geol. Surv., Canada, Mus. Bull. 46, pp. 31-41 (1927).

[2] Bruce, E. L.: Arntfield-Aldermac Mines Map Area, Beauchastel Township; Que. Bur. Mines, Ann. Rept. 1932, pt. C, p. 56.

[3] O'Neill, J. J.: The Beattie Gold Mines, Duparquet Township, Western Quebec; Que. Bur. Mines, Ann. Rept. 1932, pt. C, pp. 15-17.

ACIDIC INTRUSIVES

Granodiorite grading to quartz diorite and to albite granite forms an elongated stock near Lake Dufault, a large dyke (the Cléricy dyke) across southwestern Cléricy township, a small plug southeast of Dalembert Lake, and a small oval stock or plug in north-central Bousquet township. The Lake Dufault stock is described in the report on the Lake Dufault area. The stock in north-central Bousquet township has been described by H. C. Gunning.[1]

Pink weathering albite granite is exposed in a rectangular area ½ mile wide that extends 1½ miles southeast from the southern tip of Dalembert Lake. The granite is well exposed along the railroad in range VI, Dufresnoy township. It weathers pink to grey, is medium to coarse grained with granitic texture, and is composed of albite, quartz, epidote, sericitic mica, and chlorite. Fracture faces are plated with chlorite with here and there a speck of pyrite.

The contact of this granite against sheared andesite is exposed just north of the railroad track on the south side of a hill in lot 29, rge. VI, Dufresnoy tp. Both rocks are highly sheared, with shear planes striking south 75 degrees east and dipping 80 degrees north. The contact is tight and has not been mineralized. The volcanic rocks north of the contact are, however, strongly sheared, and are heavily pyritized along narrow zones parallel to the schistosity.

The dyke across southwestern Cléricy township extends for 9 miles from Kinojevis River just west of Cléricy to the southeast to the Davidson Creek fault in range IX, Joannès township. It is uniformly a little less than a mile wide. A small body of similar rock east of the Davidson Creek fault, north of the southeast end of the main dyke, may be a continuation of it offset along the fault.

The dyke has apparently come up along or near the contact between a thick series of andesitic lavas on the northeast and a thinner series of rhyolitic lavas on the southwest. The exact contact of the intrusive against these volcanics is most difficult to place, for inclusions of the country rocks, abundant throughout, form a larger and larger percentage of the outcrops towards the margins, until the intrusive consists simply of a series of anastomosing dykes. These, in turn, decrease in size and number until they disappear entirely. The contact shown is thus arbitrary in many places within limits of several hundred to 1,000 feet.

The rock ranges in composition from basic quartz diorite to albite granite. It is medium to coarse grained, generally massive, and consists of 10 to 40 per cent quartz, albite clouded with tiny grains of chlorite, epidote, and sericitic mica, and chlorite and actinolitic amphibole. Titanite, zircon, and leucoxene are accessory, and sprays of rutile needles are enclosed in some of the quartz grains. Nearly all the minerals are much cracked and broken. Variations in grain size and composition are marked, even within small areas, but the predominating type is similar to the granodiorite of Lake Dufault.

[1] Gunning, H. C.: North Half of Bousquet Township, Quebec; Geol. Surv., Canada, Paper 38-24, p. 3 (1938); Bousquet-Joannès Area, Memoir 231, in press.

The Clericy dyke is described by Cooke, James, and Mawdsley[1] as being separable into two parts, a western dioritic band about ½ mile wide, and an eastern granitic band. The more recent mapping of this intrusive was done by Wm. C. Gussow in 1938, and the writer's examination was confined, for the most part, to detailed studies of small areas around prospects in and near the southern end of the body, and to examination of outcrops along Kinojevis River. Both types were found in intimate intermixture in these small areas, but it may well be that, broadly speaking, the body can be divided as suggested earlier.

Marginal phases of the intrusive are dense to porphyritic and weather light grey. Inclusions of country rock up to 4 or 5 feet across are common, even in the central parts of the intrusive. Their margins, especially on those well within the body, are indistinct; some, apparently originally of andesite, contain numerous grains of opalescent quartz. Other inclusions have rusty weathering, dark green borders ½ inch wide, and the surrounding dyke rock is similarly altered.

Mineral deposits associated areally with this intrusive include heavily pyritized zones with some pyrrhotite and chalcopyrite, as on Maybell, Savard Mines, and Dufresnoy Syndicate ground, chalcopyrite-bearing quartz veins, as on Savard Mines and Dufresnoy Syndicate ground, gold-bearing quartz veins at the old Caputo (now Roybell and O'Brien) group, and pyritized, gold-bearing shear zones, as at the MacDonell showing. These several deposits are discussed under "Mineral Deposits".

Albite and quartz-albite porphyry in dykes and sills, and small masses of undefined shape of albite granite are common in La Pause map-area, especially in those parts underlain by rocks of the Malartic and the Kewagama groups. In fact, few outcrops of rocks of either of these groups are without one or more of these intrusions, whereas in the area underlain by the Blake River group they appear in only a dozen or so places, all near Kewagama-Blake River contacts. The same situation obtains in Clericy map-area, and as the extent of the Kewagama and Malartic groups is relatively much less than in La Pause area, the number of acidic intrusions of this class is correspondingly small. None was observed in Abijevis Hills, nor in the hills that extend from Dalembert to and beyond Clericy Lake.

This distribution appears to be due to structural control. Some of the intrusives in pre-Blake River rocks may be older than that group, but each variety has representatives cutting the Blake River group. All are, therefore, tentatively considered to be post-Blake River group. They are cut in turn by dykes of younger diabase, and are probably to be grouped with the pre-Cobalt series of acidic intrusions widespread throughout this part of the country.

A wide variety of rocks are represented in the many small intrusions. Many of them are strongly altered and although the least altered varieties appear divisible into two groups, one characterized by biotite as the chief mafic mineral, and the other by amphibole, alteration is too general to permit satisfactory separation on the maps.

[1] Geol. Surv., Canada, Mem. 166, p. 126.

Members of the amphibole-bearing suite range from quartz-diorite to albite syenites and to amphibole-albite granites, with their porphyritic equivalents. The best exposures of members of the suite are on the shores of La Pause Lake. Also, representatives appear in nearly every outcrop of the Kewagama group along the north flank of the La Pause anticline, and are extensively displayed in north-central Clericy township, and in lots 12 to 16, rge. X, La Pause tp. Members of the suite also outcrop along or near the southern margin of the Kewagama group near Mont-Brun, with one isolated occurrence as far south as the middle of lot 35, rge. IV, Clericy tp. Finally, a few amphibole-bearing albite porphyries occur in or near the Kewagama sediments at the southeast corner of the map-area.

The most common mode of occurrence is in dykes, which, in general, strike parallel to the schistosity or bedding of the country rock. Other masses, with shapes undefined because of lack of outcrops, are probably small stocks.

The texture of the rocks of this group range from porphyritic to coarse, even-grained, with euhedral crystals of pink plagioclase conspicuous in most hand specimens. The amount of hornblende ranges from traces to over 40 per cent. By far the most common plagioclase is albite, invariably accompanied by more or less epidote. However, some varieties contain plagioclase as calcic as andesine, and oligoclase is not uncommon. That albite is not original in all the rocks is evidenced by embayment of oligoclase crystals by albite, and replacement, in a rock with porphyritic texture, of phenocrysts and groundmass by a mosaic of albite crystals in which turbid areas preserve outlines of earlier plagioclase phenocrysts. Quartz is commonly present, in some forming 25 per cent of the rock. Potassium feldspar is decidedly rare; in only one example is it an important constituent. Biotite is subordinate in amount to hornblende, or may be entirely absent. Titanite and allanite are invariably common to abundant accessories, and in fact are distinctive features of the group. Apatite is always present, along with black iron ores and a few specks of pyrite. Variable amounts of secondary chlorite, epidote, white mica, and carbonate are present, but the rocks of the group as a whole are unusually massive and fresh.

A few dykes of aplite are associated with this group. One cutting albite syenite near the narrows in La Pause Lake has a typical sugary texture, and is composed of approximately 50 per cent albite, 25 per cent microcline, 25 per cent quartz, and a few grains of epidote, black iron ores, and a very little biotite.

Hornblende lamprophyre dykes cut members of the group near La Pause Lake, and are especially well developed in range X, La Pause township. Some of these have a spectacular porphyritic texture, with euhedral phenocrysts of green hornblende 2 cm. wide set in a groundmass of 1 mm. grain. Other constituents include biotite, albite, more or less quartz, and secondary epidote, carbonate, chlorite, and white mica.

Veins of milky to vitreous quartz are very commonly associated with this group of intrusives, again best displayed in rge. X, La Pause township. Most of them are accompanied by abundant pyrite and some carbonate.

Members of the biotite-bearing suite occur in two fairly well-defined areas: (1) in dykes and bodies of undefined shape within a strip 1 to 1½ miles wide along the northern border of the Kewagama group on the south limb of the major anticline; (2) in a large body of undefined shape across the VII-VIII range line, lots 19-24, La Pause township. In addition, a dyke of this group crops out in the middle of lot 45, rge. III, Clériçy tp., and another near the middle of lots 35 and 36, rge. IV, Clériçy tp. The acidic dykes associated with carbonated zones may be related to this group, but they are all so altered that correlation is uncertain; they are, therefore, described as a separate group.

Texturally, the rocks range from porphyritic to medium or coarsely crystalline. In most porphyritic varieties phenocrysts of quartz are conspicuous, whereas in the hornblende-bearing group they are rarely seen. Biotite is the chief mafic mineral of the majority, always more or less altered to chlorite.

The plagioclase, in twenty-one out of twenty-four specimens examined in thin section, is albite ($Ab_{95}An_5$ to $Ab_{99}An_1$); in one it is albite-oligoclase ($Ab_{90}An_{10}$), in another oligoclase ($Ab_{87}An_{13}$), and the last has andesine ($Ab_{65}An_{35}$) almost completely replaced by albite. Microcline occurs in only one specimen; age relations to the other minerals are uncertain, but it may partially replace albite. Quartz makes up 20 to 30 per cent in most varieties, but in some it falls off to not more than 5 per cent. Apatite is the only accessory common to all, but specks of pyrite, black iron ores, and a grain or two of rutile and zircon are seen in many. Secondary minerals include chlorite, epidote, carbonate, and white mica. Of particular interest is the presence in two specimens from the east shore of the Kinojevis, lot 49, rge. VII, Clériçy tp., of mica with optical properties of muscovite, except for a delicate pleochroism from colourless to pale green. It is probably the chromiferous mica, fuchsite, a common mineral in carbonated zones. Molybdenite occurs in and is associated with dykes of this group on claims of the La Pause Gold Mining Corporation, Limited.

A dyke of muscovite-bearing aplite cuts albite granite in lot 20, rge. IV, La Pause tp. It has a characteristic sugary texture, and is composed of approximately 25 per cent quartz, 25 per cent albite, 20 per cent microcline, 25 per cent muscovite, and the remainder of chlorite, carbonate, rutile, and pyrite.

Biotite lamprophyres are common associates of these intrusives. Representative examples carry plates of biotite 2 or 3 mm. in diameter, in a fine-grained, very dark groundmass composed of small flakes of biotite, grains of albite and quartz, accessory apatite, and variable amounts of secondary chlorite, carbonate, and epidote.

Veins of milky to vitreous quartz accompanied by abundant pyrite and carbonate, and in places by tourmaline, are common in and near this group of intrusives. They are best displayed south of Patris Lake on claims of the La Pause Mines.

A small body of alaskite is exposed across the north-south centre line of Bousquet township. It lies south of and is younger than a somewhat larger body of quartz diorite or granodiorite. Gunning[1] describes the

[1] Geol. Surv., Canada, Paper 38-24, p. 3.

alaskite as follows: "This is a siliceous, dark grey rock that weathers pale grey to white and much of it is slightly schistose. It consists essentially of quartz and albite, the latter predominating, and is therefore similar in composition to the quartz albitites of Cadillac. Accessory minerals are present in very minor amount and the grain size throughout is uniformly fine, averaging between 1 and 2 millimetres, in spite of the very considerable size of the body."

Acidic dykes were discovered in association with all carbonatized zones in the map-areas except one. This association is not taken to imply that the dykes caused the carbonatization, for they themselves are sheared and carbonatized to such an extent that it is difficult, in places, to distinguish them from the country rock. Their presence in these zones does show, however, that magmas were active there; the carbonatization may have been caused by later action from the same magmatic source.

Least altered dyke rocks range from feldspar or quartz-feldspar porphyries to equigranular rocks with aplitic texture. They weather pink to rusty brown, and are pink to brownish pink on fresh surfaces. They are composed of albite and quartz, in nearly equal amounts in some, or with albite predominating slightly in others. Carbonate in large anhedral grains or in veinlets is abundant, and chlorite is common. Titanite, in part altered to leucoxene, rutile associated with chlorite, pyrite, and rods of tourmaline associated with both carbonate and pyrite, are common accessories. Apatite and magnetite grains are rare.

PORPHYRITIC DIABASE

Dykes of a remarkable porphyritic diabase crop out in lots 59 and 60, rge. VII, Cléricy tp., and in lot 56, rge. IX, and lot 59, rge. X, Cléricy tp. The latter two exposures appear to be parts of a single dyke, offset by the intrusion of a large dyke of "younger" diabase. The porphyritic diabase intrudes and is younger than acidic dykes. It thus is intermediate in age between them and the "younger" diabase; dykes of similar rock in the Opasatika area are stated by Cooke, James, and Mawdsley[1] to be pre-Cobalt. However, A. E. Barlow[2] describes somewhat similar dykes that intrude rocks up to Animikean in age, so that any correlation on a purely petrographic basis is impossible.

The porphyritic diabase is characterized by euhedral to subhedral phenocrysts of plagioclase up to 5 cm. long, set in an even-grained groundmass of 1 mm. grain. The phenocrysts are completely altered to an aggregate of white mica and colourless epidote or clinozoisite. In fresher examples collected elsewhere the phenocrysts are reported to be andesine in some dykes, labradorite in others, and in a few bytownite or even anorthite. The groundmass in the Cléricy examples is composed of labradorite ($Ab_{35}An_{65}$), ophitically intergrown with pigeonitic pyroxene, green hornblende, a few anhedral grains of quartz, and a little interstitial quartz in micrographic intergrowth with chlorite, and some black iron ores moulded against labradorite. The rock may be classified as a quartz-bearing, porphyritic leucodiabase.

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[1] Geol. Surv., Canada, Mem. 166, p. 143.

[2] Barlow, A. E.: On Some Dykes Containing Huronite; Ottawa Naturalist, vol. IX, No. 2, pp. 25-47 (1895).

"YOUNGER" DIABASE

Several representatives of the great system of diabase dykes so widespread in this part of the Shield crosscut all other rocks in Cléricy map-area. In general, they dip vertically, and their courses, though sinuous, strike east of north. Exceptions include diabase dykes west of Caste Lake and several in Joannès township that, though crooked, strike nearly north.

These dykes range from 10 to 500 feet wide. They are all equigranular, and range in grain from microscopically fine to 1 cm. They are made up of labradorite ($Ab_{35}An_{65}$) subophitic against pigeonitic pyroxene and augite, considerable green hornblende, grains of black iron ores, and a very little biotite. Some varieties contain olivine, accompanied by a little interstitial micrographic intergrowth of quartz and chlorite; in others olivine is absent and quartz appears both in micrographic intergrowths and in anhedral grains. Orthoclase intergrown with quartz was identified in one specimen. The rocks thus range from olivine diabase to quartz-bearing leucodiabase.

Their mode of emplacement is a matter of some interest. None on which critical data could be obtained is emplaced in a fault. This is indicated by the crookedness of their courses, and by the manner in which they displace contacts or other dykes. Every contact that they cut, regardless of the angle of intersection, is simply displaced perpendicularly across the width of the dyke. The effect is precisely that which would be obtained if the wall-rocks were pulled (or pushed) apart at right angles to the line of the dyke, and the opening filled by diabase. In short, they appear to occupy large tension cracks.

In age, they are the youngest rocks in the area; but as none of the rocks are younger than Archæan, they can only be dated as late Archæan or, perhaps, post-Archæan. Petrographically similar dykes in other parts of the country both cut the Cobalt series and are overlain by it.[1] No one can say, therefore, with which set these should be correlated.

STRUCTURE

Broadly speaking, the structures in Cléricy and La Pause map-areas consist of large anticlines and synclines whose axes strike east to southeast, broken by regional faults nearly parallel to the bedding planes. Folds of small amplitude are rare in the volcanic flows, but several were delineated between Dalembert and Dufresnoy Lakes. Cross-faults are recognized in Lake Routhier area, along Davidson Creek, and in the northwest corner of La Pause township.

FOLDS

The volcanic flows and sedimentary strata dip steeply or are vertical. Determination of stratigraphic tops is, therefore, of first importance in any attempt to delineate folds. In volcanic rocks most of the determinations are based on forms and patterns of pillows in pillowed lavas; a few were made from asymmetrical gradation in grain from base to top of flows. In sedimentary rocks the most generally useful criterion is gradation in

[1] Cooke, H. C.: Personal communication.

individual beds from coarse-grained bottoms to fine-grained tops. In a few places minor stream channelling and crossbedding are well developed.

Strikes and dips of flows can be determined from flow contacts—the longer the exposure of the contact the more reliable the determination—or better, from intercalated beds of tuff or chert. The long axes of pillows are generally nearly parallel to the strike, but several instances were discovered where they diverge by as much as 30 degrees.

The major folds in Clériсy and La Pause map-areas are, from north to south, the Abijevis syncline, the La Pause anticline, and the Clériсy syncline. Minor folds include a series of small, tight anticlines and synclines between Dalembert and Dufresnoy Lakes, a small syncline near the south side of Clériсy map-area, with its complementary anticline on the north somewhere near Marillac and Dastret Lakes, and a steeply plunging syncline and anticline in the northeast corner of Rouyn township.

The Abijevis syncline trends a few degrees north of west across the northern part of the map-areas. The axis is fairly well defined near the east side of the areas by north-facing flows in lots 23 and 28, rge. III, Manneville tp., and by south-facing flows in lot 38, rge. IV, Manneville tp. Determinations by Mawdsley in lot 43, rge. III, and by Weeks in lots 55 to 59, rge. VII, Manneville tp., suggest that the fold extends somewhat farther east. The axis is again defined approximately by north-facing flows in lot 10 on range line III-IV, Manneville township, and south-facing flows a mile north. From lot 10 to the west edge of La Pause map-area, determinations are poor and scattered, but in Clériсy map-area most of the Abijevis Hills are burnt clean and the axis can be located in places within 1,000 feet. It crosses the northern border of the map-area in Aiguebelle township about 1¼ miles east of Destor township.

The limbs of the fold dip 70 to 90 degrees towards the axis. No satisfactory information as to the plunge of the fold was obtained.

The form of the La Pause anticline is delineated by the thick layer of sedimentary rocks of the Kewagama group on either limb. Only one determination of top was made within the sedimentary beds on the north limb; in lot 10, rge. X, La Pause tp., they face north. However, pillow lavas are abundant just north of the sedimentary layer and numerous determinations show the flows all face north. On the south limb determinations of top were made near Mont-Brun from one side of the sedimentary layer to the other. The beds all face southwest. Pillow lavas just north of the sedimentary layer in this locality face southwest, as do pillow lavas just south. In short, the northern sedimentary layer lies under pillow lavas that face north, whereas the southern layer faces southwest, lies upon one series of southwest-facing pillow lavas, and passes below a younger series of southwest-facing pillow lavas. In another series of outcrops scattered across the width of the band in northwestern Clériсy township all tops, by grain gradation, face southwest. Pillowed flows within the series in range VIII, near the Clériсy-Dufresnoy township line, face southwest, as do pillowed lavas along or near the upper contact of the sedimentary band across Dufresnoy and Destor townships. Reversals in direction of stratigraphic top are encountered in pillowed lavas and in the sedimentary layer just south of the Destor fault. The sedimentary beds are contorted and the reversals are, therefore, probably due to complex folding induced by movements along the fault.

The sedimentary bands converge westward. They do not join, for the anticline is broken by the Destor fault, one of the largest in the area. No outcrops of sedimentary rocks were found on the north limb west of lot 36, rge. X, Cléricy tp., that is, for about 2 miles east of the fault. On the map, the north limb is projected to the fault, but the last 2 miles of it is assumed to underlie a drift-covered gap, about 2,000 feet wide, that lies between outcrops of volcanic rocks. If this is correct, the band is not over 2,000 feet thick where it terminates against the fault. In contrast with this the sedimentary layer on the southwest limb in range II, Destor township, just south of the fault, is not less than 10,000 feet thick. This great discrepancy may be due either to original differences in deposition, brought to view by relative vertical displacement on the fault, or to thickening of beds on the southwest limb and thinning of those on the north limb during folding, or to both.

Because of the scarcity of outcrops in central La Pause township the anticlinal axis cannot be located with any assurance. It is drawn to bisect, roughly, the area between the sedimentary layers on the limbs.

The axis of the Cléricy syncline extends southeast from the narrows in Dufresnoy Lake to Cléricy, and thence, curving somewhat more to the south, can be located approximately as far as lot 27, rge. III, Cléricy tp. The central part of the syncline is occupied, over most of this distance, by rhyolite flows that outcrop in a strip about 1 mile wide. The strip narrows to about 2,000 feet just east of Cléricy, widens again irregularly, and terminates bluntly in lots 18 and 19, rge. IV, Cléricy tp. Pillow lavas on either side of the rhyolites face towards the axis and dip very steeply or are vertical.

