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ALLARD RIVER AREA, ABITIBI-EAST COUNTY

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GEOLOGICAL SURVEYS BRANCH

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GEOLOGICAL REPORT 57

ALLARD RIVER AREA

ABITIBI-EAST COUNTY

by

René Béland

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ALLARD RIVER AREA

ABITIBI EAST COUNTY

By René Béland

INTRODUCTION

Location and Means of Access

The Allard River area, 285 square miles in extent, is bounded by longitudes 77°37' and 78°00' west, and by latitudes 49°30' and 49°45' north. Its southern limit is one hundred miles north of the Parent-Cochrane section of the Canadian National railway. The area includes the township of Cavelier, parts of Vezza, Noyon, and Galinée, and a narrow strip across Daniel and Isle-Dieu.

Though remote, the area is easily accessible from Senneterre, Barraute, or Amos. Senneterre is a railway junction and a seaplane base where excellent transportation services are available. Airplanes can be landed on Allard river just north of the line separating the townships of Vezza and Cavelier. Bell river provides an excellent canoe route from Senneterre to Mattagami lake, a trip of about 140 miles[x]. From this lake, the map-area is reached by ascending Allard river, which enters the lake at its west end. Gizzard river, which flows across the northeastern part of the area into Bell river, is another possible route. Indienne river, also a tributary of the Bell, south of the map-area, passes only two miles from Nelson creek, which can be descended to Allard river.

From Barraute[+], road transportation is available to Laflamme river, which flows into Bell river at the southeastern end of Canica island. This route avoids Parent lake, a wide and treacherous body of water north of Senneterre.

From the town of Amos, 40 miles west of Senneterre, one can follow Harricana river northward for about 70 miles to the point where

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[x] Since the first drafting of this report, the Quebec Department of Mines has built a road along the west bank of Bell river from Senneterre to the bridge which crosses the river two and a half miles below Kiask Falls.

[+] A branch line of the Canadian National Railways has been completed, since the first writing of this report, between Barraute and Beattyville, which is situated on Bell river ten miles above Kiask Falls.

a portage, four and a half miles long, leads to the upper part of Allard river.

Field Work

Pace-and-compass traverses were run approximately north-south at intervals of three-quarters of a mile. The geological observations were plotted on a preliminary topographic map and on aerial photographs supplied by the Quebec Department of Mines. The map which accompanies this report was compiled after completion of the field work from the aerial photographs and from the survey maps of the Quebec Department of Lands and Forests. For greater accuracy, the outlines of rock exposures were traced directly from the aerial photographs.

By studying the photographs, it was possible to plan the field traverses across the higher ground and to avoid the many large swamps of the area.

The streams navigable by canoe served as base lines for the first traverses. These streams are Allard river, which has no rapids within the map-area; Gizzard river, which is easily navigable up to and for two miles beyond the rapids indicated on the map; and, in the southeastern part of the area, François creek, which, at high water, can be ascended with a light canoe for three miles above its mouth. The ground not easily accessible from these streams was traversed from four surveyed lines: parallel 49°44'06", cut in 1939; parallel 49°35'13", cut in 1937; an east-west line midway between these, surveyed in August, 1947; and a meridian near the western boundary of the area. The line at parallel 49°35'13" is difficult to follow, and parts of it had to be re-cut. The other three lines, which are more recent, had been cut in the summertime and provide excellent footpaths.

Acknowledgments

The field assistants proved very efficient. They were Clarke R. Lewis, student at McGill University, Pierre Jaoul, geologist previously employed by the Turkish government, and Robert W. Leipink, student at Queen's University. Adrien Bélanger, of Senneterre, kept the equipment and canoes in good order and contributed several geological observations. Domina Lafontaine gave satisfactory service as cook.

Thanks are due to Arthur Fecteau and his pilots for their care in flying in our supplies in good order and on schedule.

Previous Work

The northeastern part of the area touches Bell river and was cursorily examined by the first geologists who ventured into Abitibi territory. The lower part of Allard River basin appears on the reconnaissance maps of the Geological Survey of Canada. Adjacent areas to the north, east, and west have been mapped by the Quebec Department of Mines: maps and reports describing them are, or should soon be, available. Several articles on the Bell River gabbro complex, part of which outcrops within Allard river area, are to be found in periodicals. All published maps and descriptive matter pertaining to Allard River area are listed at the end of the report.

Prospecting

There has been much staking in the area, but all the claims had been dropped by the summer of 1947. In 1944-45, the St. Francis Mining Company, Limited, and in 1946 Dome Exploration (Quebec), Limited, carried on geophysical surveys and diamond-drilling campaigns. Both companies gave access to the reports of their engineers and permission to reproduce the maps and plans prepared by them, and they also supplied some drill-core specimens. No metalliferous deposit of economic value has yet been found.

At the end of the summer of 1947, the Dominion Gulf Company, Limited, surveyed the area by means of an airborne magnetometer. The results obtained have not been made available. Geophysical methods such as the airborne magnetometer must be depended upon for the systematic prospecting of the Allard River basin.

GENERAL DESCRIPTION

Relief

The country is rather flat. The ground south of Watson lake, between Allard and Gizzard rivers, is a plain, or rather a low plateau, 20 square miles in extent, covered with muskegs. Similar, but less extensive, plains occupy the southeastern part of the area near Nelson creek and northeast of François creek. Flat swamp lands flank Allard river near the southern limit of the area and near the mouths of Dome and Ourse creeks. The mouth of Gizzard river is choked with mud flats which, above water level, are covered by muskeg vegetation.

Rocky knobs with rounded tops and steep sides rise here and there, some of them 150 to 200 feet above the plain. In the northwest corner of the map-area, a group of such knobs mark the outcrop of a large diabase dyke. Four other similar hills, composed of volcanic rocks, rise between Watson lake and Allard river. The surveyed line crosses two of them; the other two are near a large stream half a mile to the south. In the centre of the area, west of Gizzard river, a few rounded hillocks of bed-rock stand above the general level of the plain.

The upper courses of several streams are deeply entrenched into unconsolidated sediments. The dendritic patterns of crests and ravines thus established give to some uplands a certain ruggedness. Allard river, and to a lesser extent Gizzard river, have cut deeply into clay and in places have developed steep banks, 30 to 40 feet high, where landslides are frequent. The bed of Allard river is lower than that of Bell river at the same latitude. During spring floods, water from Mattagami lake backs up into Allard river, which thus becomes temporarily a bay of the lake. The high river banks, which prevent a general flooding of the area, recede a little each year as blocks of clay several feet in diameter slide into the river.