Between the large diabase dyke and Cléricy Lake no reliable observations of top were obtained. East of Cléricy Lake pillow lavas in lots 39 and 40, rge. I, Cléricy tp., face south, as do those in lots 41 and 42, rge. III. However, these observations are too far apart to justify the assertion that the synclinal axis, if it extends east of Cléricy Lake, must lie south of the point of observation in range I. In this connection, an observation recorded by James and Mawdsley of north-facing pillowed lavas just east of the south end of Cléricy Lake is noteworthy. However, Gunning was unable to discover the exact place where the observation was made, nor was he able to determine which way the flows face in that neighbourhood[1]. More positive evidence is, therefore, desirable before the axis is projected east of Cléricy Lake.

The rhyolites in the central part of the syncline are strongly sheared, and in places heavily pyritized. This is especially the case at and southeast of Cléricy, for example, where they cross the Cléricy-Mont-Brun highway. There, and again at Copper Hill, in lots 57-58, rge. VII, Dufresnoy tp., the sheared, pyritized rhyolites are cut by a few, small, lenticular, chalcopyrite-bearing quartz veins, some of which are reported to contain small amounts of gold. Considerable surface prospecting for copper and gold has been done along these rhyolites, from the Rocca group near Dufresnoy Lake, to and beyond Cléricy, but long stretches are drift-covered and much remains to be learned about their mineral-bearing possibilities.

[1] Personal communication.

The flows in southwest Cléricy township, southwest of the axis of the Cléricy syncline, face northeast at least to Dastret Lake, where good determinations were made. The sedimentary layer in range VIII, Joannès township, is folded into a syncline, that is the strata along the north contact face south. Whether an anticlinical axis or a fault intervenes between this contact and the north-facing flows at Dastret Lake is not known, for the country is heavily forested and information is quite unsatisfactory. The distribution of rocks, acidic pyroclastic rocks and rhyolites around a nose of andesite, suggests that the andesites may lie in the centre of an anticline, but no south-facing flows were discovered. In fact, pillows in a flow in block 48, in the northeast corner of Rouyn township, appear to face northeast. No constructive conclusion concerning the structure in this section can be reached at present.

A series of closely spaced anticlines and synclines defined by numerous reliable determinations of top on pillowed flows, are well exposed in burnt-over ridges between Dalembert and Dufresnoy Lakes. Their axes strike about north 40 degrees west, and the limbs dip vertically or very steeply. The amplitude of the folds ranges from 1,000 to 4,000 feet. The axes of one pair, an anticline and a syncline, can be followed along the strike for about 4 miles southeast from the west boundary.

A minor anticline with an axis striking east-west is indicated in southwestern Aiguebelle township. Around the south end of La Haie Lake the flows face north, whereas those on a ridge northwest and north of Matissard Lake face south. A deep, wide valley with no outcrops lies north of this ridge. It may lie along an anticlinal axis or possibly along a branch-fault from the Destor fault.

The complicated structures in northeastern Rouyn township are described in the report on Lake Routhier area. From a standpoint of regional folding, the important feature there is the attitudes of the fold axes. The synclinal axis south of Lake Dufault strikes north 70 degrees east and plunges 60 to 90 degrees northeast. The axis of the complementary anticline, broken by the Horne Creek fault, has a similar attitude. These axes plunge more steeply, but correspond in strike to the fold axes delineated by Wilson in Rouyn, Dufault, Amulet, and the southern part of Waite areas, and evidently form part of that structural unit. On the other hand, the characteristic strike of fold axes in Cléricy map-area is north 40 degrees west and plunges, so far as known, are gentle. That is, the axes west and south of Lake Dufault diverge from the regional trend in Cléricy map-area by 60 degrees. Moreover, their plunges become steeper towards the northeast. The two trends must merge near Mud Lake in Rouyn township. Unfortunately this section is mantled with thick deposits of drift and clay.

FAULTS

Faults in Cléricy and La Pause map-areas are of two types; one, shear zones approximately parallel to the bedding; and two, cross-faults.

The Destor fault, one of the largest shear zones, was mentioned in connection with the La Pause anticline. The fault enters the area in range III, Destor township, along or near the Beattie tramway. There its trace lies in a swampy valley about 1,000 feet wide, easily followed as far

east as lot 50, range II, Destor tp. The western part of the fault in Cléricy map-area and its extension to the Macamic highway have been described by Bannerman[1].

The fault valley marks the southern edge of Abijevis Hills from the west boundary of the area nearly to Bassique Creek. South of it the country is lower and more heavily covered with drift and clay. Outcrops along the north side of the valley are of heavily sheared, carbonatized, volcanic rocks. The main fault strikes north 70 to 80 degrees west, but subsidiary shear zones on the north side strike north 60 to 80 degrees east. The course of the fault to the east where the valley widens and disappears is marked by a few small outcrops of highly sheared, carbonatized rock as far as Bassique Creek. It there enters a stretch of low ground along Paré Creek and its course can be located only within wide limits.

Shear zones and mud seams that probably form part of the main fault were intersected in four diamond drill holes on Descar ground in claim R-25137, just north of the Davangus highway. Flat holes drilled 400 feet or more northeast under the valley encountered alternations of volcanic rocks and belts up to 30 feet wide of soft, chlorite schist cut by narrow mud seams. In addition, the volcanic rocks in this section are intruded by a great number of small dykes of albite porphyry and many veins and stringers of milky quartz.

The probable eastern extension of the fault across the eastern part of Cléricy map-area is through low ground. A few outcrops of sheared, carbonatized rocks along Paré Creek are taken to mark its approximate course. West of Caste Lake along the north-south centre line of Cléricy township larger and more numerous outcrops are intensely sheared, carbonatized, and cut by many dykes of albite and quartz-albite porphyry. These features suggest that one branch of the fault may pass through or north of Caste Lake, and extend eastward near and more or less parallel to Kinojevis River. The strongly sheared, carbonatized zone on the MacCormack group, lots 23 to 25, rge. II, Manneville tp., should be noted in this connection, but more information must be obtained before it can be regarded as the Destor fault or a branch of it.

Large shear zones that may lie along a southern branch of the Destor fault are exposed on both the northeast and southwest flanks of large greenstone ridges east of Kinojevis River, in range VII, Cléricy township. On the northeast flank, particularly, the greenstone ridges drop off steeply into low ground and for 200 to 300 feet south are reduced to tremendously contorted, crenulated, chlorite schists. The contorted zone strikes north 60 degrees west and can be followed southeast for 3 miles along the strike from lot post 52-53, range VIII, into lot 2, rge. VI, La Pause tp. Farther east, outcrops are poor and its course is unknown.

Several other strike shear zones were observed in both map-areas. Those large enough to be mapped are shown, but no doubt many more are hidden by drift than are exposed. Unfortunately, their parallelism to the bedding makes it ordinarily impossible to determine displacements along those exposed, or to detect hidden shear zones from surface exposures. In

[1] Bannerman, H. M.: Central Part of Destor township, Abitibi County; Que. Bur. of Mines, P.R. 129, p. 2 (1938). Lepine Lake Area, Destor township, Abitibi County; Que. Bur. of Mines, Geol. Rept. 4, pp. 6, 20 (1940).

some instances their courses can be inferred from topographic features, but as less resistant dykes, sills, flows, and even joints, also erode to form linear valleys, such valleys probably mark shear zones only where their walls are sheared and carbonatized. Valleys with sheared walls are generally worth further investigation, both from a structural and from an economic point of view.

The main cross-faults in the areas are the Horne Creek fault and its subsidiaries, and the Davidson Creek fault. The Horne Creek fault is described in connection with the geology of Lake Routhier area. Most of the information regarding the Davidson Creek fault was obtained in detailed mapping by H. C. Gunning and is described in part by Gunning and Ambrose as follows:[1] "It strikes northeast along the valleys of Kinojevis River, Davidson Creek, and Cléricy Creek. At no place is the actual fault visible, nor as far as the writers know has it been intersected in any drill hole. However, on the walls of the valleys of the Kinojevis River and Davidson Creek, the strata are in places bent, sheared, and crushed in a manner indicative of proximity to a major fault. There are many other northeasterly trending faults in the area; but this is the only one that has a known displacement of more than a hundred feet or so . . . . . The present conclusion is that the southeast side moved northeast and downward relative to the northwest side. The horizontal component is estimated at about 8,000 feet and the vertical at close to two miles. The displacement may be considerably less along that part of the fault that lies south of the Thompson Creek fault, which strikes westward from the big bend of the Kinojevis River."[2]

The fault enters Cléricy Lake at its southwest end, but its course beyond there is not known. Lavas along the east shore of the lake show some contortion, but if it continues through the lake it must die out before it reaches the southwest band of Kewagama sediments for these show no determinable offset along the line of its projected strike.

Another cross-fault is postulated in northwestern La Pause township. It strikes north 20 degrees west; and the east side moved relatively north. The chief evidence for the fault is the offset of the north contact of the sedimentary band. Outcrops of sediments occur just north of the Manneville-La Pause township line in lot 10, but in lot 8, La Pause township, the north contact is exposed 2,400 feet south of the township line or about 2,500 feet due south of the exposures in lot 10. The south contact cannot be located accurately here from surface outcrops, but the distribution of sediments suggests a similar amount of displacement. The course of the fault north or south of the sedimentary layer is not known.

A linear valley that forms a marked topographic feature from Vaudray Lake north for 50 miles to Robertson and Taschereau Lakes may mark the course of a cross-fault of small displacement. That this displacement is very small, possibly only a few tens of feet, is indicated by evidence obtained on La Haie Lake, which lies in this valley, and again, on Kinojevis River. On La Haie Lake a distinctive bed of rhyolite breccia 50 feet thick,

[1] Gunning, H. C., and Ambrose, J. W.: The Timiskaming-Keewatin Problem in the Rouyn-Harricanaw Region, Northwestern Quebec; Roy. Soc., Canada, Trans., 3rd ser., sec. IV, vol. 33, pp. 38-39 (1939).

[2] *See also* Gunning, H. C.: Bousquet-Joannès Area; Geol. Surv., Canada, Memoir 231, in press.

overlain by massive quartz porphyry or ryholite, outcrops on the west shore. The beds strike north 70 degrees east across the lake and dip 70 degrees north. Three hundred feet away on strike, on the east shore of the lake, is a rhyolite breccia of identical appearance overlain by massive quartz porphyry or rhyolite. Two other beds of breccia, one several hundred feet stratigraphically above, the other a similar distance below, the first breccia, outcrop on both sides of the lake with no appreciable displacement. Six miles south on the same valley the contact of the Malartic and Kewagama groups crosses Kinojevis River without appreciable offset. Thus, if this valley marks the course of a fault the displacement is too small to be measured by Brunton compass survey.

However, there may have been some movement along the line of the valley, for Abijevis Hills are crossed by a whole series of north-striking faults of small displacement, some of which are marked by deep, linear valleys or scarps 100 feet or more high. The prominent west-facing scarp northeast of Davangus marks one of these faults, the horizontal offset there being 100 feet, with the east side moved relatively south. Many other similar faults were observed in this part of the area; they strike nearly north; observed horizontal displacements range from a few feet to 140 feet. Displacements on all observed carried the east side relatively south.

Some mineralization has accompanied or followed this faulting, for quartz veins were seen in a few of the faults, and the walls of others are heavily impregnated with pyrite. For example, a breccia bed cut by the scarp-forming fault northeast of Davangus is charged with nodules of pyrite up to an inch in diameter for at least 50 feet east of the fault, whereas elsewhere the breccia is free of pyrite. Also, quartz veins 3 to 4 feet wide and up to 200 feet long occur in parallel faults a few hundred feet west.

Other cross-faults with displacements of a few feet are found in many places south of Abijevis Hills. One in lot 19, rge. I, La Pause tp., strikes north 5 degrees west, and offsets a gabbro dyke 60 feet horizontally, the east side being moved relatively north. Another, in lot 17, rge. I, Manneville tp., strikes north 10 degrees east; beds east of the fault moved relatively north. Others of similar displacements offset sedimentary beds along Clayhill Rapids. Near the north side of range IV, Cléricy township, a fault striking north 80 degrees east was traced from lot 5 into lot 7. The flows there strike north 40 degrees west. Horizontal displacement along the fault, as determined in lot 6, carried the north side 300 feet relatively west.

MINERAL DEPOSITS

Many deposits that contain gold or gold and copper have been discovered in Cléricy and La Pause map-areas, and one, the Cassels-Duval mine, is nearing production. Interest in the area around Lake Dufault was intensified by the discovery, late in 1937, of a large body of massive sulphides, the Waite-Amulet Lower A ore-body. Mineralized shear zones and gold-bearing quartz veins are known in many places outside Lake Dufault area, and although no commercial ore-bodies have been discovered as yet, the possibilities are still far from exhausted.

Prospecting of much of the area is made difficult by heavy forest cover and by widespread deposits of drift and clay. These not only make areas

of mineralization hard to find, they also obscure structures that may have acted as ore controls. One point of interest that emerges from the present work is the relationship of mineral deposits to large structural features. Details of the relationships must be left, in most cases, to be unravelled by more thorough studies of restricted areas.

One structure important in localizing mineral deposits is the Destor fault. In the northwestern part of the area, where the fault is best established, it and subsidiary shear zones are characterized by intense shearing, by intrusions of numerous acidic dykes, and by heavy carbonatization, pyritization, and injection of quartz veins. Some gold has been found in several places in these zones, as on Descar ground and in other showings nearby. The large-scale structural features indicate that the fault continues southeast across Clericy and probably across most of La Pause map-areas. Across the eastern half of Clericy map-area the course of the fault is obscured by drift, but here and there even in the drift-covered areas small outcrops of sheared, carbonatized, pyritized rocks cut by acidic dykes mark its probable course. Thus, the old Richmond showing near the north-south centre line in range IX, Clericy township, the McDairmid showing on the west shore of Kinojevis River, range VIII, Clericy township, and the sheared, mineralized zones in lots 51 to 61, rge. VII, Clericy tp., probably lie along one of the main branches of the Destor fault or on faults or shear zones subsidiary to it. The shear zone on La Pause ground south of Lake Patris may lie along a further continuation of the same fault.

Similarly altered rocks cut by many acidic dykes occur in a zone that extends from the north-south centre line, range X, Clericy township, east to and beyond Caste and Matissard Lakes. Although conclusive structural evidence is lacking, the phenomena are so nearly identical with those exhibited along the known part of the Destor fault that they too may be supposed to lie along a similar shear zone or fault. If the zone persists west on strike it meets the Destor fault near the Clericy-Aiguebelle township line 2 to 3 miles west of the north-south centre line. Whether or not the Jomac (MacCormack) showings in lots 23 to 25, rge. II, Manneville tp., lie along this or a similar fault or shear zone cannot be deduced from the evidence at hand.

Another structural feature along which mineral deposits are localized is the Clericy syncline. The fold is not, of itself, important, but its centre is occupied by rhyolites that have shattered, or in places are sheared, in zones near and parallel to the synclinal axis. These shear zones are mineralized, but in contrast with most of those along the Destor fault, the mineralization consists primarily of pyritization with some pyrrhotite and a little chalcopyrite. Carbonates occur, but are distinctly subordinate; no quartz-carbonate zones such as characterize the Destor fault are found. These deposits consist of disseminated sulphides, with commonly, chalcopyrite-bearing quartz veins that carry a little gold. Examples are found on the Rocca claims, at Copper Hill shaft, and in shear zones in ranges IX and X, Dufresnoy township, just east of Dufresnoy Lake, and in and east of Clericy.

Several mineral deposits are clustered around the granodiorite dyke across southwestern Clericy township. These deposits are of two types:

(1) disseminated to massive sulphides in sheared or shattered zones cut by a few chalcopyrite-bearing quartz veins, having a little gold either with the disseminated sulphides or in the quartz veins, and (2) gold-bearing quartz veins. The first type includes the Aurel (former Harvie) and the Nubell (former Mabell) showings. They are identical with those found along the Cléricy syncline. Some of these latter are as much as 6 miles distant from the Cléricy dyke, which suggests that areal association with the dyke does not necessarily imply genetic association. The second type is represented by the gold-bearing quartz masses on Roybell (former Leroy) ground and the gold-bearing quartz vain of the No. 1 showing, MacDonell group.

Mineral deposits associated areally with the Lake Dufault intrusives consist, so far as yet known, of sheared zones with disseminated to massive pyrite and some chalcopyrite as on Continental and MacDonald ground, some chalcopyrite-bearing quartz veins with a little gold as in the MacDonald pit, and pockets of sulphides with or without quartz veins along contacts of diabase and gabbro dykes. Caution must be observed in attaching genetic significance to areal associations in this area of complex intrusion. The sheared, pyritic zones in particular closely resemble those noted elsewhere, and although the association of pockets of sulphides with diabase and gabbro dykes is too frequent to be overlooked, genetic relationship is not proved thereby. The dykes may have acted simply as dams to later mineralizing solutions. In this connection it may be well to recall that the discovery of the Lower A ore-body on Waite Amulet ground has re-emphasized the importance of dams and favourable structure in localizing ore deposition. The structure and rock distribution around Lake Dufault are such that this area deserves careful mapping and prospecting for similar structures that might contain sulphide pods of commercial size.

The sheared quartz-carbonate zone on which the Bouchard-Cléricy shaft is situated is unusual in that it has no associated acidic intrusives. The zone is exposed west nearly to Cléricy Lake, and east to lot 50, rge. I, Cléricy tp. Farther east the country is covered by a sand plain 4 miles wide; the zone was not found east of the sand plain. Although volcanic and sedimentary rocks along the La Pause-Bousquet township line are strongly sheared, no typical quartz-carbonate zones occur in them.

Gold-bearing quartz veins not apparently related to regional faults or shear zones occur in one or two places in Abijevis Hills in Destor township. Examples are seen in the Paquin claims, in lots 60 to 62, rge. IV, Destor tp., and in western Aiguebelle township. At least some of these veins are controlled by a series of north-striking cross-faults of small displacement.

The mineral deposits in Bousquet and in part of Joannès townships included in Cléricy and La Pause map-areas were examined by H. C. Gunning in 1937 and 1938. They include those held by Arrowhead Gold Mines, Limited, Mooshla Gold Mines, Limited, Agaura Explorations, Limited (Cassels-Duval option), Warrenmac Mines, Limited, and Washington Gold Mines, Limited. A report by Gunning on these properties is in press.

Molybdenite was discovered in lot 19, rge. III, La Pause tp., disseminated in an altered acidic dyke. The dyke occurs in a zone of strongly sheared, carbonated rocks on ground held by La Pause Gold Mines, Limited.

A deposit of asbestos occurs in a serpentinized peridotite that cuts volcanic rocks in the northwest corner of Cléricy map-area.

DESCRIPTIONS OF PROPERTIES

AUREL MINES, LIMITED

Reference: Geol. Surv., Canada, Mem. 166, pp. 229, 230 (1931).

Aurel Mines, Limited, is a subsidiary company wholly owned by Savard Mines, Limited. It holds twenty-seven claims, approximately 1,080 acres, in Cléricy township, formerly developed by Harvie Exploration Company, Limited, and Archean Mines Development Company, Limited. The property is in ranges IV and V, and extends about 1¾ miles east from the east shore of Savard Lake. The property lay idle from 1928 to 1939. In 1939 Beattie Gold Mines (Quebec), Limited, optioned a controlling interest, made a geophysical survey of an area near Harvie shaft No. 3, and followed this by diamond drilling.

The general geology and development by Archean Mines Development Company and by Harvie Exploration Company is described in Memoir 166. The claims are underlain by pillowed andesites and dacites; some rhyolite and rhyolite breccia are exposed near the east side of the claim group in lots 9 and 10, range V. The contact between the rhyolite and rhyolite breccia and the more basic rocks trends, where it crosses range line IV-V, about north 25 degrees west. The andesites and dacites are well pillowed, and are folded in a small, tight syncline whose axis strikes north 25 degrees west across lots 8 to 10, range IV. The volcanic rocks are intruded in the southwest part of the group by quartz diorite and granodiorite of the Cléricy dyke.

The mineral deposits on the claims consist of, first, zones with abundant pyrite, some pyrrhotite, and a little chalcopyrite and sphalerite disseminated and in veinlets, and second, chalcopyrite-bearing quartz veins. The pyritic zones have indefinite margins, but some are hundreds of feet long and 100 or more feet wide. Two zones of this type were extensively investigated, one by shaft No. 1, the other in adit No. 2. The chalcopyrite-bearing quartz veins were explored in shafts No. 3 and No. 4. Although encouraging amounts of copper were obtained in places in all of these workings except in the No. 2 adit, no commercial ore-bodies were discovered.

Work under option by Beattie in 1939 consisted of a geophysical survey in the neighbourhood of shaft No. 3, followed by diamond drilling. This work was done after the writer visited the property in June, and no information as to results was obtained. Work was discontinued in August 1939.

BOUCHARD-CLÉRICY GOLD MINES, LIMITED

Bouchard-Cléricy Gold Mines, Limited, formerly the Bouchard-Collier claims, holds a gold prospect of twenty claims in the southwest corner of Cléricy township. Camp buildings are on the I-II range line near lot post 44-45. Most of the surface work was done on the northern parts of lots 44 and 45. The property was idle when visited in August 1937.