Rock Exposures

Apart from the fifteen or so rocky hills referred to above, bed-rock is poorly exposed, principally at a few places in the beds of the major streams. In travelling the country, one soon gets the impression that the bed-rock surface itself has but slight relief and that this relief has been mantled and decreased by the thick deposits of silt and clay. The salient features of the bed-rock surface are, however, still noticeable, though considerably 'softened', in the present topography. For instance, in the southern part of the area, rectilinear depressions occupied by creeks and swamps still mark the extension eastward and westward of the shear zone exposed on Allard river. At the centre of the area, a small plateau shaped like a hammer with its handle pointing northeast probably represents the high-standing outcrop of a gabbro mass which is exposed on the west edge of the plateau.

Drainage

The area drains into Mattagami lake by way of Allard, Gizzard, and Bell rivers. Of these, the Allard, with its tributaries, is the most important. In its upper part, i.e., from the southwest corner of the map-area to a point a mile and a half north of mileage 22 on parallel 49°35'13", the river is a muddy stream flowing slowly between steep clay banks. Below this point it turns sharply west and spreads out between ill-defined banks which change their outlines as mud is moved from place to place. The lower part of the river, except at a few narrow passages between rocky spurs, has lost all erosive power and silts up its bed. Segments of abandoned channels have been noted in the northwestern part of the area.

Gizzard river shows, on a smaller scale, the same characteristics as Allard river. South of the rapids indicated on the map, it is a mature stream; below them, shores are ill-defined and the river is senile where it joins Bell river.

Watson lake is the only lake of the area. It is a shallow, muddy pond lying at the northern limit of the area. Muskegs are common and occupy much of the northern half of the area between Allard and Gizzard rivers.

Timber

With respect to timber resources, the area may be divided into two parts by a curved diagonal line, convex toward the northeast and extending from the northwest to the southeast corner. Southwest of this line lies typical burned country covered with alders, poplar, and dense coniferous shrub. The state of decay of the rare blackened stumps and the size of the poplars indicate that, in some places, the forest fires occurred only 25 to 30 years ago. In other places, fir and jackpine trees of fair size are abundant, and the burns may be older. In 1912, Bancroft (4) reported four "brûlés" in Allard River basin. A map drawn by A. Sullivan in 1909 indicates several brûlés along Allard river, probably the same ones noted by Bancroft. A few small clusters of jackpine excepted, there was, in 1948, no exploitable timber in the brûlés. Travel through the thick and shrubby bush in that part of the area is slow and difficult.

North and northeast of the line referred to above, only small patches of woodland on hill tops or along the main streams have been burned. The rest of the forest consists largely of mature black spruce, with scattered white birch and balsam fir in the dryer spots. Long distances can be walked in these woods without hardship.

Fauna

The fauna is the same as in the rest of the clay belt. Fur-bearing animals are fairly abundant and include beaver, muskrat, and lynx, as well as rabbit, bear, and moose. The streams contain sturgeon, pike, sucker, and a white scaly fish resembling a large, flattened herring.

Agricultural Possibilities

The whole area is mantled with thick clay deposits, laid down very probably in great lake Ojibway* during Pleistocene time. The clay mantle makes a very fertile soil, as shown by the thick vegetation found in the burned areas.

Farming would be hampered, however, by early frosts. During the summer of 1947, there were frosts on the 13th and 21st of June, the

*COLEMAN, A.P., Lake Ojibway: Last of the Great Glacial Lakes; Ont. Bur. of Mines, Ann. Rept., Vol. 18, Part I, 1909.

22nd of July, the 26th, 29th, and 31st of August, and the 1st of September. Bancroft (4) reported heavy frosts in the upper Allard basin on the 16th and 19th of July. The clearing and draining of the land might perhaps lessen the danger of heavy frosts.

DESCRIPTIVE GEOLOGY

General

The bed-rock of the area, at least the little of it that is exposed, is entirely Precambrian. Most widespread are chlorite schists and amphibolites of volcanic origin, which have retained the structures and appearance of lavas and pyroclastics. These rocks may be classed as Keewatin-type greenstones. Bands of metasedimentary rocks including quartzites, greywackes, sericite schists, and 'iron formation' of the jaspilite type, occur within the greenstones. The metasedimentary rocks have the same structural attitudes and show the same degree of metamorphism as the greenstones. They no doubt represent sedimentary rocks intercalated in a dominantly volcanic sequence.

Plutonic rocks occur in several places, but their contacts with the greenstones have not been observed within the map-area. The formations described in the present report have been assigned the same ages as the lithologically similar rocks of adjacent areas, where contacts are exposed and age relationships are clearer. Some of the observations in the Allard River area have confirmed the order of succession thus established. For instance, if the small granophyric and albititic dykes which cut across the greenstones in some places are related to the granites exposed at the southern and northern limits of the area, these granites would be younger than the greenstones. Similarly, the silicification which is observed in the Keewatin-type greenstones at the rapids of Gizzard river close to the gabbro-anorthosite complex exposed farther east suggests that the complex intrudes the greenstones. This observation had been made previously by Freeman and Black (15). The gabbro and diabase masses occurring at the centre and in the northwest corner of the area cut across the structural trend of the greenstones. They are also less altered than the greenstones and are petrographically similar to the dykes tentatively assigned a Keweenawan age by Longley (14) in the Lake Kitchigama area, and with those described by Freeman and Black (15) as cutting across all the other formations in the Opaoka River area.

The age of the peridotite remains uncertain. The rock is exposed in only one place, near Allard river in the centre of the area, and the exposure is only four square feet in extent. The serpentinized peridotite is probably intrusive in the greenstones.

Table of Formations

PLEISTOCENE and RECENT	Glacial deposits	Lacustrine clays Boulder clays
	Unconformity	
POST-KEEWATIN (?) INTRUSIVES	Dykes and other masses of basic intrusives	Gabbro and diabase, little altered
	Granitic intrusives	Albitite dykes Dykes of feldspar and quartz porphyry Hastingsite granite Gneissic biotite granite
	Igneous Bell River Complex	Altered gabbro and anorthosite
	Peridotite (age relationship unknown)	
	Intrusive contacts	
KEEWATIN (?)	Volcanic and sedimentary series of Keewatin type	Lavas and pyroclastics altered to chlorite schists and amphibolites Quartzite, graywacke, sericite schists, and jaspilite

Keewatin-Type Greenstones

The greenstones of the volcanic-sedimentary series have been little metamorphosed. Where they have not been too impregnated with carbonates of hydrothermal origin, they have retained their original structures and even their textures. The mineralogical assemblages are those corresponding to Harker's[x] chlorite and biotite zones. Basaltic lavas have been converted to hornblende schists containing sodic plagioclase and epidote; some thicker flows, doleritic perhaps originally, have become true amphibolites. More acidic lavas have been changed to chlorite schists which contain some sericite and albite. Banded tuffs are now green, highly chloritic schists. The recognized metasedimentary rocks are mostly non-glassy quartzites and sericite phyllites.

Amphibolites, and Hornblende-Epidote Schists

Hornblendic greenstones occur at many localities within the map-area. The principal exposures are along the banks of Allard and Gizzard rivers and near the diabase dyke that outcrops in the northwest corner of the area. They are of two types: amphibolites and hornblende-albite-epidote schists. The two have not been separated on the map because differences between them are slight and probably represent local variations in the intensity of the metamorphism.

The colour of the amphibolite is from dark green to greyish-black. The schistose rocks are paler, approaching olive-green. Volcanic structures are inconspicuous; in one exposure, vague nodules suggest amygdules; in another, layers of amphibolite which may have been lava flows are separated by thin beds of tuff-like chlorite schists containing angular fragments. Fineness of grain in these hornblende rocks suggests an extrusive origin.

In most specimens, rectangular greasy feldspars, rarely more than one millimeter long, are scattered through a dark matrix of hornblende and epidote and can be recognized with a lens. In thin sections, the amphibolites show a basalt-like texture: hypidiomorphic feldspars, partly changed to epidote and clinozoisite, are found at the centre of sheaf-like or decussate groups of hornblende porphyroblasts. Sections of the more schistose facies, cut across the schistosity, reveal a linear arrangement of the hornblende crystals as well as a layered structure caused by the concentration of hornblende crystals in sheets alternating with other sheets composed of feldspar and epidote granules. In such schists the feldspars are fractured, whereas the hornblende porphyroblasts, though curved in some thin sections, show

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[x]HARKER, A., Metamorphism; Methuen & Co., Ltd., London.

little or no deformation, as if they had developed subsequently to the foliation of the rock.

The feldspars are so replaced by epidote, chlorite, and sericite that it is almost impossible to determine their original composition. In some schistose specimens, extinction angles in relatively clear grains correspond to those of oligoclase, An_{10}. In massive amphibolites, plagioclase grains with extinctions that indicate a composition up to An_{30} have been noted. These sodic plagioclases are clearly derived from the degradation of original more calcic feldspars. The composition of the latter can be estimated only by combining the sodic plagioclase identified with the epidote contained in the rock.

The optical properties of the amphibole vary from section to section. In amphibolite specimens, the measurements are those of common hornblende: the angle $Z \wedge c$ is 27°, and the pleochroic formula is X-yellow, Y-pale green, and Z-blue-green. In some hornblende schists, the amphibole is close to ferrotremolite or actinolite in composition, with $Z \wedge c$ between 15° and 17°, and pleochroism weak: X-pale yellow, Y-pale green or colourless, Z-faint yellowish-green. In all sections, the amphiboles are seen to project into the feldspars and to have partly digested them. One of the thin sections of amphibolite examined has a pseudo-ophitic texture, with feldspar crystals enclosed in large hornblende porphyroblasts. In this section, the feldspar crystals are rectangular in shape, with their sides finely serrated against the hornblende.

All the sections examined contain abundant epidote: indeed, the mineral is recognizable in most specimens with a hand lens. It does not occur in large crystals but in clusters of small grains, 0.2 mm. and less in diameter, mostly replacing feldspar and amphibole. In many of the thin sections, the epidote mineral has a low birefringence, exhibiting anomalous blue or canary-yellow interference tints, and it is probably clinozoisite. Epidote also occurs in veinlets which fill very thin cracks in the rock.

The three minerals described, i.e., plagioclase, amphibole, and epidote, are the essential constituents of the hornblende greenstones. Amphibole is more abundant than plagioclase, and these two minerals together make up two-thirds to three-fourths of the rock, by volume. The balance is mostly epidote, with some accessory minerals, chief among which are chlorite, in shreds replacing the feldspars and amphiboles; magnetite, occurring as fine dust; ilmenite, recognized by its white, opaque alteration product known as leucoxene; and carbonates in almost circular grains, some of which may be due to hydrothermal impregnations and others derived from the degradation of the plagioclase.

In the massive amphibolites, the original texture, which from all indications was basaltic, has not been affected much by metamorphism. One of the thin sections examined contains relics of augite, probably the main original ferromagnesian mineral of these rocks, which appear to be metamorphosed basalts.

Albite-Sericite-Chlorite Schists

The albite-sericite-chlorite schists are as abundant as the hornblende greenstones and, with the latter, account for most of the Keewatin-type greenstones of the area.

The schists are greenish-grey, fine-grained, and well foliated. They are commonly paler than the hornblende greenstones and have a less dull, more vitreous, lustre due to their content of 10 to 20 per cent quartz. Narrow bands of conglomerate or breccia are common among the schists and are the best indication of their volcanic origin. Some exposures along Gizzard river and on the southwestern shore of Watson lake contain small, black amygdules of serpentine, chlorite, and epidote.

The only constituents that can be identified with a lens or the unaided eye are chlorite and minute white slivers of feldspar lying in the schistosity, which is well marked in thin sections by the parallel orientation of chlorite flakes and of the planes of deformation in the feldspar crystals. Apparently, most of the latter had completed their growth before the end of deformation and, as a consequence of the stresses to which they were subjected, were elongated along their _c_-axis or at least along some line lying in their 010 plane. Under prolonged stresses, crystals so oriented that the plane of their albite twinning (010) was parallel to the plane of foliation remained undeformed; all others were bent and granulated. The chlorite clusters, some of them measuring 2 mm. in diameter, are shredded and now fill interstices between other constituents. In all the sections, traces of original porphyritic textures incompletely destroyed by metamorphism were observed. In some, the old phenocrysts are shattered and altered. In others, there are white, opaque cores of saussurite surrounded by rims of clear albite which obviously are albitized feldspar phenocrysts. These schists also contain quartz phenocrysts, 0.2 to 0.8 mm. in diameter, with imperfect hexagonal outlines. In some sections, relics of ferromagnesian phenocrysts were observed. In these, the chlorite occurs in compact bundles sprinkled with fine magnetite, and in one of them there are lenticules, 2 mm. long, of chlorite, with penninite at their centres. Sagenitic webs of fine rutile needles are developed in the lenticles, which are thought to represent former phenocrysts of biotite.