The geology of the claims is described in detail by L.V. Bell.[1] Since then a vein, which had just been opened at the time of Bell's visit, has been further developed by diamond drilling, and by a two-compartment shaft 90 feet deep with 150 feet of lateral underground work. This vein crosses the 44-45 lot line 1,150 feet south of range line I-II; on the surface it is exposed for 160 feet along the strike, and ranges from 14 inches to 4 feet wide. It is milky to vitreous quartz, and is emplaced in highly carbonatized greenstone schists. The wall-rocks are cut by veinlets and stringers of quartz, and are heavily impregnated with coarse pyrite and some tourmaline. Some high assays in gold are said to have been obtained from surface sampling. The vein was intersected at a vertical depth of approximately 100 feet by diamond drill holes spaced 50 feet apart over a strike length of 200 feet, and yielded core lengths of 6 inches to 2 feet of milky quartz. Two holes drilled to intersect the vein at greater depths appear to have stopped short of their objective. The shaft was flooded at the time of the visit and no inspection of underground workings was possible.

A second rather persistent quartz vein, 50 feet south of the first and parallel with it, was picked up in at least four and possibly more, drill holes. The vein, 2 feet wide, crops out at the surface in a strong shear zone 4 feet wide, traced 50 feet along the strike. Surface sampling is reported to have returned low to moderate assays in gold. Several other quartz veins on the property have been stripped, but no information as to their value was obtained.

CONTINENTAL COPPER MINES, LIMITED

Continental Copper Mines, Limited, was incorporated late in 1938. It holds two large groups of claims in Dufresnoy township, one including the south halves of lots 31 to 35, range V, all of lots 26 to 36, range IV, and the north halves of lots 32 to 38, range III; the other, lots 45 to 50, range V, the north halves of lots 41 to 44 and of 47 to 50, range IV, and all of lots 45 and 46, range IV.

The first group of claims includes part of the ground formerly held by East Bay Gold, Limited, and by Gilbec Mines, Limited. Development work in 1939 was concentrated on the East Bay group, and included a thorough geological investigation, followed by extensive stripping and trenching and some 2,000 feet of diamond drilling on the old showing in lots 36 and 37, range III. Prospecting was done primarily for copper and gold.

The former East Bay and Gilbec claims lie across the eastward extension of the Dufault granodiorite stock. This body, roughly a mile

[1] Que. Bur. Mines, Ann. Rept. 1930, pt. B, pp. 30-35.

from north to south, is in contact with acidic pyroclastic breccias in the southeastern part of the property. The East Bay showing lies in these breccias. The northern contact of the granodiorite is not exposed, but must trend nearly east-west and lie 1,000 to 2,000 feet south of range line IV-V. Rocks north of the granodiorite are rhyolite flows and breccias and a few andesite flows, all cut by numerous dykes and masses of diabase and gabbro. The Gilbec showing lies in this northern part of the group, in an unusual variety of breccia, described on page 41.

EAST BAY SHOWING

The East Bay showing[1] consists of heavily pyritized, heavily sheared zones in volcanic breccias. The shear zones strike north 65 to 80 degrees west and dip nearly vertically. As outcrops are discontinuous the full dimensions of the zones are uncertain; four are exposed in a total width of about 600 feet. The northernmost and narrowest is not over 40 feet wide, is exposed at intervals along the strike for 350 feet, and is separated from the next south by about 100 feet of relatively massive breccias. The second zone is about 50 feet wide, is exposed at intervals along the strike for 500 feet, and is succeeded on the south by 50 to 60 feet of more massive rocks. The third zone is at least 100 feet wide, and is exposed in three trenches over a total length of 200 feet; it is succeeded to the south by about 100 feet of low ground. Rocks exposed in a trench 25 feet long on the south side of the low ground are relatively massive, and carry little pyrite. These are separated by 40 feet of drift from a fourth, heavily pyritized though not so strongly sheared, zone that lies just north of the lake shore. The zone is exposed in trenches over a width of 80 to 100 feet, and for 450 feet along the strike. The country rock is coarse breccia; and some trenches display 2-foot widths of pyrite, solid except for a few large fragments of breccia. A somewhat similar occurrence was discovered in trenches 1,200 feet north of this zone; there, pods of solid pyrite to 4 feet long are distributed over an exposed width of 20 feet and length of 85 feet.

The four heavily sheared, pyritized zones were drilled by the predecessor company. High percentages of copper were reported in one group of holes, and in 1939, Continental Copper Mines, Limited, drilled two holes to check these reports. The first, No. 11, was collared 615 feet north of the lake and 500 feet west of the east boundary of lot 37, range III, and drilled south 38 degrees west at a declination of 56 degrees. A survey of the hole after drilling was completed showed that below 500 feet it deviated both in direction and declination. Acidic breccias were encountered throughout, carrying disseminated pyrite and massive pyrite in seams and veins. Pyrite ranges in amount from 1 or 2 per cent in most of the core to over 50 per cent in one section 10 feet long. Small amounts of chalcopyrite are disseminated and in seams with pyrite in several sections up to 25 feet long. The highest copper content reported by the company was 2·45 per cent over 13·4 feet of core length, from 259 feet to 272·4 feet. The hole was drilled to a depth of 1,012·4 feet, with little of interest below 480 feet.

[1] Que. Bur. of Mines, Ann. Rept. 1929, pt. A, p. 122.

Hole 12 was drilled north 75 degrees west from the same point as hole 11, to an inclined depth of over 1,000 feet, but failed to obtain any encouraging amounts of copper.

Quartz veins were uncovered by trenching in this general neighbourhood, one of which carries specks of chalcopyrite, another a few flakes of molybdenite. None is known to be of commercial value.

Granodiorite was exposed in trenches 350 feet northwest of drill holes 11 and 12. It is separated by 240 feet of thin drift from the nearest trench across acidic breccias. The contact between the two must, of course, lie in this intervening, drift-covered zone, but until it is exposed its possible importance as a locus of mineralization cannot be estimated.

GILBEC SHOWING

Reference: Que. Bur. of Mines, Ann. Rept. 1929-30, pt. A, pp. 122, 123.

The Gilbec shaft was put down to investigate a copper showing nearly in the middle of lot 35, about 1,100 feet south of range line IV-V, Dufresnoy township. The following account of the development work done by the predecessor company, Gilbec Mines, Limited, is summarized from the report by the Quebec Bureau of Mines.

A two-compartment shaft was sunk in 1929 to a depth of 115 feet, and a small amount of lateral work was done from the 50- and the 100-foot levels. A crosscut north from the 50-foot level encountered disseminated sulphides. Lateral work on the 100-foot level disclosed a sheared zone that varied in width from a stringer to 10 inches, and which contained coarse pyrite and chalcopyrite.

Underground work was followed by diamond drilling, thirteen holes being put down to a total footage of 3,323 feet. An electrical survey was completed in late 1929, and from then until taken over by Continental Copper Mines, Limited, the property has lain idle.

Continental Copper Mines, Limited, cleaned out the old trenches and prepared a map showing them and the exposures adjacent to the shaft. The writer used this map in making a detailed study of the geology.

The outcrop on which the shaft is situated forms a low hill about 250 feet wide east to west and 300 feet long north to south. This hill is isolated on all sides by alder swamp, but on the northwest it is only about 200 feet to rising ground with scattered exposures.

An uncommon type of agglomerate forms most of the rock around the shaft. It is a heterogeneous mixture of blocks of all sizes up to 2 feet across, of cherty rhyolite, porphyritic rhyolite, coarse, granular, and fine, thin-bedded tuffs, and hornblende diorite. Much of the agglomerate is strongly chloritized, and is cut by a network of tiny quartz veinlets. The veinlets stand out on the weathered surface in lacy filigree, against the background of softer, dark, chloritized, rusty weathered agglomerate. In the most strongly altered material the outlines of the blocks are completely obliterated.

Bedded rhyolite tuffs, 50 to 70 feet thick, are exposed in two trenches on the southwest side of the outcrop. Though some contortion is evident, these beds strike about 40 degrees south of east and dip 45 degrees southwest. Rhyolite, mildly chloritized, is exposed near the south end of a long

trench extending southwest from the shaft. Quartz gabbro is exposed in trenches and knobs and in the excavation for the hoist room. The rock is massive, medium grained, and weathers dark rusty brown. It contains grains of opalescent quartz in a dark, chloritic matrix. Disseminated pyrite is common. It is intruded by rhyolite porphyry, for in the trench farthest northwest from the shaft, tongues of rhyolite porphyry cut through the gabbro. Fine-grained greenstone is exposed in contact with quartz gabbro in the trench west of the shaft, but its relations to the gabbro could not be determined satisfactorily. Similar rock, probably intrusive into agglomerate, is exposed in the first long trench north of the shaft.

Intrusive rhyolite porphyry, with small, scattered phenocrysts of quartz and feldspar in aphanitic groundmass, is exposed in three trenches north of the shaft. The shape of the body cannot be defined from present exposures, but it is of interest to note that in sinking the shaft, "As the shaft approached the 100-foot level, a quartz-porphyry intrusive was encountered; this rock appears to be in the form of tongues entering from the southwest. It is not exposed on surface near the shaft".[1] The rhyolite porphyry exposed in the trenches may, however, be related to the quartz porphyry met in the shaft.

The shaft is sunk in chloritized agglomerate cut by quartz veinlets. The rock on the south side is fractured along a zone that trends north 70 degrees west and dips 47 degrees south. Considerable pyrite and chalcopyrite, to perhaps 2 per cent, is disseminated through this zone across the width of the shaft. The thickness of the chalcopyrite-bearing zone could not be determined at the time of the visit.

DESCAR CORPORATION, LIMITED

References: Que. Bur. of Mines, P.R. 116, p. 7 (1937); Geol. Rept. 4, p. 25 (1940).

During 1936 and 1937 Descar Corporation, Limited, examined gold-bearing pyritized zones in a group of twenty-one claims in the southeast corner of Destor township. The claims straddle range line II-III, the Davangus highway, and extend from lot 36 to lot 48. They are crossed by the Beattie tramway.

A geophysical survey of the group in 1936 was followed by diamond drilling. The company reported a total of 13,026 feet drilled to the end of June 1937. The property has lain idle since then.

The claims extend for $1\frac{3}{4}$ miles along the Destor fault. The fault strikes south 80 degrees east, enters the group in low ground in the southwest corner of claim R-18049, and leaves it through the north end of claim R-25574. Four diamond drill holes, Nos. 29 to 32 inclusive, intersected the fault in claim R-2557 just north of the Davangus highway. The fault is marked by zones up to 30 feet wide of sheared volcanic rocks with mud seams scattered through core lengths of 400 feet. The sheared rocks are reduced in places to soft chlorite schists, and the whole section is intruded by a great number of small dykes of feldspar porphyry and injected by numerous veins and stringers of milky to vitreous quartz.

The north wall of the fault valley is a steep, south-facing scarp, which marks in this section the southern margin of the relatively rugged Abijevis

[1] Que. Bur. of Mines, Ann. Rept. 1929, pt. A, p. 122.

Hills. The rocks are well exposed in a series of fire-swept ridges and hills. They consist of flows of pillowed andesite and a few of rhyolite that strike north 60 to 80 degrees east, dip steeply north, and face north. The flows are cut by dykes of feldspar porphyry and felsite, and by dykes and masses of diorite and gabbro. Schistosity, well-developed throughout, strikes north 60 to 80 degrees east and dips vertically. In some zones 40 to 50 feet wide the rocks are reduced to paper schists and are strongly carbonatized. These shear zones are probably subsidiary to the main Destor fault.

South of the Destor fault the hills are lower and much of the country is covered with drift and swamp. Exposures on Descar ground, however, are relatively good. They consist of well-bedded greywackes with thin beds of pebble conglomerate and one bed 200 feet thick of coarse porphyry conglomerate, cut by many small dykes of albite and quartz-albite porphyry. The sedimentary beds are contorted, especially near the fault, but in general they strike north 60 degrees west, dip vertically or steeply southward, and face southwest.

Most of the diamond drilling was concentrated on the 'C' showing in claim R-25136, which underlies low ground between ridges of andesite. The western continuation of the 'C' zone may be a sheared zone that strikes north 70 degrees east across the andesite ridge in claims R-25576 and R-25139. It carries disseminated pyrite and is one of a set of shear zones apparently subsidiary to the Destor fault.

The material in the 'C' zone as disclosed in diamond drilling consists of sections of massive andesite and rhyolite alternating with sections of sheared, carbonatized, pyritized, and silicified rocks. Such altered sections range up to 22 feet of core length, and some are heavily pyritized and cut by numerous quartz stringers. The company reports $19.25 a ton in gold over 4 feet of such pyritic material in one hole, and including this section, $6 over 21 feet. However, no comprehensive statement of returns from other holes has been issued.

GUARDIAN GOLD MINES, LIMITED

Guardian Gold Mines, Limited, prospected for gold in a block of twenty-three mining claims near the east end of Rouyn Lake. Cabins were built near a small creek in lot 42, range VIII N., about ½ mile north of Rouyn Lake.

Development work, most of which was done in 1937, consisted of extensive stripping and trenching. A small diamond drill was brought on the property in September 1938, and several short holes were drilled to pick up the main vein at shallow depths. Prospecting was confined, for the most part, to the large outcrop of rhyolite along range line VIII-IX in lots 41 to 43, inclusive.

The claims are underlain by rhyolite and andesite of the Blake River group, intruded by numerous dykes and masses of diabase and gabbro. The volcanic rocks are intensively and extensively chloritized. Several shear zones up to 10 feet wide with quartz in veins and stringers were discovered in the rhyolite, but work had been insufficient to determine their lengths. Mineralization along the veins consists of heavy pyritization and carbonatization. A little tourmaline accompanies the quartz in places,

galena was discovered in one trench and arsenopyrite is reported, but none was found by the writer. Gold, it is reported, can be panned from some of the shear zones.

The main showing consists of two large quartz veins near the south side of claim R-27142. The northern, and best exposed, vein strikes north 50 degrees east and dips vertically. It has been exposed in a series of cross-trenches at intervals of 20 to 50 feet over a length of 300 feet. In this length its width ranges from 18 to 48 inches and will probably average 24 inches. Seventy feet beyond the northeast end, and approximately on strike, is a similar vein, which is exposed in a trench along the strike for 150 feet. Where it strikes north 68 degrees east, it is 4 feet wide at the west end and narrows to 8 inches at the east end. A cross-trench 90 feet still farther east disclosed a stringer of quartz about in line with the main vein, and, 125 feet north of the stringer, a lens of quartz 9 feet wide at the west end, 58 feet long, and 5 inches wide at the east end. The galena was discovered near the east end of this lens. Channel sampling of the main vein gave $13 over mineable widths in places, but the average was disappointingly low.

The southern vein joins the northern vein at its western end. It strikes north 68 degrees east and dips vertically. It ranges from 8 to 22 inches wide, and averages about 12 inches wide over an exposed length of 360 feet.

INSCO MINES, LIMITED

Insco Mines, Limited, a subsidiary of Inspiration Mining and Development Company, Limited, was incorporated in 1938 to take over a group of claims staked by the parent company. The claims are being examined primarily for deposits of copper and gold. The property consists of one hundred and ten claims, approximately 4,700 acres, all in one group in Dufresnoy township across the south end of Lake Dufault. Approximately the east half of the group is included in the southwest corner of Lake Dufault area. Only that part of the group is discussed here.

Development has included preliminary diamond drilling in late 1938, a geophysical survey in early 1939, and a small amount of diamond drilling in the summer of 1939.

The claims are underlain by rhyolites and andesites of the Blake River group, cut by sills of diorite, by a large, lenticular body of diorite and quartz diorite, by a body of quartz-feldspar porphyry, and by numerous dykes and irregular masses of diabase and gabbro, in part quartz-bearing. Minor intrusives include dykes of aplite, biotite lamprophyre, and pink quartz-feldspar porphyry. (*See* Lake Dufault report for further details concerning these rocks.)

Andesite flows, some of which are pillowed, form a layer 600 to 800 feet thick in rhyolite and rhyolite breccia. The layer, gently convex on its east side, extends across the middle of the group from the south nearly to the north side, where it is cut off by the lenticular diorite mass. The layer faces east; its dip was not accurately determined, but it appears to be between 45 and 65 degrees east. The rhyolite on which it lies is dense and massive, but at approximately 100 feet, and again at 200 feet, below the contact are beds of rhyolite breccia. Still other layers of rhyolite breccia

are included with rhyolite farther west (stratigraphically lower), on island 52. The andesite layer is important, for it not only delineates the structure of the flows, but may have acted as a dam for mineralizing solutions.

The west contact of the diorite mass is an arc roughly parallel to the arc of the andesite layer. The dip of the contact is not known, but the intrusive body is, where exposed, massive, and the possibility that it too might have acted as a dam to mineralizing solutions should not be neglected. If either the andesite layer or the diorite contact is cut by a fault or faults, which might have served as channelways for ore-bearing solutions, chances for deposition of ore-bodies would be correspondingly increased.

Two small, isolated outcrops of pillowed lavas were discovered on isle 21. It is not known whether or not they form parts of a single flow or of two flows.

Small deposits of sulphides had been discovered on some of the islands, and one or two assays showed small amounts of gold. A trench 100 feet south of the north shore of the large peninsula crosses the lower contact between the andesite layer and rhyolite. The rhyolite is sharply contorted and carries abundant pyrite.

Several areas that showed magnetic anomalies were outlined by the geophysical survey. All of them lie within the area covered by the lake, and none had been investigated up to the time of the writer's examination.

JOMAC GOLD SYNDICATE

References: Geol. Surv., Canada, Sum. Rept. 1923, pt. CI, pp. 105-107; Mem. 166, pp. 276-278 (1931).

In 1937 and 1938 Jomac Gold Syndicate staked a group of twenty-seven claims in Manneville township, which include the old MacCormack showing. The MacCormack claims were examined in 1923 and again in 1924 by H. C. Cooke of the Geological Survey, Canada. At that time surface work had been done on a ridge of strongly carbonatized, volcanic rock north of Kinojevis River, in lots 23 to 25, range II, on a sulphide zone on the north side of a ridge of rhyolite near the middle of lot 22, range II, and on a similar sulphide zone exposed on a prominent bluff south of the river in lots 14 to 17, range I.

The claims lay idle until 1938, when an extensive program of stripping, trenching, and channel sampling of the carbonated ridge was undertaken by the present stakers. Returns from this examination were disappointing. In March 1940 the company reported that it was contemplating further examination by diamond drilling.

LA PAUSE GOLD MINING CORPORATION, LIMITED

A group of twenty-six claims near the middle of La Pause township has been prospected for gold and molybdenite by the La Pause Gold Mining Corporation, Limited. Development to July 1937 consisted of approximately 1,900 linear feet of trenching and stripping, and some test-pitting.

The claims are underlain by volcanics and interbedded sediments of the Malartic group, in contact with the Kewagama group near the south-

west corner of the claims. These rocks are cut by numerous dykes, sills, and irregular bodies of albite and quartz-albite porphyry, and the whole assemblage is injected by numerous veins of milky to vitreous quartz. Mineralization consists mainly of the introduction of much carbonate, sericite, and pyrite. Work has been concentrated on two showings described below.

On the north showing, a breccia zone 35 feet wide is exposed intermittently for 200 feet along the strike. It consists of angular, dark green, chloritic fragments intruded by ribbons and dykelets of albite porphyry; this in turn is brecciated and recemented by filaments and veinlets of milky to vitreous quartz with some carbonate and pyrite. A grab sample of this material is reported to have assayed $42 in gold (old price). The possible western extension of the zone is drift covered; to the east it may be cut off by a mass of porphyry exposed 180 feet east of the main trench, or it may continue along the southeast edge of the hill for some distance. Possibilities could be tested by very little shallow trenching and adequate sampling.

Also on the north showing is a layer of almost solid pyrite 2 feet thick, exposed 95 feet along the strike. A picked sample of this material assayed a trace in gold.

Most of the development work to date has been done on the south showing, on and around exposures that outcrop through thin drift on the southeast side of a large ridge near range line III-IV. This ridge is separated by a few hundred feet of low ground from a bold outcrop of bare rock to the south.

The volcanic rocks exposed in these outcrops include flows, pillow lavas, and pyroclastics. In the southernmost exposures the rocks, though locally schistose and contorted, are relatively massive and undeformed. They face south, and aside from a minor bend, strike north 60 degrees west and dip 50 to 70 degrees southeast. In sharp contrast the smaller outcrop just south of the valley displays pillows too deformed to permit a structural determination, and a schistosity striking about east, and dips vertically to 60 degrees north. The volcanic rocks just north of the valley are even more sheared. All original volcanic structures are obliterated and the rocks are reduced to contorted chlorite-carbonate schists. A remarkable feature is that this schistosity, though maintaining an average strike of north 60 degrees west, has an unusually low dip of 30 to 50 degrees southwest. Farther north along the crest and north side of the ridge, the schistosity disappears and the rocks are undeformed breccias and massive flows, some with well-developed pillows. These beds face southwest, strike north 60 degrees west, and dip 60 to 70 degrees southwest.

These data are interpreted to indicate that the low ground of the valley marks the surface trace of a fault, on which the beds south of the fault have been carried upwards relative to those north of it.

North of the valley many albite and quartz albite dykes and sills intrude the volcanic rocks. The intrusives are more or less sheared, carbonatized, sericitized, and charged with pyrite. Furthermore, many of them are cut by numerous veins of milky to vitreous quartz. Although these bodies are somewhat schistose, they are very much less sheared than are the enclosing volcanic rocks, and several of them cut sharply across

the schistose planes of the volcanic rocks. Though not conclusive, the latter evidence indicates they were emplaced after the main period of deformation had come to a close. They may, therefore, post-date the fault described above, and this structure may have acted as control not only for the intrusives, but also for the quartz veins that followed them.