All feldspar grains clear enough for optical measurements in sections normal to X or Z have the extinction angles of albite. They occur as anhedral crystalloblasts, as clear rims around degraded plagioclase grains, and as small rectangular crystals scattered through the rock. Other alteration products of the original feldspars are chlorite and sericite; there is very little epidote.

The matrix enclosing the feldspars consists of flakes and shredded bundles of chlorite and sericite, the parallel disposition of which determines the schistosity. The proportions of chlorite and sericite vary greatly, perhaps according to the basicity of the original rock; the more quartzose the schist, the lower is its content of chlorite.

Quartz occurs in the schists, not only as phenocrysts as noted above, but also as small anhedra and interstitial grains. Part of the quartz has probably been brought in by hydrothermal solutions, for the schists in many places are criss-crossed by veinlets of quartz and carbonates. Some of the quartz may also have resulted from the mineralogical changes produced by metamorphism. It would be very difficult to estimate how much of the quartz in these rocks is original.

The composition of the schists may be summarized as follows: 30 to 50 per cent feldspar, 5 to 25 per cent quartz, 15 to 50 per cent of chlorite and sericite. The heavy accessories noted are: magnetite, ilmenite-leucoxene, and apatite in euhedral crystals. Some specimens also contain carbonate grains of various shapes and sizes, probably products of hydrothermal action.

The albite-sericite-chlorite schists are metamorphosed equivalents of feldspathic rather than mafic lavas, of probable dacitic-andesitic composition, perhaps even rhyolitic in some cases.

Epidotized Felsite

Two rocky knobs rise above the surrounding plain near milepost 8 on the 49°44'06" parallel. They are exposures of a hard grey rock, very fine-grained, breaking with a conchoidal fracture resembling that of a fine quartzite. Steep-dipping beds of agglomerate and breccia, striking east-west, are also exposed on the knobs. Very small pillows were recognized in the grey rock close to the clastic beds. The whole assemblage is undoubtedly of volcanic origin. Half a mile to the south there are two other exposures of the same rocks. The grey rock, without pyroclastic beds, is also exposed at the bend of Gizzard river, three-quarters of a mile south of the centre-line of Galinée township.

The disposition of these two groups of exposures between Allard river and Watson lake suggests that the grey felsite forms two narrow bands within the greenstones. On the map, these bands have been distinguished from the other volcanic rocks because of their resistance to erosion and their peculiar petrographic character.

At first sight, the grey felsite suggests a rhyolite or a silicified rock. In thin sections, however, quartz appears only as rare and small phenocrysts. The rock is made up mostly of a pilotaxic mixture of rectangular grains of feldspar, which have been transformed into sericite, chlorite, and epidote. Scattered angular phenocrysts of altered feldspar stand out in the even grained groundmass; though they seem much larger than the groundmass feldspars, their greatest dimensions are not above 0.5 mm. In one section, the feldspar phenocrysts have been replaced by sericite only; this suggests that the feldspar was potassic. All interstices between the feldspar crystals, phenocrysts and groundmass included, are filled with fine shreds of chlorite and epidote. The latter mineral also fills rounded cavities which may be vesicles.

The aphanitic grey rock, perhaps originally vitrophyric, is a highly feldspathic lava in which sericite, chlorite, and especially epidote, were developed during metamorphism. The name 'epidotized felsite' under which it is here described indicates better than any the composition and evolution of the rock.

Pyroclastics

Mention has been made, on an earlier page, of the occurrence of pyroclastic bands within the greenstones. Well banded green schists of probable pyroclastic origin and composed of thin alternating white and green beds are also found intercalated in the metasedimentary rocks described below. The white beds contain much ankeritic carbonate and quartz whereas the green beds are highly chloritic, which suggests that the whole assemblage represents stratified tuffs. Some of the rocks described below as greywackes may be lithic tuffs; metamorphosed tuffs are perhaps the most difficult rocks to identify.

Metasedimentary Rocks

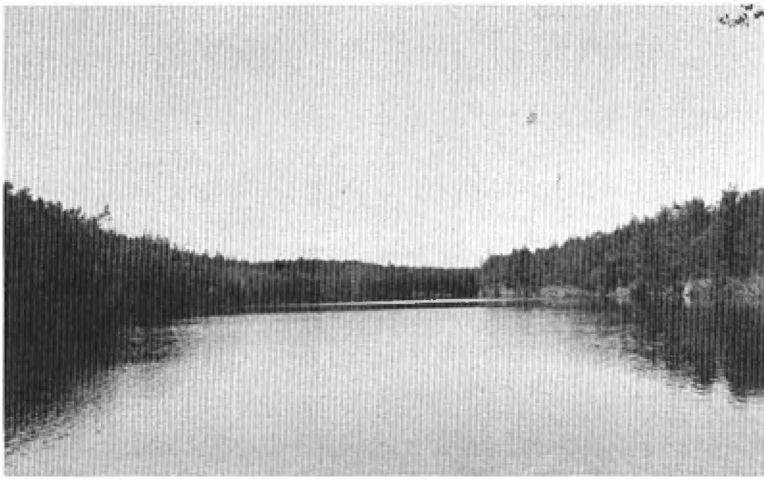
Metasedimentary rocks are exposed for 600 feet along the north bank of Allard river, three and a half miles south of parallel 49°35'13", at the point where the river turns sharply westward. Farther west, along the "S" bend of the river, the banded and stratified rocks disappear, their place being taken by tuff beds and lava flows metamorphosed into chlorite schists and amphibolites.

In their westernmost exposures, the metasedimentary rocks are strongly sheared and are deformed into crumbly schists, so that the nature of the original rock or rocks from which they have been derived is a matter of doubt. This sheared zone is mineralized; the schists are cut by veinlets, and are replaced along their schistosity by

A.- Mattagami lake, from mouth of Allard river.

B.- Middle section of Allard river, at centre of area.

Plate 11



A.- Upper Allard river.

B.- Lower Gizzard river.

A.- Upper Gizzard river (Photo P. Jaoul).

B.- Spruce forest at head of rapids, Gizzard river.

Plate IV

A.- Old " brûlé" along meridian close to western limit of map-area.