A quartz vein, 26·4 feet wide and exposed 190 feet along the strike, outcrops on the south side of the ridge south of the valley. One hundred and ten feet west on strike a mass of quartz 19·5 feet wide and 40 feet long is exposed; it was channel sampled, but only low assays in gold were obtained.

Many quartz veins are exposed for short lengths in trenches north of the valley. They measure up to 10 feet wide, but the lengths of most are unknown. Observations on three of the veins show that they strike due east, whereas the schistosity strikes 30 degrees south of east. They are of milky or vitreous quartz, containing much pyrite, chlorite, carbonate, and a very little tourmaline.

Molybdenite was discovered in a pinkish, medium-grained, feldspathic intrusive exposed in the southeasternmost trench on this showing. The intrusive is composed of about 70 per cent albite crystals (An_2), whose peripheries are more or less granulated, minor amounts of white mica and chlorite, about 25 per cent of a carbonate, and 3 to 5 per cent of pyrite and molybdenite.

The rock has been deformed since the albite crystals were formed, as shown by the peripheral granulation, and by warping and breaking of the mica plates. Finally, it was irregularly jointed and fractured, and it is along these later structures that pyrite and molydenite were deposited. Pyrite is the earlier sulphide. It occurs mainly along the fractures in coarse, euhedral crystals ⅛ inch or so on a side, and in aggregates of crystals to 1 inch in diameter. In polished surface a few specks of magnetite are seen enclosed in pyrite, or disseminated through the gangue.

Molybdenite, finely divided, is deposited along the fractures in thin, irregular sheets. It is clearly later than the pyrite, crystals of which it embays and veins. The average grade of the material was not known at the time of the visit. Picked samples were said to have given 6 per cent molybdenite, but the average would certainly be much less. The size of the deposit, too, was unknown. Chlorite schist, evidently on the contact of the intrusive, is exposed in the northwest corner of the trench. The extensions of the body in other directions might be explored by trenching, but the cover of boulders and clay is 3 to 5 feet thick where now trenched, and presumably deepens east and south towards the low ground of the valley.

Molybdenite was noted also in altered albite porphyry on the trail about 1,500 feet northeast of the cabin.

LOTS 51 TO 61, RANGE VII, AND LOTS 54 TO 61, RANGE VI, CLÉRICY TOWNSHIP

Reference: Que. Bur. of Mines, P.R. 135, pp. 26, 27 (1939).

Lots 51 to 61, range VII, extend from the east bank of Kinojevis River to the east side of the township. They and those in range VI are crossed by the contact between the south-facing volcanic rocks of the

Malartic group and the overlying conglomerates and greywackes of the Kewagama group. The contact trends about north 65 degrees west across lots 51 to 56, range VII, crosses range line VI-VII near lot post 56-57, and then, near the middle of lot 58, bends sharply to north 40 degrees west, to cross the township boundary about 3,200 feet south of the range line.

The greenstones north of the contact consist mostly of pillowed andesites. All are more or less sheared, but along the northeast side of the northernmost ridge, across lots 54 to 60, range VII, they are strongly sheared and intensely contorted in a zone about 200 feet wide, traceable for a mile.

The volcanic rocks are intruded by several dykes of quartz-albite porphyry and albite porphyry that grade, in places, into albite granite. One of these dykes, traced for 8,000 feet along the strike, attains a width of 400 feet where it crosses the north-south road in lots 52-54, range VII. Another dyke of highly sheared granitic rock follows the volcanic-sedimentary contact for 5,000 feet, from the middle of lot 54, range VII, to leave lot 51 near its western end.

Conglomerate in beds to 25 feet thick is interbedded with greywacke through some 150 feet of section just south of the sedimentary-volcanic contact. The rocks grade southwards into well-bedded greywackes, well exposed in lots 56 to 59, range VI. The greywacke is much contorted, and cut by many narrow dykes of albite porphyry.

A dyke of younger diabase, striking a few degrees east of north, extends across range VI in lots 56 to 59. In lots 59 and 60, range VI, a few exposures of porphyritic diabase are found that may be parts of a second north-trending dyke.

The structure as exposed, aside from minor contortions in the greywackes, consists essentially of a series of steeply dipping, south-facing strata. A shear zone, roughly parallel to the strike, is exposed near lot line 51-52, range VII; others are developed within or along the granite dyke that follows the contact in lots 51 and 52, range VII. The zone of strong contortion noted on the northeast side of the north ridge is believed to lie along a major fault, probably one of the main branches of the Destor fault.

Mineral deposits within this section are of two types, first, carbonate zones, and second, quartz-tourmaline veins. One of the largest carbonate zones is exposed within the shear zone in lots 51 to 52, range VII. The rocks are reduced to chlorite-carbonate schists, heavily mineralized with pyrite. Some trenching and test-pitting of the zone has been done. A sample of the most heavily carbonatized and pyritized material assayed a trace in gold. Other less well exposed carbonate zones were seen along the north side of the granite dyke in lot 51, range VII. No samples were collected for assay.

Many short, irregular lenses of quartz, up to 2 feet wide, cut greenstones near the south side of lots 59 and 60, range VII. The veins carry considerable tourmaline, pyrite, and some carbonate. Two samples assayed nil in gold.

Although samples collected by the writer for assay gave discouraging results, the examination was necessarily cursory. Ross, reporting on claims in this section for the Quebec Bureau of Mines, records better returns from

a channel sample across a siliceous zone 3 feet wide in lot 51, range VII. The geology in this section between Kinojevis River and the east side of the township marks it as favourable prospecting ground.

MacDONALD MINES, LIMITED

The property consists of 1,150 acres in range III, Dufresnoy township, and includes the south halves of lots 37 and 38, all of lots 39 to 44, inclusive, and the north half of lot 45. It is being prospected primarily for gold and copper. The main line of the Canadian National Railways from Noranda to Taschereau is just over ½ mile north of the northeast corner of the property. Camp buildings are on the shore of the northeast bay of Lake Dufault.

The current program of work on the property was begun in late 1937 and was continued in 1938 and 1939. Development consists of careful geological examination controlled by picket lines run north and south at 200-foot intervals. This was followed by stripping, trenching, test-pitting, and about 8,000 feet of diamond drilling.

The property covers the eastern nose of the Dufault granodiorite stock, which underlies most of the north halves of lots 39 and 40 and nearly all of lots 41 and 42. The western contact, established by surface work and drilling, can be followed southeastwards across lots 39, 40, and 41, but near the east side of lot 41 it must bend sharply southwest, for granodiorite is exposed in outcrops distributed entirely across lot 42, in strippings near the south side of lot 41, by diamond drilling near the south side of lot 39, in outcrops on the lake shore in lots 36 and 37, and on islands 31 and 32. The triangle so outlined is occupied by acidic pyroclastic breccias identical in appearance with those on Continental ground around the East Bay showing. The eastern contact of the granodiorite with rhyolite lavas crosses range line III-IV near the east side of lot 43. It was picked up in diamond drill holes 12 and 14, and can be followed southwards through scattered outcrops to the southwest corner of lot 43. It thus trends nearly due south for nearly a mile. South of range line II-III information is much less complete, but the contact probably swings west to join the inner contact somewhere west of islands 31 and 32.

The rhyolite lavas east of the stock are intruded by numerous dykes and masses of diabase and gabbro, some of which are quartz-bearing. In addition, one outcrop of diorite was discovered in lot 43, near the east side of the lot and 1,400 feet south of range line III-IV. The same rock was intersected near this outcrop in diamond drill holes 14 and 15.

Because of the massive character of the volcanic rocks the structure is most difficult to decipher. Structures in the district as a whole suggest that the rhyolite flows east of the granodiorite probably strike nearly north or slightly west of north, and dip steeply east or are vertical. The trend of the eastern contact of the granodiorite thus may reflect the strike of the flows.

Drill holes Nos. 9 and 11 near the western boundary of the MacDonald ground, approximately on the strike of the shear zones exposed at the East Bay showing, encountered heavily sheared and pyritized zones with

a little chalcopyrite. Hole 9, drilled north 30 degrees west at a dip of 45 degrees, entered coarse granodiorite at 70 feet and continued in it to the bottom of the hole at 590·4 feet. The granodiorite is well mineralized with pyrite, and specks of chalcopyrite are present in several places. Several short sections are sheared and shattered, particularly between depths of 90 and 221·5 feet; and from 169·6 to 221·5 feet the granodiorite is reduced to a sericitic schist heavily mineralized with pyrite carrying splashes of chalcopyrite between 210 and 210·7 feet. In hole 11, 225 feet south 60 degrees west from the collar of hole 9, and drilled parallel with it, the company reports that acidic breccias were encountered from 50 to about 200 feet, sheared acidic breccias from 200 to 265 feet, more normal breccia from 265 to 304 feet, and intensely sheared rock to 658 feet. From 658 feet to the bottom of the hole at 722 feet the rock is recognizable granodiorite. The core throughout is well mineralized with pyrite and some chalcopyrite.

Information is too incomplete to permit the assumption that these shear zones form part of a structure that includes the East Bay shear zones. If they do, a structural feature of some size and possible economic importance would be indicated.

The MacDonald pit, a copper-gold showing, is in lot 43, about 1,900 feet north of range line II-III. The country rock is granodiorite, here considerably fractured and cut by several quartz veins. The quartz veins strike north 10 to 30 degrees east and the largest is 5 feet wide at its maximum. This large vein terminates near the south edge of the pit. For 15 feet north of its south end the vein is heavily mineralized with coarse pyrite, considerable chalcopyrite, some sphalerite, and galena. The wall-rock is well pyritized. Assays reported by the company gave $4 to $5 in gold over widths of 5 feet. The vein was cut by diamond drill holes at a vertical depth of 35 feet, but assays were disappointing.

Pyritization, other than that noted above, is widespread through the volcanic rocks on the property. Local concentrations are reported by the company to give good returns in gold and copper. To date work on these has been more or less incidental to the general geological exploration, and their full size and character remain to be determined.

MacDONELL GROUP

A gold prospect of six claims in range X, Joannès township, formerly held by Marillac Gold Mines, Limited, is now known as the MacDonell group. Cabins near the main showings, about 1½ miles east of Marillac Lake, are reached by a trail from Kinojevis River.

Development work to July 1939 consisted of extensive surface work, which disclosed three gold-bearing zones. The No. 2 showing was tested at depth by three diamond drill holes.

The claims lie across the southwest contact of the Cléricy quartz diorite and granodiorite dyke, near its southeastern end. The dyke is about 3,500 feet wide in this section. The southwestern contact, against acidic pyroclastic rocks and rhyolites, is not exposed; inclusions of country rock are rare, as are apophyses of granodiorite around the margins.

All the showings are in granodiorite. The intrusive rock is, in general, massive, but is sheared here and there across zones up to 10 feet wide, which strike northeast to east and dip from 60 degrees north to 70 degrees south.

The No. 1 showing lies 100 feet south of the cabins in claim R-23116. A quartz vein 50 feet long in sheared granodiorite is exposed in a trench. The vein strikes north 45 degrees east and dips vertically. It is 6 inches wide at the northeast end, swells in 20 feet to 44 inches, pinches to 6 inches in 12 feet more, then swells to 3 feet and pinches to 6 inches again in the remaining 18 feet. The vein lies parallel to the schistosity. At the southwest end the schistosity swings to north 65 degrees east, and although two very narrow shear zones are exposed 10 feet apart in a cross trench 11 feet west, no quartz was observed.

The vein quartz is white, with chlorite and a little carbonate along fractures. No pyrite was observed in the vein proper, but the wall-rock, of sheared granodiorite, carries carbonate and pyrite in ¼ inch cubes over widths up to 1 foot. The vein is reported to assay $12 in gold a ton over widths of 3½ feet, and a length of 40 feet.

The No. 2 showing is about 500 feet northeast of the southwest corner of claim R-12670. It consists of a 10-foot sheeted zone of granodiorite, silicified and cut by a network of quartz stringers. The sheeting strikes north 65 degrees east for 45 feet from the west end, then turns to north 80 degrees east for 95 feet. The dip, too, is variable, from 60 degrees north near the bend to 75 degrees south 20 feet east of the bend. Parting planes are slickensided and covered with chlorite and fine-grained pyrite. Visible gold was reported from one of the trenches near the western end, and surface sampling gave interesting returns in gold over widths of 3 feet and a length of some 70 feet. Vein material was intersected in one drill hole at an approximate vertical depth of 100 feet, in another at an approximate vertical depth of 250 feet. This material may be part of the same vein as is exposed at the surface, and if so, the vein near its eastern end must dip about 70 degrees south.

Trenches 250 feet east of the east end of this zone have exposed sheeted granodiorite with basic inclusions. One hundred and eighty feet west of the west end a few quartz stringers are exposed and 100 feet farther west a quartz stringer zone 6 inches to 5 feet wide in sheeted granodiorite is exposed for 200 feet along the strike. This latter zone has not been investigated and appears on the surface to be barren.

About 350 feet northwest of this showing a third sheeted zone is exposed in three cross-trenches over a length of 95 feet. It is reported that modest returns in gold were obtained here over widths of 3 feet.

McDAIRMID SHOWING

Reference: James, W. F., and Mawdsley, J. B.: Cléricy and Kinojevis Map-Areas, Témiscamingue and Abitibi Counties, Quebec; Geol. Surv., Canada, Sum. Rept. 1924, pt. C, p. 124.

A sheared quartz-carbonate zone in lot 44, rge. VII, Cléricy tp., is known locally as the McDairmid showing. It is reported that gold can be panned from the zone where it is exposed in an adit on the river shore.

The zone consists of sheared, contorted greenstone schist, heavily carbonatized. It is exposed across its strike for 37 feet from the entrance of the adit, where it grades into more intensely sheared material 7 feet wide, which lies along less sheared to massive andesite in the face of the adit. Schistosity near the entrance strikes north 50 degrees west and dips 65 degrees northeast. In the 7-foot shear zone the dip decreases to 45 degrees northeast. A dyke of pink feldspar porphyry, broken, pyritized, and carbonatized, is intruded parallel to the schistosity in the carbonate zone near the entrance. The dyke is there 18 inches wide, and is exposed in cross trenches to the northwest for a total length of 75 feet. It widens northwest to 3 feet where last exposed.

The material in the shear zone near the face of the adit consists of about 50 per cent very soft chlorite schist and 50 per cent of quartz-carbonate lenses. In addition, there is a small amount of fuschite, much disseminated pyrite, and some molybdenite. The molybdenite occurs, with chlorite and finely divided pyrite, on slips in carbonate lenses.

MINING CORPORATION OF CANADA, LIMITED (VILLE-MARIE PROPERTY)

Mining Corporation of Canada, Limited, carried out a program of diamond drilling in 1939 on claims known as the Ville-Marie property. The claims, T-289 to T-291, T-1940 to T-1942, and T-2806 to T-2809, inclusive, lie in ranges VIII and IX, between lots 33 and 41, Rouyn township. Development work before 1939 consisted of surface trenching, test-pitting, and a prospect shaft 20 feet deep near the middle of claim T-2806. A detailed geological survey was made of part of the property in 1937 by a private company, and later a magnetometer survey was made. Diamond drilling by Mining Corporation was in progress, with over 5,000 feet completed, when the property was visited in September 1939.

The property is underlain by volcanic rocks of the Blake River group. Outcrops in the northwest corner of the claims are good; the remainder is largely drift covered. The exposures in the northwest consist of rhyolite and rhyolite breccia, with one well-exposed, distinctive layer of bedded tuffs and breccias. Intrusive rocks, in addition to intrusive bodies of rhyolite probably nearly contemporaneous with the flows, include numerous dykes and masses of diabase and gabbro, and a small dyke of younger diabase, probably a part of one of the dykes that passes through the Horne mine.

The layer of bedded tuffs and breccias crosses the southeast corner of claim T-290; it strikes almost due south, dips 70 degrees east to vertically, and, as shown by excellent crossbedding, faces east. At the southern end, in block 31, it is 400 feet wide, and terminates against the Horne Creek fault. The layer swings east of north out of claim T-290 into T-1940, where it either pinches out or is faulted off across the northwest corner of the latter claim. The layer is of great significance in interpretation of the geology in this locality, for not only does it define the attitudes of the flows in which it lies, but also it is believed to be correlative with bedded tuffs and breccias at the Horne mine, south of the Horne Creek fault. It

is thus the main piece of evidence used in determination of the horizontal displacement on the Horne Creek fault.

The few outcrops, and the diamond drilling, show that the volcanic rocks under the low ground are extensively intruded by diabase and gabbro, and in part are strongly chloritized. Intrusions of the same type of rocks are, of course, widespread in the Horne mine, where they are named meta-diabase. North of the Horne Creek fault at the Horne mine, exposures are poor, but diabase and gabbro are not found. On Ville-Marie ground south of the Horne Creek fault, a few bodies of these intrusives appear, but they are scarce. Their abundance north of the fault here and south of it at the Horne mine, with similar distribution relative to the tuff and breccia bed, thus constitutes additional evidence favouring their correlation.

If the correlation is correct, it places the Ville-Marie and adjacent properties north of the fault in an interesting geological position, for though now separated from the Horne mine by over 2 miles, before displacement occurred on the Horne Creek fault the tuff and breccia layer would have been continuous. It must be emphasized, of course, that the rocks now exposed at the surface on the two properties did not lie at equivalent levels before faulting, for there has almost certainly been vertical as well as horizontal displacement on the Horne Creek fault.

In addition to this main fault, the property is crossed by one or more branch faults, which strike east of north to northeast, or north of east. Displacement on these branch faults, where measured, is not great. Small shear zones and planes of schistosity are parallel, in general, to the trends of the branch faults. They strike across the trends of the flows at wide angles, and where the flows have planes of easy parting, as flow planes, the rock weathers into a rubble of small, sharply angular blocks. The sheared and broken rocks, especially west of the tuff and breccia layer, are extensively mineralized with disseminated pyrite.

PAQUIN CLAIMS

References: Que. Bur. of Mines, P.R. 129, p. 3 (1939); Geol. Paper 4, p. 26 (1940).

Gold-bearing quartz veins were discovered in 1938 in lot 42, rge. IV, Destor tp., in claims held by A. Paquin of Noranda. In 1938 the claim was optioned by W. B. Maxwell, Manager of Beattie Mines, Limited. Surface trenching was followed by diamond drilling in 1938.

The veins, of milky to vitreous quartz, are exposed about 1,200 feet north of range line III-IV, on the north side of a ridge of pillowed andesite and rhyolite, extensively intruded by massive gabbro and diabase. All the veins occur in gabbro. The westernmost vein, trenched along the strike for 106 feet, strikes north 68 degrees west over the southern 34 feet, then swings to north 40 degrees west. It dips 65 degrees southwest. It is 3 feet wide on the south end, narrows to 1 foot near the middle, and then widens again to 3 feet at the north end, where it disappears under heavy drift. The wall-rock is mineralized over 18 inches or less on either side with pyrite and a little chalcopyrite. Bannerman reports some galena and sphalerite as well. Interesting values, according to him, have been obtained over widths up to 9 feet. Two diamond drill holes, 150 and 250 feet north of

the north end, were drilled to intersect the vein at shallow depths. Seventy and 110 feet south and east of the south end, two small stringers of quartz cut gabbro, and may form part of the main vein or vein system.

A second quartz vein, also in gabbro on the north flank of the ridge, is exposed about 350 feet northeast of the north end of the first vein. It strikes north 15 degrees west and dips 60 degrees west. It has been trenched along its strike for 80 feet. The quartz ranges from 1 foot to 18 inches wide, and frays into stringers on the south end. The vein has a tight foot-wall, but is rusted and broken along its hanging-wall. Inclusions of wall-rocks are abundant in the quartz. Five diamond drill holes, spaced 40 to 70 feet apart, were drilled to intersect the northward continuation of the vein below low ground.

A third vein, 2 to 3 inches wide, is exposed 280 feet east of the second vein. It is trenched for 24 feet along its strike of north 20 degrees east. Other small lenses of vuggy quartz are exposed nearby.

Bannerman reports that the two westerly veins were shown by diamond drilling to extend northward below the drift-covered depression for over 300 feet. Though interesting returns in gold were reported from the exposed veins, in the drill intersections the veins are small and contain somewhat less gold.

PRIMROSE EXPLORATION COMPANY, LIMITED

Reference: Que. Bur. of Mines, P.R. 116, p. 25 (1937).

This company held, in 1939, a group of nine claims in Cléricy township, formerly known as the Lusko-Hamilton group. The claims lie across range line IV-V and include the south halves of lots 18 to 22, inclusive, range V, and north quarters of lots 18 to 22, inclusive, range IV. A frame building was put up on lot 19, just north of the range line.

Development work was concentrated on a gold-bearing quartz vein along the range line in lot 20. The vein is exposed on the north flank of a ridge of pillowed andesite. The flows strike north 40 degrees west, dip 80 degrees southwest and face southwest. The vein has been trenched and stripped from a point 80 feet west of lot post 20-21 for 310 feet west along the range line. It dips 45 degrees north at the east end and 30 degrees north in the middle. It pinches at either end, but averages about 30 inches thick over most of its length. Rocks in the hanging-wall are sheeted over 4 inch widths in places, but are mostly massive. In the foot-wall they are pyritized for 18 inches or less from the vein. Mineralization consists of rather scanty pyrite in both foot-wall and hanging-wall. The company reported that visible gold was found in several places along the vein.

Thirty feet north of the west end of the main vein a second quartz vein 80 feet long strikes north 70 degrees west and dips 40 degrees north. This vein consists of two quartz branches about 1 foot apart at the surface, which join 5 feet down the dip into a single vein 1 foot thick.