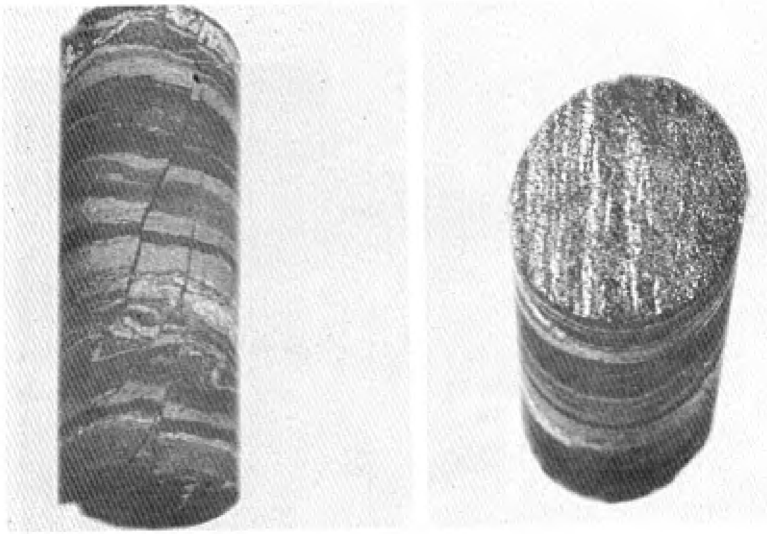
B.- Beaver dam (Photo P. Jaoul).

Plate V

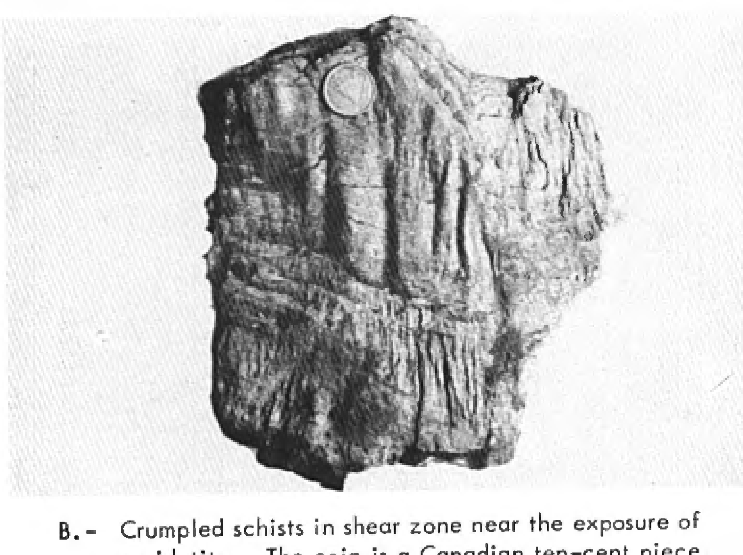
A.- Shear zone explored by St. Francis Mining Company, Limited.

B.- Drag folds in metasedimentary rocks near a shear zone.

Plate VI

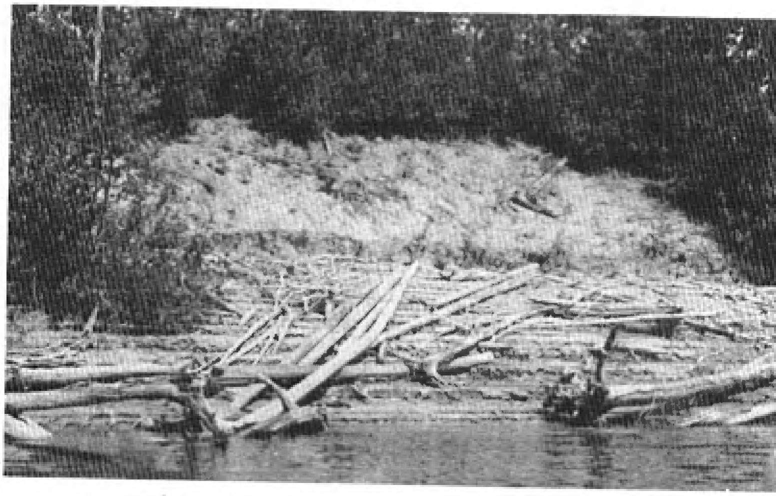


A. - Plications and b-lineation in jaspilite (natural size)



B. - Crumpled schists in shear zone near the exposure of peridotite. The coin is a Canadian ten-cent piece.

Plate VII



A.- Brown clay in bank of Allard river.

B.- Boulder clay near an exposure of greenstone.

A.- Glacial striae on a greenstone exposure.

B.- Three-foot layers of boulder clay within varved clays, north shore of Mattagami lake.

infiltrated masses, of sulphides, quartz, and ferriferous carbonates. In the eastern exposures, the rocks are less fissile and their bedding is well preserved although plicated and crumpled.

In 1945-46, the St. Francis Mining Company, Limited, explored the mineralized shear zone by means of a geophysical survey and diamond-drill holes. The Company has graciously made available not only its maps and cross-sections, but also a suite of core specimens representing a complete section across the zone. This material gave a clearer idea than was possible from our field observations of the thickness and attitude of the metasedimentary rocks in the zone and revealed the presence of altered lavas amongst the bedded phyllites and iron formation.

Sericite and chlorite phyllites of sedimentary origin occur near the western limit of the map-area, between mile-posts 28 and 29 of parallel 49°35'13". There is in that locality also much shearing and impregnation by carbonates, quartz, and pyrite.

A very small exposure of impure quartzite or greywacke occurs at the foot of a rapid in a tributary of Allard river, a mile and a half south of parallel 49°44'06" and two miles east of the main river. The Dome Exploration Company reports that diamond drilling in the western part of the area has cut thin layers of greywacke. The probable extensions of these metasedimentary bands have been indicated on the map, but the contacts as sketched are highly hypothetical.

Iron Formation or Jaspilite

In the ground explored by the St. Francis Mining Company, there are several layers of iron formation of the jaspilite type. One of them is exposed in the river bank and is three feet thick. Several other jaspilite beds, one of them four feet thick, were cut by the drill holes. These beds are not distributed uniformly among the other rocks but are bunched in zones, the thickest of which is 43 feet and has 23 distinct layers of jaspilite interstratified with tuffs. The thickest jaspilite layer in that zone measures eight inches.

Each of the jaspilite layers or beds is made up of two alternating types of laminae: one black-purplish rich in specularite and magnetite, the other red and jasper-like. The dark laminae are almost opaque under the microscope, but red hematite and quartz grains can be identified in them. The jasperoid laminae are mosaics of fine quartz dusted with hematite. In some beds of the iron formation, the jasper laminae have been replaced by thin, white or mauve, sheets of quartz and carbonates. Some of the sheets have sinuous contacts from which veinlets of quartz and carbonates cut across the dark laminae;

where this occurs, the quartz-carbonate mixture is rich in pyrite. The iron formation beds are generally fractured and brecciated; they must have afforded circulation channels for the mineralizing solutions. The engineers of the St. Francis Mining Company recognized this fact and directed their drilling toward the iron formation layers outlined in earlier magnetometric surveys. The jaspilite beds deflect an ordinary compass needle; and it is on the basis of such observed deviations that the band explored by the St. Francis Mining Company has been projected eastward on the map, and another band, perhaps the continuation of the first one, has been sketched four miles farther west.

Crystalline Schists and Greywackes

The most common rocks in the St. Francis drill cores are highly fissile schists of diverse colours, all fine-grained, with bedding parallel to the schistosity. Three principal types may be distinguished: a grey-black slate, a greenish-white sericite phyllite, and a layered schist, similar to the tuffs described above, in which light coloured beds alternate with highly chloritic ones.

The grey-black schist has not been seen outside of the ground explored by the St. Francis Mining Company, where it is perhaps the most abundant lithologic unit. A bedding, parallel to the schistosity and clearly marked by alternating grey and black laminae less than three centimeters thick, is the most distinctive feature of the schist. Thin sections oblique to the schistosity show felty masses of chlorite and sericite — the proportions of each varying from bed to bed — in which are set small rounded and indented grains of quartz and grains a few millimeters in diameter possibly of feldspar. The chlorite and sericite flakes have a common orientation and are disposed in leaves which, under the microscope, show the fine plications and miniature faults characteristic of slates and low-grade phyllites. Some beds contain more quartz and are more arenaceous than others; they have been crumpled and stretched so that they present the aspect of 'boudinage' on a very small scale. The grey-black schist was apparently impermeable to mineralizing solutions for it contains scarcely any carbonates, which, in the adjacent rocks, are present in abundance.

The grey-black schist, which might be termed an argillite, grades into true greywacke in which clastic detritus is visible to the unaided eye. Part of the coarser detritus consists of spindle-shaped rock fragments, some dark and several centimeters in length, others paler and only two to three millimeters long. The fragments lie in the plane of schistosity and have their long dimensions parallel to give the rock a linear structure which is discussed below. Under the microscope, the dark fragments, and some of the pale ones, look like pieces of rock. Besides these lithic fragments, the greywacke contains grains of clear quartz and of deformed seriticized feldspars. Cementing the detritus is a sericite paste in which appear chlorite shreds and small crystalloblasts of clear albite.

A somewhat different variety of greywacke is exposed in the northern part of the map-area. Its foliation is less perfect and the detrital characteristics are more evident. Spherical grains of quartz and angular fragments of feldspar may be seen with a lens. Thin sections show the rock to be composed largely of rounded grains measuring from 0.5 to 0.4 mm. in diameter. Most of them are quartz grains welded to one another by peripheral secondary enlargement. Others are fragments of cryptocrystalline rocks of unknown origin. There are also angular grains of feldspar, the composition of which could not be determined; some are probably detrital, others may be crystalloblasts. All the coarser constituents, detrital and autochtonous, are bound in a highly chloritic, almost opaque matrix. The rock represents a mixture of water-worn quartz grains and rhyolite fragments, with volcanic dust.

Sericite phyllites are scarce in the ground explored by the St. Francis Mining Company, but they constitute the main unit in the metasedimentary rocks exposed near the western limit of the map-area. The phyllites are extremely fissile and almost white. Ankeritic carbonates and pyrite are scattered through them and give a spotted appearance to their weathered surfaces. In thin sections, these phyllites appear very fresh. Their chief constituent is quartz, which is associated with shredded sericite and some feldspar. Part of the quartz occurs in equidimensional grains 0.4 to 0.5 mm. in diameter, but most of it is in mosaic-like clusters of very small grains. The feldspar grains have the same shape and distribution as the quartz but are less abundant. A strongly pleochroic chlorite, probably close to biotite in composition, occurs in the sericite matrix. The original bedding of the rock is marked by thin layers of fine quartz mosaic in which are scattered minute flakes of sericite. The feldspar grains are very fresh, and all in which optical measurements could be made have compositions close to albite (An_{10}). Like the sericite, the chlorite, and the 'nascent' biotite, the feldspar is crystalloblastic.

Intrusive Rocks

Peridotite

A small (four square feet) outcrop of serpentinized peridotite lies within a group of greenstone exposures at the centre of the map-area, along the bank of Allard river. It is separated from albite-chlorite greenstone by fifteen feet of rusty and strongly laminated schist. The peridotite is black, non-schistose, but it is criss-crossed by a multitude of intersecting slickensided fractures. The original constituents of the rock have been replaced by serpentine and by fibrous radiating amphiboles, and even their outlines have been largely erased. Some serpentine aggregates, however, have conserved the general outline of olivine crystals, and clusters of acicular amphibole mixed with serpentine have the general shapes of crystals that originally may have been pyroxene. The only mineral now present which may be a primary constituent is a brown amphibole that somewhat resembles biotite.

Gabbro-Anorthosite Complex

Coarse gabbroic rocks are exposed along the lower part of Gizzard river and on two hills less than a mile from the river. In the exposures along the river bank and on the more southerly of the two hills, the rock is greenish-grey and is composed of feldspar and what appears to be pale green hornblende, both in euhedral crystals as much as one mile long. A gabbroic texture is apparent in thin section though obscured by secondary minerals. The feldspar has been transformed into epidote and saussurite. The rare clear rims observed have a composition close to An_{25}. The amphibole, which makes up less than a quarter of the rock, is pale green and fibrous. What appear, in hand specimen, to be large single crystals of hornblende are seen in thin section to be aggregates of amphibole fibres mixed with serpentine. Some of the bundles of fibres are crossed by opaque parallel lines which may represent the parting planes in original, and now completely replaced, pyroxene crystals. The heavy accessories recognized are apatite, ilmenite, and pyrite.