Forty-seven feet north and 28 feet west of the west end of the second vein a third quartz vein striking north 80 degrees west and dipping 30 degrees north is exposed for 10 feet in a trench, and in a pit 30 feet farther west on strike a quartz vein, 6 to 8 inches wide, is exposed, with

stringers up to 3 inches wide branching from it. Fifty feet west of the pit there is a trench 150 feet long. Only andesite is exposed, but much of the trench is caved.

An adit was driven 93 feet south into the north face of the hill, to intersect the vein below the surface. At 93 feet, according to report, a vein carrying gold was intersected; in a drift carried along the vein only small amounts of gold were obtained. The main vein was not reached. The company reports that 260 feet of lateral underground work was completed. The property has been idle since late 1937.

RICHMOND SHOWING

References: Geol. Surv., Canada, Sum. Rept. 1924, pt. C, p. 123. Que. Bur. of Mines, Ann. Rept. 1929, pt. A, p. 128.

Two ridges of carbonatized greenstones cut by large quartz veins outcrop near the middle of range IX, Cléricy township, just east of the north-south centre line. The showing has been opened up by a series of cross-trenches up to 350 feet long, spaced 200 to 250 feet apart, and by diamond drilling. No work has been done on the showing since 1929.

The claims on which the showing lies were originally the Richmond group. They were taken over (about 1926) by Richburn Mining Company, Limited, and optioned to Star Gold Mines, Limited, in 1929. Most of the exploration was carried out by the latter company.

The two ridges of sheared, carbonatized greenstones trend north 80 degrees west, and are separated from one another by a strip of low ground about 200 feet wide. The north ridge is 1,200 feet long, the south ridge 500 feet. The carbonatized greenstones are intruded by a dyke of albite granite, exposed on the south side of the north ridge. The granite is even, medium grained, and composed of about 50 per cent albite, 35 per cent quartz, and 15 per cent chlorite. Grains of apatite, magnetite, leucoxene, and pyrite are common.

The sheared and carbonatized rocks are injected by a network of lenticular, tourmaline-bearing quartz veins up to 40 feet wide and 200 feet long. Three ages of quartz are recognizable in the veins, first, a milky to pinkish quartz, brecciated and injected by tourmaline-bearing quartz, cut in turn by veins of dark grey quartz. In addition, scattered through the tourmaline-bearing quartz are many perfectly euhedral, doubly terminated crystals of quartz to $2\frac{1}{2}$ inches long and $\frac{1}{2}$ inch wide.

On the north side of the north ridge a zone of disseminated pyrite 20 feet wide was traced 100 feet, according to a report by the Quebec Bureau of Mines. Earlier, James and Mawdsley reported that grab samples taken when the property was staked gave encouraging results.

ROCCA GROUP

Mr. Nicola Rocca and associates held, in July 1938, as mining claims in Destor township, lots 23 to 30, inclusive, range I, lots 20 to 25 and the south half of lot 26, range II, and the south half of lot 24, range III. Cabins are built on the east shore of the north bay of Dufresnoy Lake. Some returns in gold and copper are reported from surface showings.

The main showings, visited in July 1938 and August 1939, are on two parallel ridges that trend south of east across lots 25 to 27, ranges I and II. The ridges are burnt clean and the showings have been opened up by considerable trenching, stripping, and test-pitting.

The ridges consist of massive rhyolite and rhyolite breccia, which form part of the rhyolite layer in the centre of the Cléricy syncline. The flows strike about north 60 degrees west and dip vertically or steeply south. The rhyolite of the south ridge is extensively fractured, broken into small joint blocks, and mineralized with much massive, fine-grained pyrite and some chalcopyrite. Zones 4 or 5 feet wide of almost solid pyrite are exposed in trenches across the strike over widths of 50 to 80 feet. Similar sulphide zones are found along the strike for at least 500 feet, and one zone 55 feet wide can be followed for over 300 feet along the north flank of the ridge. Mr. Rocca states that picked samples of solid sulphides assayed 1½ to 3 per cent copper.

The rhyolites of the north ridge are less fractured and carry no large zones of sulphides. Some small deposits of disseminated pyrite, with, in one pit, considerable specularite, have been opened up by test pits along the south flank of the ridge.

ROYBELL MINES, LIMITED

References: Que. Bur. of Mines, Ann. Rept. 1929, pt. A, p. 126; Que. Bur. of Mines, P.R. 116, p. 25 (1937).

A gold-bearing quartz mass was discovered in the autumn of 1936 at the northeast corner of claim R-25918 in the Caputo group, southwest Cléricy township. The Caputo group was acquired by Leroy Mines, Limited. In 1939 this company was consolidated with Nubell Gold Mines, Limited (formerly Mabell Mines, Limited), to form a new company, Roybell Mines, Limited. Roybell Mines, Limited, now holds twenty-two claims, 560 acres in all, which cover parts or all of lots 8 to 22, rge. I, and lots 8 to 12, rge. II, Cléricy tp. Showings on the Nubell claims consist of two, copper-bearing, pyritic zones.

After the discovery was made on the Caputo group, four claims, R-26003 to R-26006, inclusive, which include the east end of the discovery, were staked by O'Brien Gold Mines, Limited, and one claim, R-26002, was staked by them on the west side of the group. Preliminary development on the main showing was carried out under option by O'Brien Gold Mines, Limited, in 1935, but the option was allowed to lapse in 1936. Preliminary work consisted of stripping, trenching, and channel and bulk sampling of the quartz masses, followed by 3,500 feet of diamond drilling. Leroy Mines, Limited, undertook to examine the mass more thoroughly underground, and sank a three-compartment shaft to 265 feet, with levels at 125 and 250 feet. On the 125-foot level a crosscut was driven 65 feet south; on the 250-foot level a crosscut was driven 103 feet north. All underground workings were flooded when the writer visited the property in June 1939. Information concerning them and the geology disclosed therein was very kindly supplied by Mr. E. Bregent, Managing Director of Roybell Mines, Limited.

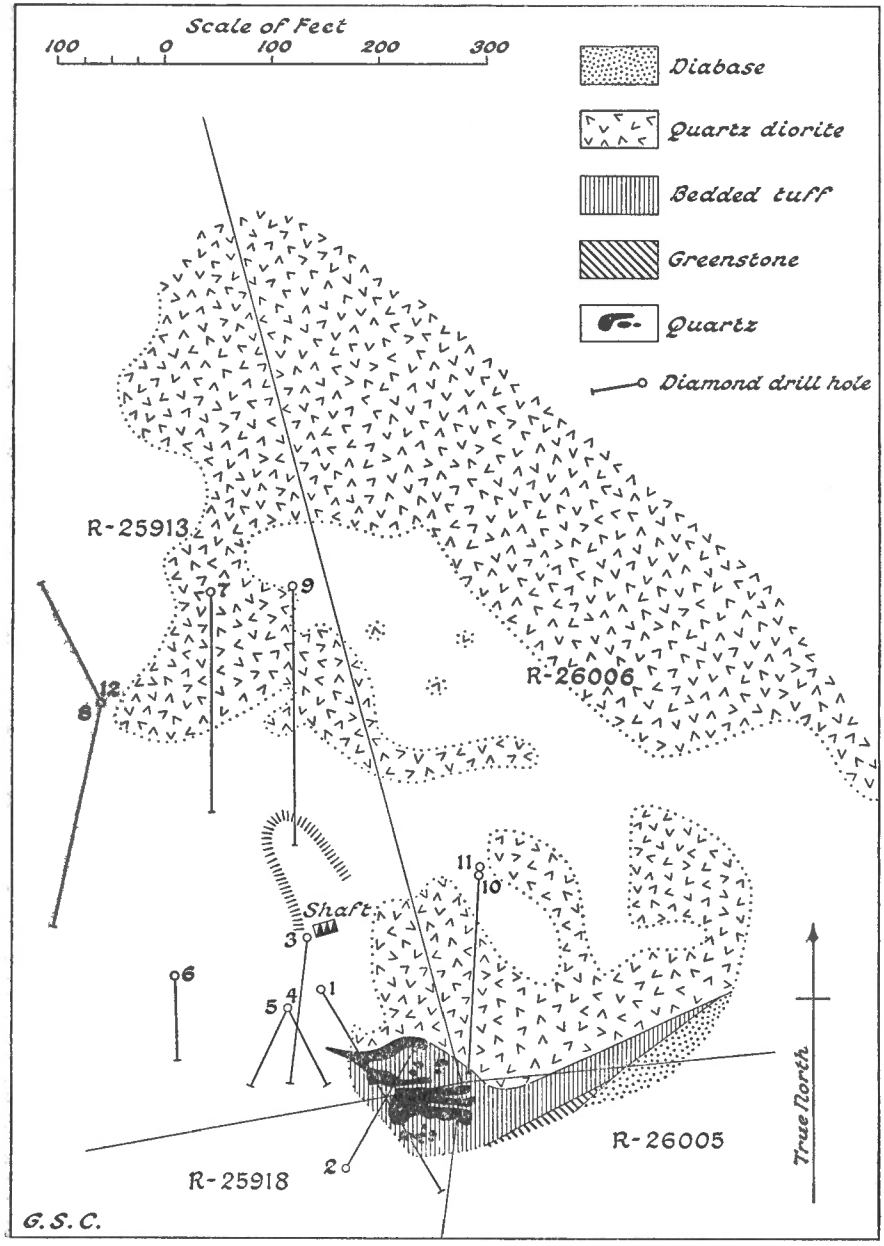

Figure 1. Geological sketch of Caputo showing, Roybell Mines, Limited, Quebec.

The quartz masses are injected into a layer of bedded tuffs that forms an inclusion in, or an embayment into, the southwest margin of the Cléricy quartz diorite and granodiorite dyke. As shown in Figure 1, the tuffs are about 120 feet wide at the west side of the exposure, narrow sharply to the east to 30 feet, and are cut off along a dyke of younger diabase. The diabase dyke is probably not less than 300 feet thick. The tuffs are intruded by quartz diorite on the north and are in contact with fine-grained, basic greenstone on the south. Bedding in the tuffs strikes north 80 degrees east; dips range from 65 to 80 degrees north. The schistosity strikes parallel to the bedding, but in the wide western part its dips are more variable and range from 45 to 75 degrees north; in the narrower eastern part the schistosity dips 80 degrees north. In some places near the quartz masses, both bedding and schistosity are sharply contorted. The decrease in width of the tuff bed from west to east may be due either to more active stoping by the quartz diorite along the eastern part, or to expansion of the tuffs by contortion, shearing, and injection by quartz in the western part. The absence of inclusions of tuff in the quartz diorite near the contact, and the contorted character of the tuffs in the wider part suggest that the latter explanation is correct.

The quartz diorite is coarse grained, massive, and weathers grey. Outcrops are mottled with dark inclusions of fine-grained greenstones. The inclusions are of all sizes up to 4 or 5 feet on a side. The quartz diorite itself varies notably in content of mafic minerals.

Granite, or granodiorite weathering pink, cuts quartz diorite in irregular dykes, or forms isolated outcrops 20 feet or so in diameter. The relations are well displayed in an outcrop near the southwest corner of the cookery. The amount of granodiorite appears to increase towards the interior of the dyke.

Quartz, milky to vitreous, forms two large and several small masses in the tuffs. The large masses measure 130 feet and 83 feet in longest dimension, and are 23 and 25 feet wide, respectively. Both finger out bluntly towards the east; the southeastern one ends on the west, the other passes under drift at the west end. The north contact of the north mass dips 45 degrees north, and intersections obtained in diamond drill holes 3 and 10, and in the shaft on the 125-foot level, indicate that vein material continues at this dip to a vertical depth of 138 feet (upper contact). On the 250-foot level, although greenstones (tuffs?) were encountered the amount of quartz is negligible. The quartz may have pinched out, or it may be displaced along a vertical fault that Mr. Bregent states was encountered 25 feet north of the shaft. A sharp valley, deepening westward, crosses the cleared area from east to west between the headframe and the office. No definite information was obtained on the surface to mark this as the trace of a fault, but sheared material that might lie along a fault was encountered in diamond drill holes 7 and 9 vertically below the north edge of the valley. However, in these same holes, 27 and 19 feet, respectively, of vein material was encountered at points about 200 feet down the projected dip of the vein in the shaft. That is, if these intersections are part of the surface vein, that vein is not seriously disturbed by faulting for 400 feet down the dip. The barren north crosscut on the 250-foot level may be driven in a non-quartz bearing section of the vein structure.

Continuity of vein material along the strike is indicated in drill holes 200 feet east of the shaft. Drilling west of the shaft is too incomplete to indicate continuity of the same vein in that direction, although 22 feet of vein material was encountered at 278 to 300 feet in hole 8.

The vein, at the surface, consists of milky to vitreous quartz with here and there considerable tourmaline and a few scattered aggregates of epidote. Visible gold is reported to be common, but although some particles were discovered by the writer in quartz on the dump, he saw none in place. The assay plan supplied by the company shows that gold occurs only in the quartz. In the northwestern quartz mass the gold tends to be along or near the foot-wall, and a high-grade section, returning $24.15 in gold a ton over 9 feet or $14.09 over 19·7 feet, is open on the west, but pinches out sharply to the east. A second section about 50 feet long and averaging about 4 feet wide lies along the foot-wall farther east; it contains $12 to $15 in gold a ton. Distribution of gold in the southeast mass is more erratic. Bulk sampling gave returns up to $17.06 in gold a ton over 9 feet, and one section 10 feet wide and 20 feet long probably would average between $4 and $5 in gold a ton.

Assays of diamond drill cores in deposits of this type are unreliable as indicators of probable value. They may be much too high or too low. In this deposit most of the vein intersections gave nil or trace in gold, although in holes 3 and 10 some encouraging returns were obtained. Channel sampling of the vein in the shaft gave encouraging returns on the west face and somewhat lower returns on the east face.

The Nubell showing, developed by Mabell Mines, Limited, is described by the Quebec Bureau of Mines. Two zones bearing disseminated pyrite, some pyrrhotite, and a little chalcopyrite are exposed in two parallel ridges of acidic volcanic rocks that trend northwest across claims T-1280 and A-14585. The eastern zone, in claim T-1280, can be followed along the crest of the ridge for about 1,200 feet; it ranges up to 200 feet wide. It has been opened up by stripping, trenching, and test-pitting. A total of 12,734 feet of diamond drilling is reported. The property has been inactive since 1930.

SEGUIN CONSOLIDATED MINES, LIMITED

References: Que. Bur. of Mines, Ann. Rept. 1933, pt. A, p. 113; 1932, pt. A, p. 75.

Seguin Consolidated Mines, Limited, was organized in 1937. It took over the assets of Seguin Rouyn Gold Mines, Limited, which included a group of thirty-two claims in the northeast corner of Rouyn township. The property is crossed by a power line that goes south to the McWatters mine. Interest was aroused in the group by discovery in 1932, about 1,200 feet north of the present camp-site, of a well-mineralized zone about 50 feet wide, with quartz stringers that carried coarse visible gold.

Well constructed camps were built on the north shore of Lake Routhier. The property was prospected by Seguin Rouyn Gold Mines, Limited, from time to time between 1933 and 1937. Surface work included a careful search for outcrops, followed by stripping and trenching where rock was found accessible. A shaft was sunk on the discovery outcrop

and approximately 11,500 feet of diamond drilling was done. A map showing the location of all surface workings and outcrops, prepared by Mr. Seguin, was made available to the writer and was used throughout his examination.

The claims are underlain almost exclusively by acidic, pyroclastic rocks of the Blake River group. A few flows of massive, cherty rhyolite, a dyke and some small outcrops of intrusive diabase, feldspar porphyry, and a large, northeast-striking dyke of younger diabase complete the assemblage.

The discovery outcrop is in lot 49 and is crossed by range line VII-VIII. It is isolated by several hundred feet of swamp from other outcrops. The rock is heavily sheared, pyritized, fine, acidic breccias or tuffs. The schistosity strikes north 85 degrees east and dips 80 degrees north. A few quartz stringers to 2 inches wide occur in the sheared rock parallel to the planes of shearing. All the rock on the dump around the shaft is of the same character as that on the surface. So far as known, no encouraging amounts of gold were encountered in sinking the shaft, nor in later diamond drilling below the discovery site.

A group of outcrops 1,000 feet north and 300 to 700 feet east of the shaft was extensively trenched and diamond drilled. Acidic pyroclastic tuffs and breccias, with a body of rhyolite, form the country rock. The rocks are strongly sheared; shear planes strike north 85 degrees west and dip 85 degrees north. In the south end of the westernmost trench the rocks are reduced to a paper schist, and are mineralized with considerable pyrite and carbonate. The shear zone may extend east through a water-filled and caved section in the next cross-trench 200 feet east. No information was obtained as to returns in gold from surface showings, but drill holes put down to test the deposit at depth gave low returns over considerable widths.

Quartz-carbonate veins, carrying considerable tourmaline and pyrite, are uncovered in some of the trenches across outcrops of pyroclastic breccias west of the McWatters power line and east of Dufault Creek. Whether or not these gave any returns in gold is not known.

WILTSEY-COGHLAN MINES, LIMITED

References: Que. Bur. of Mines, Ann. Rept. 1933, pt. A, p. 104; 1934, pt. A, p. 85.

Wiltsey-Coghlan Mines, Limited, holds as mining concessions a group of sixteen blocks between Trémoy and Rouyn Lakes. Development work to the end of 1934 is described in reports by the Quebec Bureau of Mines. It consisted chiefly of diamond drilling, and sinking of two shafts, No. 1 to a depth of 84 feet, No. 2 to 101 feet. A small amount of lateral work was done from each shaft. Some chalcopyrite and gold were reported in a crosscut from the No. 1 shaft. No work has been done since 1934.

The property is underlain by rocks of both the Blake River and Cadillac groups. The only intrusive rock identified is diabase cutting mixed breccias near the No. 2 shaft. Some sills or dykes of diorite may accompany the andesite flows.

The group lies, for the most part, within an area of structural complexity. The Horne Creek fault crosses block 31 from west to east just

south of range line VIII-IX. A fault, which may be the eastern continuation of the Andesite fault known south of the Horne mine, is postulated across the group from west to east through blocks 149, 150, and 151, approximately along Trémoy Creek. A third fault, striking about north 60 degrees east, is postulated across blocks 194, 190, and the southwest corner of 151. Other faults are suggested by some features of the structure, but no definite information as to their location was obtained. The faults divide the area into several blocks, and as the flows were folded before they were faulted, the present structure is difficult to unravel. (*See also* Structure, Lake Routhier area.)

The No. 1 shaft was sunk in an outcrop of intensely sheared, carbonatized, chloritized rhyolite, charged with disseminated pyrite. This outcrop is one of a group of similarly altered rhyolite outcrops along Trémoy Creek near the north-south centre line of the township. They lie along or near the presumed extension of the Andesite fault.

No. 2 shaft is 675 feet northeast of No. 1 shaft. It is put down in massive greenstone, sparingly mineralized with disseminated pyrite. The massive greenstone extends 60 feet south of the shaft, across the strike, where it is in contact with a layer of breccia 30 feet thick. The breccia contains fragments of felsite, and possibly dacite, to 6 inches across. The contact strikes north 70 degrees west and is considered to mark the division between the main body of andesite flows to the north and the section of rhyolite flows to the south. Twenty-five feet north of the shaft the massive greenstone is in contact with strongly chloritized andesite breccia, which extends to the north side of the outcrop. Both this breccia and the one to the south are intruded by fine-grained dykes of diabase, and the same rock is exposed in the north end of a trench just south of the shaft.

Some work was done on a ridge of carbonatized, pillowed andesites near the east side of block 190. The flows are strongly sheared; shear planes strike north 80 degrees east and dip 60 degrees north. Near the west end of the outcrop, quartz stringers form a vein system about 50 feet wide, traced 250 feet along the strike. The veins are accompanied by pyrite, some tourmaline, and a little chalcopyrite. Similar, sheared, carbonatized, pillowed andesite is exposed about 350 feet farther east along the ridge. The sheared rocks are in contact on the south with relatively massive pillowed andesites that strike east and face south. A quartz stringer system, 10 feet wide, is exposed in the sheared zone for 125 feet along the strike. No information as to returns from these zones was obtained.

LAKE DUFAULT AREA

INTRODUCTION

The geology of a small area 4½ miles long from north to south and 2½ miles wide along the east side of Lake Dufault was done in greater detail than the remainder of Clericy map-area. Much of the area is occupied by Lake Dufault, but exposures are good on most of the many small islands, and along the shores of the mainland. The country east of the lake, except in parts of ranges IV and V, Dufresnoy township, is forest covered and exposures are, consequently, poor. However, mining companies have been actively prospecting in ranges III, IV, and V, and all were very kind in placing information at the writer's disposal. Thanks for generous co-operation are extended to Messrs. T. D. Dougan and A. C. Lee, of Continental Copper Mines, Limited; to Messrs. Stewart Troop and J. W. Campbell of MacDonald Mines, Limited, and to Messrs. J. P. Norrie and H. E. Silver of Insco Mines, Limited.

GENERAL STATEMENT

The supracrustal rocks included in the area of the Dufault Lake sheet are rhyolites, acidic pyroclastic breccias and tuffs, andesites, and dacites, all of the Blake River group. They are intruded by a lenticular body of diorite and quartz diorite, by numerous dykes, sills, and irregular bodies of diabase and gabbro with or without quartz, and by a stock of granodiorite. In addition, sills of a variety of diorite distinct from those mentioned above are exposed on islands 37, 54, and 58, and a small body of quartz-albite porphyry is exposed on islands 54 and 56. Other minor intrusives include dykes of aplite, pink feldspar porphyry, and biotite lamprophyre. Alteration of the lavas has been extreme in many places; it consists, for the most part, of intensive chloritization, but pyritization is prominent locally.