The rock exposed on the other, more northerly, hill is somewhat different, but evidently it is related to the one just described. It contains no large hornblende crystals or amphibole aggregates. Blue opalescent quartz fills the interstices between the feldspar crystals. The specific gravity of the rock is slightly higher than that of the hornblende type, due, as revealed by the microscope, to a large content — not less than 75 per cent — of epidote and clinozoisite. The two minerals occur in granular aggregates which, in shape, are rectangular with sutured edges. It would thus seem that these aggregates have retained the shape of the original feldspar crystals they have replaced, remnants of plagioclase which are still to be seen within some of the aggregates. The interstices between these former feldspar crystals are filled with quartz — in veinlets and fine-grained aggregates — calcite, sericite, fine-grained epidote, and a strongly-pleochroic, uniaxial negative, chlorite. The rock is an epidotized anorthosite belonging, like the altered gabbro, to the Bell River complex as described by Freeman and Black (15).

Granitic Intrusives

Gneissic Granite

A medium grained gneissic granite is exposed near the southern limit of the area, in the bed of a major tributary of Allard river. The gneissic structure is due to the disposition of the ferromagnesian constituents — chiefly hornblende, with some biotite — in dark streaks amidst pink bands of quartz and feldspar. In thin section, the quartz and feldspar crystals are seen to be much granulated, with the larger ones remaining as augen surrounded by a granulitic mixture of quartz and feldspar. Most of the feldspar grains are perthitic and show the grid twinning of microcline. Some are untwinned and have the optical properties of orthoclase. There are also large grains of oligoclase (An_{15}) projecting into the microcline crystals. Hornblende is the main ferromagnesian mineral. It occurs in hypidiomorphic crystals, 2 to 4 mm. long, deep blue-green in colour with brownish tints. Part of the hornblende seems secondary and may have been derived from original pyroxene. As supporting this view, it may be noted that, in one thin section, the extinction angle $Z \wedge c$ in the central part of one of the hornblende crystals was measured as 40°. Other crystals are crossed by opaque lines disposed like a diallage parting. Some of the hornblende crystals appear porphyroblastic and project into the feldspars. Biotite, a brown variety, is much less abundant than hornblende, constituting only six to eight per cent of the rock. The accessory minerals are apatite, sphene, and pleochroic epidote, associated with the biotite and probably secondary.

Hastingsite Granite

Two exposures of a pinkish-grey granite were seen in the northwest corner of the area. They mark the extension of a tongue of granite mapped by Longley (14) farther north and related, according to him, to the Lake Kitchigama granite. The rock is composed chiefly of quartz and oligoclase (An_{25}), the latter in idiomorphic crystals penetrated along their edges by small grains of microcline perthite. These two minerals make up about 80 per cent of the rock. The other constituents are biotite and hastingsite in about equal amount, microcline, and small crystals of apatite, zircon, magnetite, and epidote as heavy accessories. Hastingsite was identified by its colour, ranging from seal-brown to dark green, its uniaxial negative character, and its strong dispersion, with the uniaxial cross for violet light being turned to the left with respect to the same cross for red light. The hastingsite penetrates the feldspars, replaces the edges of the biotite, and is accompanied by epidote, all of which suggests that it is, in part at least, secondary.

Granophyric and Porphyritic Dykes

Felsitic dykes, some massive, some sheared, were observed in several places. They are indicated on the map by lines parallel to their strikes.

The largest of these dykes is exposed on the east bank of Allard river, near the northern limit of the area. It is 150 feet thick and cuts across chlorite schists. The rock is fine-grained, pinkish-grey, spotted with epidote, and criss-crossed by pink felsitic veinlets. It is composed chiefly of a granophyric mixture studded with corroded phenocrysts of sodic oligoclase and of quartz. No orthoclase was identified, but some may be present since, for the most part, the feldspars are altered beyond recognition. Ferromagnesian minerals constitute less than one-fifth of the rock and consist chiefly of chlorite flakes scattered through the feldspars. There is also an acicular amphibole in radiating clusters replacing the feldspars.

Another unsheared dyke, one foot thick, cuts across banded tuffs along the edge of the shear zone explored by the St. Francis Mining Company. It penetrates the shear zone and, where it does so it has, like the other rocks of the zone, been strongly laminated. The rock is white and glassy, resembling a rhyolite. It is cut by intersecting fractures filled with rusty carbonates. In thin sections, idiomorphic phenocrysts of albite (An_5) and rounded phenocrysts of quartz are conspicuous. They are set in a fine groundmass of quartz and albite which contains also clusters and anhedral grains of carbonate, near which crystals of muscovite have developed. These last two minerals are obviously of hydrothermal origin.

Similar strongly sheared dykes were encountered in the drilling on the property of the St. Francis Mining Company, and also in holes put down by the Dome Exploration Company along the west bank of Allard river, a quarter of a mile north of parallel 49°35'13". At this last locality, a dyke three to four feet wide has been exposed by trenching over a distance of 700 feet. The rock has been converted to a sericite schist in which the microscope reveals deformed, and in some cases enlarged, albite phenocrysts. Secondary carbonates accompanied by large flakes of muscovite are plentiful in the groundmass.

The gold mineralization investigated by the St. Francis Mining Company and by the Dome Exploration Company is no doubt closely related to these albitite dykes.

Gabbro and Diabase

In the northwestern part of the area, five rocky hillocks, smoothed and polished by glacial erosion, rise above the plain. In four of them, the rock is a rather coarse diabase. As they line up in a northeast-southwest direction, a diabase dyke has been sketched on the map with the four hills as centre. Forest fires that had burnt the country to the south had also swept the tops of these hills, while leaving the woods in each side untouched; the edge of the burnt area, as it appeared in 1947, marked the presumed borders of the dyke. The diabase is massive, has an ophitic texture, and is composed chiefly of white plagioclase crystals up to 4 mm. long and dark pyroxene and amphibole grains of similar dimensions, with scattered grains of clear quartz. The ophitic texture is striking in thin sections. The feldspar, a sodic labradorite (An_{51}), is fresh. The pyroxene is augite-diallage; it contains schiller inclusions, and is partly changed to a green hornblende, some crystals of which have brownish edges. The other minerals identified are green biotite containing zircons surrounded by pleochroic halos, magnetite, and interstitial quartz.

At the centre of the map-area, a group of contiguous hills form a plateau shaped like a hammer with its handle pointing northeast. The western edge of the plateau is a low gabbro cliff. This gabbro is almost black, rusty in spots, and is composed of large hornblende crystals studded with white feldspars and with chloritic nodules containing grains of pyrite. The latter explain the rusty colour of some exposures. In a general way, the rock resembles the diabase of the four hillocks, described above, but in thin sections many differences appear. Bundles of amphibole fibres have completely replaced the original pyroxene crystals, whose outlines, however, are vaguely marked by strings of magnetite grains. The feldspar crystals are zoned and at their centres are much saussuritized. Optical measurements on clear grains indicate compositions ranging from andesine to calcic labradorite. The rock contains no quartz. Despite these differences, this altered gabbro has, lithologically, a closer resemblance to the diabase than to the rocks of the Bell River complex. Some structural observations cited on a following page also tend to relate the altered gabbro to the diabase.