BLAKE RIVER GROUP

Rhyolite and rhyolite breccias of the Blake River group are exposed on several islands and on the mainland of Lake Dufault in the southwest corner of the area. They also form large outcrops on the mainland east of the lake in ranges I and II, and again in ranges IV and V, Dufresnoy township.

A layer of andesite 600 to 850 feet thick is interbedded with rhyolites in the southeast corner of the map-area. It is important, first, because strike, dip, and direction of top can be determined from it, whereas such determinations ordinarily can be made only with difficulty on rhyolites; second, because it may have acted as a dam to mineralizing solutions and so caused local concentrations of ore minerals. The layer was traced northward across the peninsula that separates the southeast from the southwest bay on Lake Dufault, and thence northward across islands 48, 49, 52, 54, and 37. North of island 37 no exposures of the layer were found, and it appears probable that it is cut off by the intrusion of diorite.

Determinations of dip are poor, but three observations indicate an eastward dip of 45 to 65 degrees. Forms of pillows exposed on the hill just north of the Rouyn-Dufresnoy township line, and again on islands 48 and 49, indicate that the flows face east.

This attitude corresponds roughly to the attitudes determined by Wilson for flows within the Dufault area, just west. It is of interest to note that a similar flow of andesite in rhyolites was mapped by Wilson just north of the granodiorite, about on strike with the andesite layer here described.

Pyroclastic rocks are the third main variety of volcanic rocks included in this sheet. They are confined entirely, so far as known, to an elliptical area around the northeast bay of Lake Dufault, on ground held by Continental Copper Mines, Limited, and by MacDonald Mines, Limited. The area is surrounded on the north, east, and south by Dufault granodiorite, and on the west by diorite. The pyroclastic rocks are remarkably massive and uniform in appearance over wide areas. They range from fine-grained, greyish or bluish grey weathering tuffs to medium coarse-grained tuffs or fine breccias, with angular fragments ¼ to ½ inch across. The fragments are ordinarily difficult to pick out, for these are typical crystal tuffs, with numerous crystals and grains of quartz and white feldspar set in a fine-grained, grey matrix. As the fragments themselves are quartz and quartz-feldspar porphyries, they are almost indistinguishable from the groundmass.

Because of the exceptionally massive character of the rocks no determinations of attitude were made within this area. Elsewhere rocks of this type occur in the uppermost parts of the Blake River group. If this is true here, failure to find extensions of these rocks beyond the intrusives might be attributed to structure; that is, they might occupy a local downwarp in a syncline.

The andesite layer included in Lake Dufault and Lake Routhier areas outlines the trend of the volcanics as a wide arc convex towards the east, which plunges 45 to 65 degrees east. The andesite layer north of the granodiorite may mark the continuation of this arc, cut by diorite, and crossed from east to west by the Dufault granodiorite stock. The lavas north of the granodiorite stock at the Gilbec shaft strike north 50 degrees west and dip 45 degrees south. The direction in which they face at this point is not known. North and east of there pillowed andesites face north, strike north 40 to 60 degrees west, and dip steeply or vertically.

Faults and shear zones are exposed in a few places. On Continental ground a shear zone at least 20 feet wide is exposed in a trench just north of the lake shore in lot 37, rge. III, Dufresnoy tp. The zone strikes 35 degrees west of north, dips vertically, and is filled with soft, chloritic schists. Two hundred to 560 feet north of this trench the rocks are intensely sheared and pyritized in a zone that strikes north 60 to 70 degrees west and dips vertically or steeply north. Two thousand feet east diamond drilling on MacDonald ground disclosed strongly sheared, pyritized zones about on strike with the zones on Continental ground. The two may form parts of a single zone of shearing and pyritization.

A possible shear zone across the northeast corner of the sheet is indicated by indirect evidence. Outcrops of rhyolite in lots 40 to 43, inclusive, range IV, mark off a linear valley, about 300 feet wide in lot 41,

which strikes 45 degrees south of east. The rhyolite along the valley walls, and in one outcrop near the middle of the valley in lot 40, is strongly sheared and carbonatized. The shear planes strike north 40 to 50 degrees west and dip 80 degrees north to 70 degrees south. The suggested shear zone, if projected northwestward, would follow a creek valley across lots 35 to 39, range V, and then pass through the depression that lies along the bottom of the steep scarp on the north side of the granodiorite ridge in lots 30 to 32, range VI. Volcanic rocks north of the depression are strongly sheared in about the same direction. The shear zone, if it exists, is one of a system of strike shears, difficult to detect from surface examination, but which may be of considerable structural, and possibly of economic, significance.

A carbonate-quartz filled fracture, which may be part of a fault, is exposed on island 16. The fracture crosses the island at its narrowest part. It strikes north 45 degrees east and dips 75 degrees south. The fracture, with its quartz-carbonate filling, can be followed for 110 feet along the strike. At the northeast end it is 15 inches wide; at the southwest, 6 inches. The vein is sparingly mineralized with pyrite. A shallow pit has been sunk near the southwest end.

Another fault may cross the Rouyn-Dufresnoy township line and enter the Lake Dufault area in or near lot 31. Data concerning this possible fault are included in the report on Lake Routhier area.

INTRUSIVE IGNEOUS ROCKS

About two-thirds of the Dufault Lake area is underlain by large intrusive bodies, grouped by Cooke[1] under the general name of the Lake Dufault granodiorite. Cooke subdivided the masses into an older eastern part and a younger western part intrusive into the eastern. The larger subdivisions were further subdivided on petrographic and areal data.

Since this work was done, forest fires have brought to view many new outcrops, and much new information has been gained through the drilling and trenching operations of mining companies. As a result, some of Cooke's boundaries are here revised, and the revision in turn compels a reconsideration of some of his conclusions as to form and magmatic history of the igneous masses. The writer here confines the same "Dufault granodiorite" to the later mass, and will refer to the older part as the Dufault diorite and quartz diorite.

In addition to these larger intrusive bodies, dykes and irregular masses of diabase and gabbro are numerous and widely distributed; so much so that it is difficult to find an outcrop of Blake River volcanic rocks that does not contain one or more. Minor intrusives include one or two small dykes of biotite lamprophyre, a body of quartz-feldspar porphyry, and dykes of aplite. The following is the succession, so far as known, in descending order:

Diabase—one dyke
Dufault granodiorite
Biotite lamprophyre
Diabase and gabbro dykes and masses

[1] Cooke, H. C.: The Compound Laccolith of Lake Dufault, Quebec; Trans., Roy. Soc., Canada, 3rd ser., vol. 24, sec. IV, pp. 89-98 (1930). *Also* Geol. Surv., Canada, Mem. 166, pp. 118-126.

Feldspar porphyry
Quartz-feldspar porphyry
Aplite
Dufault diorite and quartz diorite
Diorite sills

The age relations of several of the above rocks are as yet imperfectly known. The biotite lamprophyre may be older or younger than the Dufault granodiorite; the aplite may be younger than any of the rocks; and the age relations of the feldspar porphyry to the other intrusives are entirely unknown. These, however, are small, relatively minor bodies; the age relations of the larger masses will be seen, from the evidence cited below, to be fairly well established.

DIORITE SILLS

The oldest diorite forms eastward dipping sills intercalated with pillowed lavas on islands 54 and 37, and all of small islands near 55 and 37. They are separated from the remainder of the Dufault diorite and quartz diorite because they are petrographically distinct from those rocks, and because on isle II, angular blocks of diorite of similar character are included in coarse, feldspathic Dufault diorite. In addition to this evidence of age relationships, Cooke reports that "on the large island near the south shore of the lake, across which passes the centre line of Dufresnoy township, there is a two-foot dyke of feldspathic diorite cutting through the more basic diorite, and exhibiting slightly chilled edges". This occurence was not observed by the writer.

The diorite of the sills is massive and of uniform medium (2 to 3 mm.) grain. Weathered surfaces are grey and granular; fresh surfaces are medium dark green, with cleavage faces of feldspar rarely visible. It is composed of albite with much included epidote, actinolite, and grains of carbonate. The mineral composition is estimated at 65 per cent feldspar and 35 per cent amphibole.

DUFAULT DIORITE AND QUARTZ DIORITE

The Dufault diorite and quartz diorite underlie a large, crescent-shaped area across the eastern half of Dufault Lake, and extend southwest from isle 62 in a dyke that is on strike with a dyke of the same rock on the peninsula south of Sergius Bay. The southern point of the crescent lies just south of the Rouyn-Dufresnoy township line. Northward the crescent widens to include nearly all the east and north shores of Dufault Lake and adjacent islands. The eastern contact is poorly defined, first, because it lies in bush-covered country, and second, because the volcanic rocks along the contact, and the intrusive rock as well, are so severely altered that it is difficult to distinguish them one from the other. North of the lake's north shore the crescent is interrupted by the eastward extension of the granodiorite stock. The diorite appears again on the north side of the stock, with the east contact lying some distance west of the Dufresnoy township north-south centre line.

The part of the intrusive south of the granodiorite stock is divisible into two parts, one with a high content of feldspar and little or no quartz, the other with quartz negligible to 35 per cent, less feldspar, and more mafic

minerals. The two types grade imperceptibly into one another and the line of division is arbitrarily placed between the western and eastern parts, where quartz first becomes visible in the hand specimen.

The western, or quartz-free diorite is composed of white feldspar and amphibole. It is notable for its variability in grain, ranging from medium grained to very coarsely pegmatitic, with plumes of amphibole up to 3 inches long and feldspar crystals an inch or more in length. The composition is likewise notably variable, from 90 per cent feldspar and 10 per cent amphibole to about equal amounts of each. No regularity of distribution of the several phases, coarse to fine, or amphibole-poor to amphibole-rich, was observed. On the contrary, though the average rock is composed of about 60 per cent feldspar and 40 per cent amphibole in crystals ½ inch or so long, it passes into coarse pegmatitic phases, or into more acidic or basic phases within a foot or so and back again to average almost at random.

Inclusions of felsite and some of unquestionable rhyolite are common within this rock. The texture of the diorite around such inclusions is coarse, with amphibole plumes 2 or 3 inches long. This feature is well illustrated in outcrops on island 17, and on the south end of island 16.

To the east of the mass of quartz-free diorite is a rock in which quartz is present, in amounts ranging from a few grains to 35 per cent. As stated, the two types grade imperceptibly into one another, and the line of division is arbitrarily placed where quartz begins to be visible to the unaided eye. The percentage of quartz increases from west to east. Outcrops on islands 29 and 30 have less than 5 per cent, but those on the mainland to the east have 20 to 40 per cent. The eastern boundary of this mass is only approximately located, partly because it lies in heavy bush, but mainly because both the intrusive and the volcanic rocks with which it is in contact are severely chloritized.

Where the amount of quartz is only about 2 per cent the mineral is present in irregular grains interstitial to the feldspar. As the percentage rises, most of the quartz appears in micrographic intergrowth with albite, and the latter is comparatively fresh.

As mentioned, the eastern edge of the intrusive is chloritized, so intensely that it is converted into a soft mass of dark green chlorite studded with little grains of quartz that alone have escaped alteration. The alteration gradually becomes less toward the west and fades out. The increasing chloritization toward the east thus coincides with the increase in quartz content; but investigation has not gone far enough to determine whether there is any genetic connection between the two. Certainly chloritization was somewhat later than quartz deposition, as shown in the following paragraph, but how much later is not known.

Cooke has described the course of chloritization as follows, and the observations of the writer confirm his data. "In the least altered specimens the feldspars are laced with cracks filled with chlorite and some sericite, and a lesser number of these cracks also cut through the quartz crystals. In both quartz and feldspar the veins have irregular replacement edges, and, in the feldspars, aggregates of chlorite have developed like a fungus in the areas between veinlets. The non-chloritized parts of the albite crystals are spangled with minute grains of sericite or paragonite. In

other thin sections various more advanced stages of alteration can be seen, up to the final stage in which all the feldspar is converted into chlorite and sericite, and even the edges of the quartz crystals are attacked. In these sections the only indication of the original composition is the simultaneous extinction of groups of quartz crystals in the chloritic matrix."

The gradual nature of the change in composition from coarse diorite on the west to quartz diorite (termed graphic granite by Cooke) on the east, and the gradational contacts prevailing in general between the different phases, make it necessary to conclude that all these rock types were originally part of the same magma, and were injected at or about the same time. The cause of the change from west to east is, however, far from clear. Cooke considered it as due to differentiation in place under the influence of gravity, complicated by disturbances when the mass was partly solidified. The disturbances, he suggested, caused the intrusive relations observed between rocks here described separately as diorite, and that called Dufault diorite, and produced banded structures by partial intermingling of the already differentiated basic and acid types.

It will require much more detailed study than the writer has devoted to the problem to prove or disprove the accuracy of Cooke's conclusions. Two points suggest, however, that his solution may not be wholly correct.

(1) Part of the Dufault diorite and quartz diorite contains up to 35 per cent of graphically intergrown quartz and albite. This mass is chloritized, and chloritization grows more intense toward the eastern side of the mass. In Lake Routhier area lavas of various sorts have been much chloritized and myrmekitic quartz has been introduced by the action of hypogene solutions. Hawley,[1] after studying the much chloritized granodiorite of Siscoe Island, Dubuisson township, Quebec, states that micrographic intergrowths of quartz and feldspar that characterize it have been introduced during alteration; a conclusion also reached by Gussow.[2] It seems possible, therefore, that the chloritized quartz diorite of the Dufault mass may have reached its present composition through introduction of micrographic quartz and chlorite into an originally uniform body of coarse diorite similar to that that now constitutes the western, unchloritized part of the mass. If so, of course, a part of the evidence for gravitative differentiation is rendered valueless.

(2) There is much evidence that the magma under consideration was very "juicy", or rich in volatile constituents. This is indicated not only by its numerous pegmatitic phases with their long plumes of amphibole, and by the equally numerous varieties made up wholly of feldspar with more or less quartz, but also by its action on the surrounding country rocks. It is, therefore, possible that many of the observed variations in composition were produced during and after consolidation by rearrangement of constituents through interaction with the volatile materials; in other words, through the rock "stewing in its own juice."

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[1] Hawley, J. E.: The Siscoe Gold Deposit; Trans., Can. Inst. Min. and Met., vol. 35, p. 373 (1932).

[2] Gussow, W. C.: Petrogeny of the Major Acid Intrusives of the Rouyn-Bell River Area of Northwestern Quebec; Trans., Roy. Soc., Canada, 3rd ser., vol. 31, sec. IV, p. 137 (1937).

DIABASE AND GABBRO

Diabase and gabbro, in part quartz bearing, form numerous dykes and intrusive masses in the area. They are most common east and north of the Dufault diorite and granodiorite, in acid lavas of the Blake River group. All these dykes are composed of secondary minerals and belong to the group commonly termed the "older gabbro". The group includes dykes of more than one age, for it is common to find one gabbro cutting another. There is such a close petrographic resemblance between them, however, that, lacking other means of distinction, the whole group is of necessity mapped as a unit. The gabbros are especially well displayed in Lake Routhier area, and are described in detail in the report on it.

The volcanic rocks cut by them are extensively chloritized in places, as described in detail in the account of the Lake Routhier area. White weathering, flinty rhyolites are converted into dark, soft, chloritic masses, in which only a few residuals of rhyolite or relict quartz phenocrysts remain.

Chalcopyrite, pyrrhotite, and pyrite accompany the gabbros, in grains disseminated through them, in small aggregates along contacts, or disseminated through widths of a few feet of the bordering country rock. Quartz in short lenses or irregular veins may accompany the sulphides. Many of these pockets have been explored by trenches or test pits, both in this and the Lake Routhier area, but although some gold has been found in them, none has proved worth commercial development. Nevertheless, the association is too marked to be overlooked, and the possibility of genetic relationships between the basic intrusives and the sulphides should not be dismissed.

Diabase and gabbro dykes, in part quartz bearing, cut the Dufault diorite and quartz diorite in many places. That they are dykes is demonstrated by the presence of chilled margins on some, by inclusions of fragments of coarse diorite in others, and by their irregular courses through larger intrusives. That is to say, at least some members of the group are younger than the Dufault diorite. The age relations to the Dufault granodiorite are not so clear. In one place on the northeast bay of the lake, the writer found a crooked, dyke-like mass of basic, altered diabase, petrographically like the diabases of the group, apparently cutting the Dufault granodiorite. The mass is less than a foot wide and is exposed for only a few feet along the strike. On the east end it pinches off, and on the west runs beneath the lake; it is strongly flow-textured, the lines of flow paralleling its crooked course. It is difficult to avoid the conclusion, therefore, that it is a true dyke, and younger than the granodiorite. Nevertheless, this is the only example seen, and as several ages of diabase are known within the group it seems reasonable to place most of them as pre-granodiorite. Both Gill and Schindler[1], and Wilson[2] place all the diabases, except the so-called "Younger diabase" of Waite-Amulet area as pre-granodiorite.

DUFAULT GRANODIORITE

The main mass of the Dufault granodiorite lies just west of Dufault Lake, where it is about 2¾ miles across from north to south. A long arm

[1] Gill, J. E., and Schindler, N. R.: Op. cit., p. 399.
[2] Wilson, M. E.: Roy. Soc., Canada, sec. IV, p. 66.

about a mile wide runs east from this body, to cut across the Dufault diorite. It passes across the north arm of the lake and then north of the east arm, to curve around the northeast bay in a fish-hook shape and connect with the southern body. This throughgoing connection, not recognized in previous mapping, has been established by the detailed examinations, trenching, and drilling of Continental Copper Mines, Limited, and MacDonald Mines, Limited. The total length of the body from east to west is thus about 6·7 miles.

Petrographic descriptions of the body are given by Cooke, who classified the rock as an albite granite. Later M. E. Wilson classified it as a granodiorite, and his usage is followed here to avoid confusion. It is a greenish grey rock, weathering to pink and grey tints, and is rather variable in composition. Quartz constitutes from 10 to 40 per cent of it, amphibole from 30 per cent in the less siliceous to as little as 2 per cent in the most siliceous. The remainder is mainly albite, heavily charged with alteration products. The mafic minerals are much altered to chlorite, actinolite, and epidote.

The bulk of the main body on the west is a rock with about 20 per cent of quartz, and this passes gradationally, on the east side of the north arm of the lake, into a highly siliceous phase with about 40 per cent of quartz. This change, coupled with very low easterly dips observed by Cooke on the west boundary of the mass, caused him to conclude that the mass was sill-like and had been differentiated in place. The present revision of the boundaries brings this siliceous phase into a central position with less siliceous rocks both to the west and east, so that the mass seems more likely to be a stock with a quartz-rich centre than a differentiated sill.

MINOR INTRUSIVES

Biotite Lamprophyre

A dyke of biotite lamprophyre cuts diabase on the north end of the large peninsula on the south side of Lake Dufault. The dyke is 18 inches wide and has chilled margins ¼ inch wide against diabase. The lamprophyre contains sparkling plates of biotite set in a dark brown, fine-grained groundmass. No phenocrysts appear within the chilled marginal material.

Quartz-Feldspar Porphyry

Quartz-feldspar porphyry is well exposed on the west shore of isle 54. The porphyry intrudes the diorite on this island, and is intruded by diabase dykes. Isle 56 is made up of the same porphyry. The rock weathers light grey. It contains phenocrysts of nearly pure albite up to 5 mm. long, and of quartz 2 or 3 mm. in diameter set in a dense, dark green groundmass. Some of the quartz is in amygdules. The estimated composition is albite, 40 per cent; quartz, 10 per cent; epidote, 25 per cent; chlorite, 15 per cent; actinolite, 10 per cent.

Aplite Dykes

Two narrow dykes of aplite of typical fine grain and sugary texture were found intrusive into diorite, one on the middle of the west side of isle 16, the other on the mainland due north of this island. The dykes

are irregular in trend; they range from 3 inches to 3 feet wide. They consist of quartz, 35 per cent; oligoclase (An_{12}), 60 per cent; and chlorite and epidote, 5 per cent.

Pink Feldspar Porphyry

Pink feldspar porphyry is exposed about 120 feet south of the shore of the large peninsula on the south side of the lake. A strip 18 inches wide is exposed for 10 feet along the east contact of the body. The contact strikes 5 degrees east of north and dips vertically. The rock weathers pink, is considerably sheared and carbonatized, and contains phenocrysts of pinkish feldspar 2 or 3 mm. long in a fine-grained, green matrix. Tiny specks of pyrite are disseminated through it.

LAKE ROUTHIER AREA

INTRODUCTION

Lake Routhier area, in the northeast corner of Rouyn township, is 6 miles long from east to west and 4 miles wide. All but a strip 1½ miles wide along the southern edge is included in Clericy map-area. This part of Rouyn township was subdivided in 1938; geological mapping on a scale of 1,000 feet to 1 inch was done by means of north-south traverses spaced 600 feet apart.

Outcrops in the northwest part of the sheet, as far east as Dufault Creek and south to range line VIII-IX, are in burnt-over country and are excellent. South of range line VIII-IX, the country is forested, and exposures, though numerous, are generally poor. East of Dufault Creek to the Rouyn-Joannès township line, the country is heavily forested and much of it is covered with thick deposits of clay and drift. Outcrops are rare, and except where the bedrock is uncovered by stripping or in trenches exposures are very poor.

Mining companies have been active in this area for 20 years and most, if not all, of the ground is staked at the present time. Companies operating within recent years include Mining Corporation of Canada, Limited, Guardian Gold Mines, Limited, and Seguin Consolidated Mines, Limited. In 1934 Wiltsey-Coghlan Mines, Limited, investigated a group east of Trémoy Lake. Other mining concessions are held by Waite-Amulet Mines, Limited, Quemont Mining Corporation, Limited, Osisko Lake Mines, Limited, Osisko Rouyn Exploration Company, Limited, and Noranda Mines, Limited.

GENERAL GEOLOGY

Lake Routhier area is underlain by volcanic rocks of the Blake River group and sedimentary rocks of the Cadillac group. The volcanic rocks, which extend over most of the area, are intruded by numerous dykes and irregular masses of diabase and gabbro, in part quartz bearing. In addition, they are, in places, intensively chloritized and carbonatized. Acidic intrusives aside from sills of rhyolite believed to be essentially contemporaneous with the flows, are represented by only two small dykes of feldspar porphyry. Biotite lamprophyre dykes, one of which is exceptionally long, cut the volcanic rocks.

The lava flows are tilted steeply and are sharply folded. The folds are broken by the Horne Creek fault, possibly by the Andesite fault, by a northeast-striking fault of unknown, but probably considerable, displacement, and by a large number of minor faults. In addition, there are almost certainly a number of undiscovered faults.

Gold deposits are known in several places, but to date no commercial ore-bodies have been discovered. This is somewhat remarkable, for a producing gold mine, the McWatters, lies just over a mile south of the sheet, the great copper-gold ore-bodies of the Horne mine are less than ¾ mile

to the west, and many other gold, or gold-copper, mines are nearby. However, in spite of the very considerable amount of work done, the possibilities of discovery are by no means exhausted. Although most of the surface showings have been examined, much of the area covered by drift must be regarded as virgin prospecting ground.

BLAKE RIVER GROUP

DISTRIBUTION AND DESCRIPTION

The volcanic rocks of the Blake River group are subdivided, lithologically, into three main groups: (1) andesites and dacites with related pyroclastic rocks; (2) rhyolite and rhyolite breccias; (3) acidic, pyroclastic rocks made up of fragments mostly of quartz porphyry and quartz-feldspar porphyry. Areally each type predominates in one part of the area. Andesites are found mostly south of the Horne Creek fault and west of Lake Routhier, rhyolite and rhyolite breccias north of the Horne Creek fault and east to Dufault Creek, and acidic pyroclastic breccias in a strip about 1 mile wide on and north of Lake Routhier to the east edge of the sheet.

Andesites and dacites in about equal amounts, with related pyroclastic rocks, outcrop over most of the area between Trémoy and Rouyn Lakes, over much of the area south of Rouyn Lake, and along the south shore of Lake Routhier and Kinojevis River. Although they form many hills and ridges, the country is all forested and exposures are, consequently, not of the best. Breccias and ropy forms are common, and pillowed flows are abundant. One flow has pillows up to 14 feet long and 8 feet across, with prominent amygdaloidal borders 4 inches wide. It was traced eastwards along the strike for 4,000 feet from the northeast bay of Trémoy Lake. Another pillowed flow with large pillows contains abundant spherulites. This flow is 800 to 1,000 feet stratigraphically above the first mentioned and was followed for about the same distance. Similar, spherulitic, pillowed andesite is exposed on the north shore of Rouyn Lake in lot 44 and again at Mercier landing. Across lots 32 to 36 the spherulitic lava can be used as an horizon marker, as suggested by Connolly and Hart[1]. Whether or not the spherulitic lavas on Rouyn Lake are at the same horizon is not known.

A layer 800 to 900 feet thick of pillowed and massive andesite between Trémoy and Dufault Lakes trends north 75 degrees west, dips 70 degrees north to vertically, and faces north. It lies in a thick series of rhyolites and some lenses of rhyolite are included in it. It extends from the west margin of the sheet to 500 feet east of the north-south centre line of the township. At its eastern end, well exposed on the northwest side of a narrow, northeast trending valley, it is 200 feet wide. On the east side of the valley, although exposures are good, the layer could not be found. The valley apparently marks the trace of a fault, one of a system that split off from the Horne Creek fault in this section. One or two flows of pillowed andesite appear within the rhyolite section 700 to 800 feet stratigraphically below the main layer.

[1] Connolly, H. J., and Hart, R. C.: Structural Geology of the Osisko Lake Area, Quebec; Can. Inst. Min. Met., Trans., 1936, p. 10.

A second layer of andesite flows of similar character and thickness is exposed on the east shore of the southwest bay of Lake Dufault. This layer trends north 25 to 30 degrees east, dips 45 to 65 degrees east, and faces east. It can be followed northwards across Lake Dufault. South of Lake Dufault the layer does not appear[1]. The two layers are thus not directly correlatable, but they appear to be at nearly the same horizon in the rhyolite section. Their failure to join may be due to wedging or to faulting.

A third series of andesite flows, intercalated in rhyolites, occurs in an arc, convex east, which extends from the Rouyn-Dufresnoy township line, lot 32, southeast and south to cross the power line in lot 41, range IX S. The flows are pillowed, and range from 20 to 400 feet thick. They are well exposed, but are cut into so many fragments by cross-faults that neither the number of flows, nor the stratigraphic thickness through which they occur, can be determined with assurance. One flow, the thickest, is composed of very large pillows, with amygdaloidal borders 4 to 6 inches thick. It is well exposed on range line IX-X at lot post 40-41. Fragments of it in fault blocks occur through range X S. and appear on range line X S.-X N. at lot post 40-41. Fragments of the same flow also occur in scattered outcrops south to the power line. Although broken by faults, and in discontinuous outcrops, the pillows are so distinctive that it seems probable they do belong to a single flow, which may, therefore, be used as an horizon marker. It should be noted, too, that it resembles greatly one of the pillowed flows traced east from the northeast bay of Trémoy Lake, south of the Horne Creek fault.

Albite rhyolite flows with or without brecciated flow tops, and in part with numerous spherulites, and albite rhyolite pyroclastic breccias are perfectly exposed in cleanly burnt ridges between Trémoy and Dufault Lakes, and east to Dufault Creek. The total thickness of this series of flows is estimated to be about 8,000 feet, of which 800 to 900 feet near the middle, and 500 to 1,000 feet near the top, are of andesite.

The ordinary, massive rhyolite weathers light grey or creamy grey, and is slightly darker on freshly broken surfaces. Phenocrysts of quartz 1 mm. or so in diameter, and of albite 2 or 3 mm. long, are evenly but sparingly distributed in a very fine-grained to aphanitic groundmass of quartz, albite, sericitic mica, and granules of epidote or clinozoisite. Apatite, zircon, and black iron ores are common accessories. A few flakes of chlorite and tiny grains of carbonate and pyrite are found here and there. Planes of schistosity are generally inconspicuous or absent.

Flow breccias are similar petrographically, but are distinguished by angular blocks of rhyolite, 6 inches or so across, cemented in a matrix of massive rhyolite.

Columnar structures are well developed in several flows. The patterns, in plan, of many of these structures bear a striking resemblance to columnar structures formed in lavas by contraction on cooling, but their origin appears to be quite different. One flow, 350 feet thick, in which these structures are well developed, is exposed in places across its entire width about halfway between Trémoy and Dufault Lakes. It was traced

[1] Geol. Surv., Canada, Map 453A, Rouyn Sheet, Noranda Area, Que.

along the strike for nearly 1¼ miles. It overlies, with a sharp contact, a bed of rhyolite breccia, and passes upwards into flow breccia 25 feet thick. The strike is north 70 degrees west, dip steeply north.

The rock composing the columns in all the flows is typical rhyolite. Poorly developed parting planes, oriented parallel to the regional schistosity, are present in some of the columns.

The intercolumnar material consists, in the example illustrated, of fissile rhyolite with quartz and albite phenocrysts of similar sizes and distribution to those in the rock composing the columns. The fissility, or platy cleavage, is well developed throughout, and the cleavage planes nearly everywhere lie parallel to the walls of the columns. In other examples no platy material is present along fracture surfaces, but each fracture is bordered by a narrow, irregular strip of altered rhyolite. Both it and the cleavable, intercolumnar rhyolite weather yellow, in vivid contrast with the light grey weathering rhyolite of the columns. In both the yellow colour seems to be due to a greater abundance of sericitic mica and minerals of the epidote group, in contrast with the relatively "fresh" rhyolite of the columns. These secondary minerals may have formed in part during development of platy cleavage, but in others it seems to be due to the spread of solutions, presumably hydrothermal, from fractures.

The dips of the long axes of columns, estimated from the dips of the faces, are steeply north or vertical. This, it will be recalled, is nearly the same dip as that of the flows. Such an orientation distinguishes these columnar structures sharply from columns developed in flows as a result of contraction on cooling, for in them the columns stand perpendicular to the chief cooling surface. These flows form part of the south limb of a syncline with an axis that plunges steeply northeast. When the fold was formed, beds on the south limb must have moved differentially, the northern members moving up and southeast relative to the southern members. Minor drag-folds, and cross-fracturing in shear zones in adjacent flows and breccia beds, indicate that such movements actually did take place. The axes of the columns are oriented roughly parallel to the axes of the drag-folds, and it may be suggested that the columnar structures were formed by the same movements that formed the drag-folds.

Of the many beds of rhyolite breccia between Trémoy and Rouyn Lakes, one is distinguished by its excellently bedded tuffs, ranging from ½ inch to 1 foot thick. Gradation in grain and crossbedding within the beds is perfectly developed. It is well exposed just east of the old camp-site on Ville-Marie claims, near the middle of lot 35, range IX S. It strikes north, dips 70 degrees east, and faces east. The north end of the layer is wedge-shaped, either because the beds pinch or are faulted off. East of the camp-site the layer is about 250 feet thick. In the south end of the lot, in property held by Wiltsey-Coghlan Mines, Limited, it widens to 400 feet before terminating against the Horne Creek fault near range line VIII-IX.

A layer of bedded breccias and tuffs of identical appearance crosses block 28 from east to west. The easternmost exposures are in lot 32, range X S., 600 feet north of range line IX-X, whence it can be followed through numerous exposures into block 28, then through continuous

exposures into the southwest corner of block 27. It strikes north 75 degrees west, dips 70 degrees north to vertically, is from 300 to 500 feet wide, and faces north. It is separated on the east by 3,500 feet of drift from the northernmost exposures of the north striking layer on Ville-Marie ground, and direct correlation is not possible. Nevertheless, the two layers are so nearly identical in type of bedding, crossbedding, thickness, and composition, that they are probably parts of a single, though discontinuous and faulted layer.

About 950 feet south of this breccia and tuff layer in block 28 there is a layer of andesite that can be followed to the west margin of the sheet. This andesite layer (as previously noted, page 73) is probably correlative with the one that strikes nearly north across the west part of block 27. The breccia layer might serve as a check on this correlation, for if the andesite layers are the same, a breccia and tuff layer correlative with the one in block 28 should appear 1,000 feet or so east of the andesite in block 27. Unfortunately, exposures in this section are much poorer, and although beds of breccia of similar appearance were found at the right stratigraphic horizon, no beds of tuff were discovered and a satisfactory check was not obtained.

Acidic pyroclastic breccias and tuffs, which form the third and uppermost division in the group, are well exposed on the isthmus between Rouyn and Routhier Lakes, and in many trenches on Seguin Consolidated ground. The rocks range from coarse breccias with fragments 3 or 4 feet across to fine, bedded tuffs. Most of the fragments in the coarse breccias are of quartz and quartz-feldspar porphyries, but fragments of rhyolite, and felsite are common, and one or two other varieties of volcanic rocks are generally represented. The most common acidic breccias are unsheared, massive or with poorly developed bedding, made up of fragments 1 to 10 inches across of porphyritic rocks set in a pseudoporphyritic, coarse-grained matrix. Sorting is characteristically poor in the coarse breccias, but many of the fragments are remarkably well rounded. Well-bedded varieties are commonest in the strata just below the sedimentary strata of the Cadillac group. Examples are exposed between Rouyn and Routhier Lakes along the sides of the large diabase dyke and on two rock islands in the east end of Rouyn Lake. Fine-grained, rhyolitic tuffs alternate with thicker beds of pseudoporphyritic, coarse-grained tuffs or fine breccias.

In thin section the coarser tuffs are seen to be composed of broken crystals of nearly pure albite, quartz grains, numerous grains of carbonate, mats of finely divided chlorite, sericitic mica, minor but variable amounts of actinolitic amphibole, epidote grains and rods of rutile and tourmaline, grains of leucoxene, and specks of pyrite. The texture can be described as chaotic. Schistosity is poorly developed for the most part, but locally, as near the Seguin Consolidated shaft, they are well sheared and pyritized.

RELATIONS TO THE CADILLAC GROUP

The transition from these rocks to the overlying Cadillac sedimentary strata is shown in an outcrop on the southeast shore of Rouyn Lake, just north of range line VI-VII. The outcrop is about 75 feet across the strike. The lowermost rocks exposed are typical, acidic, pyroclastic breccias, with

rounded and angular fragments to 4 inches across in a grey, pseudo-porphyritic matrix. The coarse breccia is about 60 feet thick; it passes upwards into a bed 15 feet thick of the same composition as the matrix of the breccia. Bedding planes within this tuff or fine breccia are marked by thin films of black, argillaceous material. The films thicken to about 1 inch in the upper part and divide the rock into well-marked beds a few inches thick. The argillaceous material is identical with that that makes up, with very fine-grained, siliceous material, the Cadillac strata on Rouyn Lake. In the next outcrop, 150 feet north, the beds are typical Cadillac sediments. The gradational change from acidic breccias and tuffs of the Blake River group to slaty and siliceous sediments of the Cadillac group is complete in these two outcrops. Thus the change from volcanism to sedimentation is complete within only a few feet of section, but was, nevertheless, gradational. This conclusion is in agreement with observations made by Gunning[1] along the same contact in Bousquet township.

CADILLAC GROUP

DISTRIBUTION

Sedimentary rocks of the Cadillac group are exposed in one outcrop on the Rouyn-Joannès township line in range VIII, and in the centre of the Rouyn Lake syncline. The outcrop on the township line forms the westernmost expression of the small northern syncline. In the Rouyn Lake syncline the sediments appear first on an island east of Mercier landing. The synclinal axis trends northeast and east, and plunges gently east. As a consequence, the exposed width of sediments increases gradually to about 4,500 feet across the point that forms the east side of Lake Routhier. Exposures around the lake shores are good, and exposures by stripping can be found in range VII, Rouyn township, as far east as lot 54. Between there and the Rouyn-Joannès township line no exposures of sedimentary rocks were discovered.

THICKNESS

The maximum thickness of the group in Lake Routhier area is about 1,800 feet. This is only a small part of the thickness known farther east, in Joannès township, where the minimum thickness with the top missing is 6,000 feet.

DESCRIPTION

On the east shore of Lake Routhier, and in the exposures just east of it, the sedimentary rocks consist of coarse to fine greywacke, massive to well bedded. In addition, a few pebble beds 2 inches to 18 inches thick are found, the pebbles being of cherty or felsic material, ¼ inch or less in diameter. Slates form beds several feet thick. They weather black or dark grey, and have well-developed cleavage. On the isthmus between Rouyn and Routhier Lakes, on the southern shores of Rouyn Lake, and on nearby islands, the Cadillac group is made up of beautifully bedded, silty slates. Individual beds, 3 inches to 1 foot thick, consist of black, slaty material in the bottom half or two-thirds, and this grades upwards into white weathering, exceedingly fine-grained chert or siliceous silt.

[1] Gunning, H. C.: Bousquet-Joannès Area; Geol. Surv., Canada, Memoir 231, in press.

Lenticular quartz veins, or irregular masses of quartz, accompanied by a little pyrite, chlorite, and muscovite, are common in the sedimentary beds around Rouyn Lake. None of them appears to be of commercial importance.

INTRUSIVE IGNEOUS ROCKS

GENERAL STATEMENT

Intrusive igneous rocks in Lake Routhier area include quartz diorite sills and dykes of rhyolite porphyry, dykes and irregular masses of diabase and gabbro, in part quartz bearing, two dykes of later diabase, two small dykes of feldspar porphyry, and dykes of pebble-bearing lamprophyre.

RHYOLITE PORPHYRY

Dykes and sills of rhyolite porphyry cut volcanic rocks of all types in the Blake River group. None was discovered cutting the Cadillac group. Most of them are probably quasi-contemporaneous with the lavas. Where they intrude rhyolites the problem of distinguishing them from rhyolite flows is analogous to the problem of distinguishing intrusive diorites in areas largely underlain by andesite flows. Where exposures are very good, as in the area north of Trémoy Lake, distinctions can in some cases be made. There, a sill of rhyolite porphyry 300 to 110 feet thick, intrusive into rhyolite and rhyolite breccias, is exposed across the north-south centre line of the township just north of range line IX-X. The sill was traced along the strike for 2,600 feet. No apophyses from it were seen, but chilled contacts 1 inch wide are present on both sides, and the body cuts gradually across the strike of breccia beds. The rock weathers grey or light grey, and has a somewhat rougher surface than typical rhyolite flows. The rock consists of epidotized and sericitized phenocrysts of albite up to 3 mm. in length and small, euhedral to anhedral phenocrysts of quartz 1 mm. in diameter in a groundmass of fine-grained quartz, albite, a little chlorite, epidote, carbonate, leucoxene, and accessory zircon, apatite, and rare grains of pyrite.

QUARTZ DIORITE

One outcrop of coarse quartz diorite occurs near the north end of lot 28, range X. This quartz diorite is included with the large lenticular body exposed around Lake Dufault, and is described in the previous part of this report.

DIABASE AND GABBRO

Distribution

Dykes and irregular bodies of diabase and gabbro are common nearly everywhere throughout the area. They are particularly abundant and well exposed around the small lake in range X, and east and southeast of this lake to range line VIII-IX. Furthermore, many scattered outcrops in low ground along the creek draining the little lake are of the same rock, and diamond drilling on Ville-Marie ground disclosed large bodies of diabase and gabbro cutting rhyolite almost all the way across the low ground. In short, a strip of country about 8,000 feet wide, west of and

parallel to Dufault Creek, is full of these intrusions. South of the presumed eastern extension of the Horne Creek fault only a few dykes occur; the swarm of intrusives appears to be cut off along the fault.

Diabase and gabbro also appear in abundance on and south of the southeast bay of Trémoy Lake.

Age

This group of intrusives, which includes dykes of at least two and probably more ages, is the type often referred to in this country as "older gabbro". The term "older gabbro" is very loosely defined, and includes rocks of several widely separated ages, from sills and dykes contemporaneous with the oldest volcanic flows to those later than the Cadillac group. The group here considered is younger than folding of the Blake River group and Cadillac group, but is older than the younger diabase.

Description

Rocks of the group range from fine grained or aphanitic to coarse grained (over 5 mm.). They are dark green and weather dark rusty green to almost black. They commonly resemble massive, extrusive andesite. Dykes and masses cut at random across folded and schistose rocks, but are themselves characteristically unsheared, except along some late, throughgoing shear zones.

All the minerals that now compose the rocks are secondary, with the possible exception of rare anhedral quartz grains. In decreasing order of abundance the minerals present are albite, actinolitic amphibole, chlorite, carbonate, accessory leucoxene, and magnetite. Myrmekitic quartz and albite or albite-oligoclase is common to abundant. The myrmekite, in section, characteristically occupies oval areas and groups of areas that extend into many of the albite crystals. One specimen in which the albite (An_{1-3}) is heavily charged with chlorite, is crossed by a layer of myrmekite within which chlorite is practically eliminated. The albite in the myrmekite is more calcic (An_8) than the altered albite. It thus appears that myrmekite was introduced after the rock was chloritized, i.e., that it was one of the latest phases of the alteration.

Chloritization is widespread also in the lavas cut by networks of diabase dykes. All types of volcanic rocks, andesites, dacites, and rhyolites, are strongly affected; no matter what the original rock, whether intrusive diabase or extrusive lavas, the end products are so nearly alike that they cannot be distinguished one from another in hand specimen. As a consequence, beyond observing that areas of chloritization are also areas intruded by a network of diabase dykes, the writer was unable to reach a satisfactory conclusion as to the relationships between the intrusives and the subsequent alteration. Nevertheless, the areal association suggests that the alteration is related in some way to the magmatic activity that led to emplacement of the dykes.

The effects of chloritization on andesites are strikingly illustrated in an outcrop about the middle of range VIII N., near lot line 33-34. The pillows are clean-cut and well formed, some 3 feet long on the average, and have chilled rims ½ inch thick. They strike north 30 degrees west, dip 80 degrees north, and face north. They are cut by a few anastomosing

dykes of diabase. Eastward a few feet along the strike, a remarkable situation is displayed. The pillows are blotted out in an irregular patch of dark green to almost black, velvety surfaced, massive, chlorite rock. The chlorite rock fills in around and follows the outline of some of the pillows as though the chilled rims had offered some obstacle to the progress of alteration. In others the rims are broken through, and half the pillows are gone. No trace of their outlines could be detected in the chlorite rock. The change from hard surfaced, green andesite in the pillows' interiors to darker, soft-surfaced, chlorite rock is completely gradational. Within 30 feet east of this point the last traces of pillows are gone and the rock is uniformly chloritized throughout.

The chloritization of rhyolite breccia is illustrated just south of the power line on ground held by Guardian Gold Mines, Limited. The breccia consists of sharply angular fragments of rhyolite in a matrix of fine-grained, acidic material. In the early stages the matrix becomes green, soft, and massive, but the fragments remain, their white to creamy, flint-like surfaces in striking contrast with the dark, velvety, chloritic matrix. As chloritization advances the outlines of the fragments become corroded and blurred, and the fragments themselves progressively less definite, more irregular, and fewer, until none remains. In the end product the only constituent that remains is an occasional quartz grain and, as these may be confused in hand specimens with myrmekite, which was plentifully developed during chloritization, their value as indicators of the rock's original character is small.

The massive rhyolites between Trémoy and Dufault Lakes, which show columnar jointing (*See* page 73), strike eastward into an area cut by a swarm of diabase and gabbro dykes, and there become chloritized. West of this area they are typically cream coloured, flinty, and, in the columns, massive. Where chloritized they are converted into a massive chlorite rock that here and there preserves, over areas of a few square yards, a pattern identical with that seen in the rhyolites. The rock within the polygons is similar to that in the unpatterned chlorite rock, i.e., it is dark green and soft, with a pitted surface due to weathering out of carbonate crystals.

The change from nearly normal, massive rhyolite to strongly chloritized rhyolite takes place within 30 feet in an outcrop near range line VIII-IX, on ground held by Guardian Gold Mines, Limited. Three thin sections taken at intervals of about 15 feet across this zone have the following characteristics.

The feldspar in the least altered specimen consists of broken or angular crystals of albite. These are partially replaced by very fine myrmekite, clouded with sericitic mica and dust-like particles, and are traversed along cracks and fractures by seams of flaky chlorite. Only a few small grains of carbonate and some grains of partially leucoxenized iron ore are present. The composition, estimated from thin section, is plagioclase, 60 per cent; quartz, 15 per cent; chlorite, 15 per cent; myrmekite, 3 per cent; iron ore, 5 per cent; sericite and carbonate, 2 per cent.

In the second section the albite crystals are extensively replaced by myrmekitic quartz, with here and there a fragment of plagioclase entirely surrounded by myrmekite. Chlorite in seams and in mats in the ground-

mass is much more abundant; a few euhedral crystals of carbonate are present as well.

The most thoroughly chloritized specimen consists of a few remnants of plagioclase in mats of chlorite flakes, granules of leucoxene, myrmekite, and a few persistent discrete grains of quartz. In addition, euhedral crystals, as well as scattered grains of carbonate, become prominent. The composition estimated from thin section is chlorite, 35 per cent; carbonate, 20 per cent; feldspar, 20 per cent; myrmektite, 20 per cent; and quartz, 5 per cent.

The presence of myrmekite in these rocks as well as in the basic intrusives is noteworthy. It points to the conclusion that myrmekite is introduced in both cases as part of the process of secondary alteration, and is not primary in the intrusives. In the lavas, as in the basic intrusives, it tends to merge into pseudo-graphic patterns, and to show the same replacement relationships towards crystals of albite.

Pyrite, pyrrhotite, and a little chalcopyrite are sparingly disseminated in, or form small bunches and pockets along contacts of, the basic intrusives. Quartz veins and masses accompany many of the sulphide deposits, and specularite and a little tourmaline are common. Many of the pockets have been opened by shallow pits and trenches, and some, as on the Gilbec, have been prospected by shafts. None of these deposits has as yet been shown to have commercial possibilities, but the areal association between the basic intrusives and sulphide deposits is so pronounced that the possibility of a genetic relationship between the two cannot be dismissed. The problem goes far beyond the scope of this report, but the writer is convinced that it merits serious consideration, not only because of its academic interest, but because of its possible economic significance as well.

PEBBLE-BEARING LAMPROPHYRE DYKES

Two lamprophyre dykes that contain numerous pebbles of several types of rocks were discovered. One, small and poorly exposed, cuts rhyolite and rhyolite breccia near the middle of lot 42, range X N. The other is well exposed nearly across block 28, and east into lots 31 and 32, ranges X S. and IX N., i.e., over 6,250 feet along the strike. The dyke ranges from 30 to 60 feet wide, and here and there splits around partitions of rhyolite 2 to 6 feet wide.

The rock of the dyke is fine grained, with soft, dark greenish weathered surface. It is massive, aside from irregular cracks and joints, some of which carry thin seams of carbonate. It is composed mainly of albite, carbonate, chlorite, and quartz; minor constituents include epidote granules, apatite, leucoxene, and magnetite. The texture of most specimens is even grained, but here and there is a large flake, $\frac{1}{10}$ to $\frac{1}{8}$ inch in diameter, of chlorite, probably pseudomorphic after mica. The rock apears to be an altered mica lamprophyre.

The most remarkable feature about the dykes is the presence within them of large numbers of well-rounded to subangular pebbles of rhyolite, felsite, andesite, and diorite. The pebbles range from tiny fragments to blocks or boulders 1 foot in diameter. Many are so well rounded that they look like well-worn stream or beach pebbles. They are scattered unevenly

through the long dyke from end to end. They tend to occur in groups, and in some sections one or two pebbles occur in every square yard of the dyke, whereas in other places they may be 10 to 15 yards apart. Contacts of the pebbles with dyke rock are clean and sharp; no variations in the composition of the matrix were noted.

The rhyolite and felsite pebbles may be detached fragments of adjacent country rocks. The place of origin of the andesite and diorite pebbles is a puzzle, for on the surface at least the dyke is separated from rocks of these types by several hundreds of feet of rhyolite.

FELDSPAR PORPHYRIES

Feldspar porphyries are exposed in two places widely separated from one another, one on the southwest corner of the large island in the north end of Trémoy Lake, the other in the north end of a trench in lot 4, range B. These two porphyries are distinctly different petrographically.

The porphyry on the island in Rouyn Lake resembles, in hand specimen, syenite porphyry exposed in the Horne mine. The syenite porphyry there is younger than meta-diabase (diabase of this report) according to Price.[1]

The rock is pink, with abundant phenocrysts of potassium feldspar to $\frac{1}{8}$ inch long in a pink, aphanitic groundmass. In thin section the groundmass is seen to contain laths of albite with a tendency to arrangement in bunches, finely divided quartz, epidote, actinolitic amphibole, and accessory titanite and apatite. Specks of pyrite are associated with a mass of white vein quartz in the dyke.

The porphyry exposed in the trench in lot 4, range B, contains many pink phenocrysts of feldspar to $\frac{1}{2}$ inch long. The rock is sheared and fractured, and the fracture faces are slickensided and plated with chlorite and specks of pyrite. It is composed of phenocrysts of chloritized albite, a few aggregates of quartz grains, abundant carbonate, epidote, and chlorite. In a rock that appears so fresh in hand specimen, the intensity of alteration is surprising. The south contact of the porphyry against fine-grained greenstone is exposed in the trench. Near the contact small fragments of the greenstone are included in the porphyry, and sharp projections of the porhpyry extend into greenstone. Pyrite is abundant in the greenstone along the contact. If the greenstone belongs to the group of intrusive diabases, this dyke as well is post-diabase in age.

STRUCTURE

MAJOR FOLDS AND FAULTS

Structurally the area is divided into two distinct sections, one north, the other south, of the Horne Creek fault. North of the fault the rocks are well exposed and the main structural features are fairly clear. South of the fault, on and east of Rouyn Lake, the main features are likewise fairly clear, but between Rouyn and Trémoy Lakes data are too incomplete to do more than suggest possible solutions for the structural puzzle, none of which is entirely satisfactory.

[1] Price, Peter: The Geology and Ore Deposits of the Horne Mine, Noranda, Quebec; Trans., Can. Inst. Min. Met., vol. 37, 1941, p. 115.

In the section north of the Horne Creek fault, that is, in the northwest quarter of the area, the rocks are mainly rhyolite flows, but trends and attitudes are delineated by layers of andesite and by the layer of well-bedded tuff and breccia. Thus, a layer of andesite enters the area from the north in the extreme northwest corner of the area. This layer strikes north 25 degrees east, dips 45 to 65 degrees east, and faces east. Across block 28 the flows strike north 75 degrees west, dip 70 degrees north or are vertical; according to observations on pillows and of graded grain and crossbedding in tuffs, they face north. That is, the flows here form a large V, open to the northeast. None of the beds can be followed around the angle of the V; it is probably broken along a northeast-striking fault. The fragments of andesite flows west of Dufault Creek in range X mark out the south limb of the same V, but here the flows strike north 30 to 50 degrees west, dip steeply to vertically, and face northeast. The tip of this part of the V must fall on the north-south centre line of the township, near the middle of range X N., for in lot 32, just south of the Dufresnoy-Rouyn township line, pillows in an andesite flow strike north 65 degrees east and face southeast.

The V is the surface expression of a syncline. The plunge of the fold is probably steeply to the northeast, for the limbs dip steeply to vertically and approach one another nearly at right angles.

As the beds on the south limb are followed eastward, they are found to curve sharply southwards; on Ville-Marie ground they strike south, dip 70 to 90 degrees east, and face east. The circumference of the curve, as outlined by the fragments of andesite flows just west of Lake Dufault, is broken by almost innumerable faults. The faults strike, in general, about north 60 degrees east and the surface trace of many of them is marked by a steep-walled, linear valley. The horizontal displacements that were determined range from negligible to a possible maximum of 500 feet, with 50 feet most common. The displacement on most of them is right hand, though small left hand displacements were observed on some.

The southeast-trending beds outline an anticline with a steep plunge eastward to northeastward. The beds terminate against the Horne Creek fault, which lies just south of the axis of the fold. This fold is the easterly extension of the "Noranda anticline", named by Wilson in the Rouyn sheet.

East of Dufault Creek the location of the axis of this anticline is not known. Structures tentatively outlined in Cléricy map-area indicate that the Noranda anticline and the syncline next north both die out somewhere between Dufault Creek and Kinojevis River.

The Rouyn Lake syncline involves sedimentary beds of the Cadillac group as well as underlying volcanic rocks of the Blake River group. The sedimentary beds are well exposed on the south shore of Rouyn Lake, appear in scattered outcrops between Rouyn Lake and Routhier Lake, and on the east shore of Routhier Lake. Graded bedding is beautifully developed in exposures on Rouyn Lake, and occurs here and there east of Routhier Lake. Crossbedding is rare. Beds that face north dip 60 to 70 degrees north, those that face south dip 80 degrees north or are vertical. The fold is thus asymmetric, with a vertical to overturned northern limb.

The axis of the syncline extends north of east from the west end of Rouyn Lake, passes just north of the two small islands on the southeast side of Rouyn Lake, swings across the narrow isthmus between Rouyn and Routhier Lakes, and extends eastward somewhere about the middle of the area underlain by sedimentary rocks east of Routhier Lake.

Pillowed andesite flows south of the axis, between the two lakes, face north, as do similar flows along the south bank of Kinojevis River. Pillowed andesites along the north shore of Rouyn Lake face south and dip vertically. There is some evidence to suggest that the syncline may be broken along or near its axis by a fault or faults[1], but without more information than is available, their existence must remain problematic.

In the section between Trémoy and Rouyn Lakes, some elements of the structure can be defined. A series of andesite flows east of the northeast bay of Trémoy Lake strike north 70 degrees west, dip 80 degrees north, and face north. This attitude is maintained to the east side of lot 39, range VIII S., but there continuity of outcrops is broken by a strip of low ground 1,000 feet wide. Southwards across the strike, that is, along a line drawn 20 degrees east of south 1,000 feet or so east of Trémoy Lake, andesites 7,000 feet wide are succeeded by a layer of rhyolite about 2,500 feet wide, and these again by north-facing, pillowed andesites to the south edge of the sheet. The layer of rhyolite can be followed east from the lake for 6,000 feet, but is there lost in the strip of low ground 500 feet wide. East of the low ground only south-facing andesites are found, in flows that form the north limb of the Rouyn Lake syncline. This distribution and the attitudes of the rocks involved make it reasonably certain that the flows striking east from Trémoy Lake terminate against a northeast-striking fault of considerable displacement. Its surface trace must lie in the low ground noted, cross range line VIII S.-VIII N. about lot 41, and extend southwest to cross the north-south centre line of the township about the middle of block 72. Connolly and Hart postulated a fault or faults about the same place, although they did not extend it northeast of Trémoy Creek[2].

Another fault is postulated along or near Trémoy Creek. A shear zone is exposed near the middle of the boot-shaped peninsula on the east shore of Trémoy Lake. Outcrops 3,000 feet east on strike both north and south of the dam near the north-south centre line of the township are of strongly sheared, carbonatized, and pyritized rhyolite. If a fault passes these and includes the shear zone on the shore it is nearly on strike with the Andesite fault of the Horne mine. The trace of the presumed fault in Lake Routhier area is 4,000 feet south of, and nearly parallel with, that of the Horne Creek fault. East of the north-south centre line the trace is not known. It may follow Trémoy Creek nearly to Rouyn Lake, and so account for the strong schistosity of an outcrop of rhyolite breccia at the falls 500 feet north of the creek's mouth, or it may extend directly east through low ground to or beyond the northernmost bay on Rouyn Lake.

Still another fault, trending about east-west, may follow low ground just south of Trémoy Lake. Other faults, as suggested by Connolly and Hart, may be present.

[1] Kinojevis Sheet; Geol. Surv., Canada, Map 306A, 1935.

[2] Connolly, H. J., and Hart, R. C.: Structural Geology of the Osisko Lake Area, Quebec; Can. Inst. Min. Met., Trans., 1936, Fig. 3—Glenwood fault.

As a result of this extensive faulting, it is impossible, as yet, to correlate structures from one fault block to another with any degree of assurance. Until that can be done the forms of any folds that existed in the volcanic rocks before faulting must remain in doubt. One interpretation, based on the disposition of acidic pyroclastic rocks around a nose of pillowed andesite at the east end of Rouyn Lake, the discovery of north-facing flows in an outcrop south of the small creek, lot 44, range VIII S., and the tentative correlation of the south-facing spherulitic lavas on the north shore of Rouyn Lake with the north-facing spherulitic flows across lots 32 to 39, range VIII, places the north-facing flows east of Trémoy Lake on the north limb of a faulted anticline, the south-facing flows on the north shore of Rouyn Lake on the south limb. These limbs would, according to this interpretation, be displaced relative to one another along the northeast-striking fault, the horizonal displacement being left hand. The northern limb, and possibly the southern limb as well, is further broken into at least two and possibly several blocks by east-trending faults.

The Horne Creek fault is not exposed at the surface in Lake Routhier area. Its general location is determined by the rock distribution and by structural trends, but its course is through low ground and the trace of the fault or fault zone cannot be accurately placed from surface exposures. It is best defined for ½ mile along and just south of range line VIII-IX, across lots 32 to 35. Its trend there is north 75 to 85 degrees west. Westward it passes through an area devoid of outcrops, to the east shore of Trémoy Lake in lot 28, 1,800 to 2,400 feet south of range line IX S.-IX N. West of the shore it must curve gradually south of west to join the fault where it is known north of the Horne mine. East of lot 35 it probably continues with about the same strike at least to lot 39, range VIII N. A branch of it, or perhaps the main fault, must trend northeast from there, for southeast-striking andesite flows terminate abruptly at or just south of the power line in lot 42, range IX S. If the main fault continues southeastward, it must pass south of the large outcrop of rhyolite in lots 41 to 43, range VIII N., along a course that would carry it into a bedding fault somewhere not far north of the northeast end of Lake Routhier.

A system of subsidiary faults branches off from the north side of the Horne Creek fault along courses that strike about north 55 degrees east. The most westerly of these faults follows the steep-sided, linear valley that crosses range IX S.- IX N. in lot 30. The andesite layer across block 28 is terminated against this fault. The horizontal displacement cannot be less than 500 feet. A parallel valley, believed to mark the course of a second subsidiary fault, lies 1,500 feet east and crosses range IX S.- IX N. near the east side of lot 32. A third fault of this set may cross range VIII-IX just west of lot post 33-34. Still others probably split off from the Horne Creek fault east of lot 35, for the andesite flows in the northern part of lot 41, range IX S. are faulted by this system.

The courses of these faults across the low ground south of the small lake in range X S. are not known, but andesite flows in rhyolite northeast, east, and southeast of the lake are broken into fragments by a whole series of faults trending north 55 to 60 degrees east. The faults are spaced 115 to 1,500 feet apart; horizontal offsets, where they could be measured, range from a few inches to 200 feet. On nearly all of them the offset is right hand.

Horizontal displacement along the main Horne Creek fault can be determined if rocks north of the fault can be correlated with those south of it. Distinctive beds are ordinarily few and far between in sections of volcanic rocks, and this region is no exception. However, several clues have come to light that, taken together, make correlation seem plausible. The first is the layer of bedded tuffs and breccias described on Ville-Marie and Wiltsey-Coghlan ground. The rocks in this layer are strikingly similar to those in a layer south of the fault at Noranda mine, both in type of bedding and in composition. Furthermore, the layers face in the same direction. If these layers are correlated other layers on either side that appear to correspond come into line with one another. The position of the andesite layer south of the breccia in block 28 corresponds approximately to the position of the Chadbourne andesite[1]; the two are very similar lithologically. Again, the andesite just west of Dufault Creek, north of the fault, falls into line with the andesite layer east of Noranda, which is well exposed east of the northeast bay of Trémoy Lake. As noted, a pillowed flow in the northern andesites is almost identical in character with one exposed in the flows east of Trémoy Lake. Still another clue is offered by the disposition of the diabase dykes. South of the fault they appear in great abundance in the Horne mine, in and just east of the layer of breccia and tuff. North of the fault only one or two isolated occurrences are known until Ville-Marie ground is reached, but there diabase is very abundant in the low ground east of the breccia and tuff layer. As mentioned on page 91, diabase is only known in one or two places south of the fault, on Ville-Marie ground.

The correspondence in position of these features, which follows correlation of the tuff and breccia bed, is strong evidence that the correlation is correct. The horizontal offset so indicated on the Horne Creek fault is a little over 2 miles, the north side being displaced relatively east. However, actual movement on the fault doubtless included a vertical as well as a horizontal component. Evidence in Rouyn area suggests that the north side was displaced upwards with respect to the south. Again, although the several layers correspond approximately in position and closely in character they do not correspond in thickness as they should if movement along the fault was strictly horizontal. Any vertical movement that tended to carry the beds on the north upwards would produce horizontal offsets on east-dipping beds, the north side being apparently shifted east. In short, although the horizontal offset is estimated at over 2 miles, the net movement on the fault might have actually been largely vertical; more probably it was a combination of vertical and horizontal movement.

MINOR SHEAR ZONES, FAULTS, AND SCHISTOSITY

Minor shear zones in which the rock is commonly reduced to a paper schist occur in many places in the area. Many of them lie parallel to the bedding and as a consequence it is difficult or impossible to determine whether or not displacement has occurred along them. Some are narrow, with well-defined walls of relatively massive rocks; in others paper schist

[1] Geol. Surv., Canada, Rouyn Sheet, 1939, Map No. 453A.

passes across the strike, into schistose rocks, and these in turn into relatively massive rocks. An example of the latter type occurs along the south side of the large outcrop in block 27. There, rhyolite along the north side of a steep-walled, narrow valley is reduced to paper schist. Planes of schistosity strike north 75 degrees west and are vertical. The paper schist extends 100 to 200 feet north of the valley, and then grades off into several hundred feet of schistose rhyolite.

An interesting development of schistosity is seen in the area east and south of the small lake in range X S. Rocks in this area are cut by the system of subsidiary faults from the Horne Creek fault as noted. The faults strike north 55 degrees to 60 degrees east. The rock in the fault blocks is strongly sheared, and along the valley walls is reduced in many places to paper schist. The schistose planes both along the valley walls and also in many places within the fault blocks strike north 55 to 65 degrees east and dip steeply northwest or are vertical. In one outcrop on range line X S.- X N., well-bedded rhyolite tuff strikes north 50 degrees west and dips 60 degrees northeast. It is sliced along vertical planes, which strike north 65 degrees east. The planes are spaced 1 to 2 inches apart; on each of them the bedding planes of the tuff are offset a fraction of an inch; each shows a tiny drag along the fracture. The movement indicated by the drag and the offset is right hand, that is, in the same sense as the offset on the subsidiary faults. The implication is that shear zones and schistosity that strike in this direction were formed by the same movements that developed the faults. It should be noted that outside of the area cut by the subsidiary faults, schistosity is much less prominent, and in general strikes parallel to the bedding. It may have developed during folding, whereas the schistosity that cuts across the bedding in the fault blocks developed during faulting.

Well-defined shear zones 10 to 20 feet wide cut sedimentary beds on the south shore of Rouyn Lake and the east shore of Lake Routhier. They strike nearly due east and are alined one with the other in such a way as to suggest they form part of a single, east-striking fault. Another small shear zone or fault cuts sedimentary beds on the north shore of Kinojevis River, lot 54, range VII S. It strikes east, parallel with the course of the river at this point and to the south contact of the Cadillac group against pillowed andesites of the Blake River group. Up river about 800 feet and on the opposite bank a sheared, contorted zone, possibly along a fault, strikes north 50 to 70 degrees east. The zone is 50 feet wide; shear planes on the north side dip 55 degrees north; those on the south side dip 70 degrees south. The rock within the zone is dark grey to greenish black, with poor parting. Thin sections were not examined but the rock has clearly been intensely deformed, with milling down of the original grains to give the present fine, almost slaty, texture. Such milled rocks, or mylonites, are not uncommon in zones of intense deformation. The contorted zone on the north side of the river has already been noted, and it may be that the sedimentary-volcanic contact along this section of the river was a locus of considerable movement, but information is at yet too scanty to permit more than a suggestion.