Unconsolidated Sediments

Excepting the numerous swamps and muskegs, the unconsolidated deposits in the area consist for the most part of light brown, slightly arenaceous clay. Even in well exposed sections such as the steep banks of upper Allard river, the brown clay shows no bedding. It is remarkable that the varved clays so common in the adjacent regions are nowhere exposed in the Allard River map-area. It was observed at several greenstone exposures that the brown clay is separated from bed-rock by a thin layer of boulder clay. Prospectors working in the area might keep in mind that, where boulder clay appears at the surface, bed-rock is probably not far below. Most of the cascades and rapids in the streams of the area occur at gravelly or bouldery barriers which are remnants of water-washed ground moraines.

An interesting occurrence of boulder clay was observed along the north shore of Mattagami lake. A three-foot-thick layer of grey boulder clay is intercalated in varved clay, marking a temporary advance of the ice front over the clays deposited in a preglacial lake. Such an advance explains the crumpling, apparent slumping, and fracturing observed in varved clays by Auger (13) in the eastern part of Mattagami Lake area.

STRUCTURAL GEOLOGY

Folding

All strata and lava flows in the area strike nearly east-west and dip at angles of 75° to 90°. This suggests isoclinal folding about east-west axes. At the northern rapid of Gizzard river, pillows in a silicified lava have their tops northward. At the same latitude, along Allard river, grain gradation in greenstones indicates tops facing southward. The east-west line joining the two exposures would follow an anticlinal axis. Pillows facing southward occur in felsitic lava exposed near mile-post 16 of parallel 49°44'06". This exposure must belong to the north limb of a syncline complementary to the anticline just outlined. The two folds fit into the folding pattern described in the Opaoka River area to the east*. In the southern part of the area, the metasedimentary rocks face south.

Fractures

There are in the area two main systems of fractures, one striking northwest-southeast, the other northeast-southwest. They are reflected in the drainage pattern. The northwest-southeast system is represented by the strong shear zone which crosses Allard river half a mile below François creek. The zone is 300 feet wide at the river and dips vertically. Southwestward, it follows François creek and continues as far as Taibi lake. Northwestward, all the rocks exposed along its projected strike are sheared, and the zone must cross the western limit of the area. The overall width of the zone is 300 to 400 feet, but intense shearing has been localized along certain planes so that the zone is divided into several parallel sheared bands, the widest of which measures 30 feet. Between these bands the rocks are drag-folded but weakly laminated. All the exposed drag-folds have vertical axes and their attitudes indicate that the north walls of the slip planes have moved eastward with respect to the south walls. Drag plications are also common in the drill core from the St. Francis Mining Company claims. All the schists possess a b-lineation (Sander's notation), manifested by the alignment of spindle-shaped elements such as clastic detritus and pheno- or meta-crysts, or by fluting in the foliation planes. The b-lineation is everywhere parallel to the drag fold axes; this is particularly well displayed in the jaspilite layers. Jacques Béland, Laval University student, attempted to establish the strike and dip of bedding and schistosity in the six bore holes drilled by the St. François Mining

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*BLACK, J.M., The Bell River Igneous Complex; Doctorate thesis, McGill University, 1942.

Company. Using the core specimens and drilling plans provided by the Company, and assuming the b-lineation to be everywhere vertical, he found that bedding and schistosity strike nearly east-west in all the holes except Nos. 4 and 5 — the most easterly — where slight departures from the general strike were deduced. These departures are parallel to an inflection of the magnetic contours on a magnetometric map, also supplied by the Company. All small drag-folds in the core are parallel and indicate relative eastward movement of the north walls along the slip planes. The magnitude of this horizontal slip is not known but it cannot be great if the layer of jaspilite indicated by compass deviations four miles west of the drill holes represents the continuation of the main band of iron formation.

The schists are oxidized and leached at a vertical depth of 70 feet in hole 6, which suggests that meteoric waters travelled down the shear plane. The conductors indicated by the Bieler-Watson method and shown on the St. Francis Mining Company maps are perhaps nothing more than fissures along which surface waters circulate. In hole 5, the core is strongly laminated where a Bieler-Watson conductor is indicated.

Another shear zone, parallel to that just described but less extensive, is indicated in the centre of the map-area. At its western end, this zone is marked by the laminated, vertically dipping schists that flank the small outcrop of peridotite referred to on an earlier page. Its continuation is seen one mile farther southeast in a series of highly fissile greenstones exposed on the south side of Allard river and, beyond this again, in the schistose dyke that was drilled by the Dome Exploration Company.

At the head of the rapids of Gizzard river there is a third shear zone of unknown extent, parallel to the other two.

The northeast-southwest system of fractures finds its chief expression in the trend of the large diabase dyke in the northwestern corner of the map-area and in the joints which have determined to a large extent the course of Allard river and its tributaries in the northern part of the area. In the hammer-shaped mass of gabbro described on an earlier page, both the northwest-southeast and the northeast-southwest fracture directions are represented. The 'handle' part has a trend parallel to that of the large diabase dyke, and that is one reason why the gabbro is believed to be of the same age as the diabase, rather than related to the Bell River gabbro-anorthosite complex. It should be noted, however, that the hammer-like outline attributed to the outcrop of the gabbro mass is based solely on the topographic relief and is not even suggested by the few rock exposures observed.

ECONOMIC GEOLOGY

Mineralization

The diamond drilling completed to date has revealed no mineral deposit of economic size, but the possibilities of the area have not been exhausted.

The great shear zones are impregnated with carbonates and pyrite, and are criss-crossed by quartz veinlets. In some localities, indicated on the map, chalcopyrite and sphalerite occur, and assays of the mineralized rock have shown low tenors in precious metals.

In 1945, the St. Francis Mining Company, Limited, drilled six holes aggregating 2,122 feet near a sharp bend of Allard river, three and a half miles south of parallel 49°35'13". The Company reports that 15 per cent of the core was assayed and gave rather low returns for gold. The two best sections were found in two layers of pyroclastic rock crossed by gold-bearing veinlets. Some of the core specimens show quartz-carbonate veinlets one to two inches thick, containing crystals of brown sphalerite.

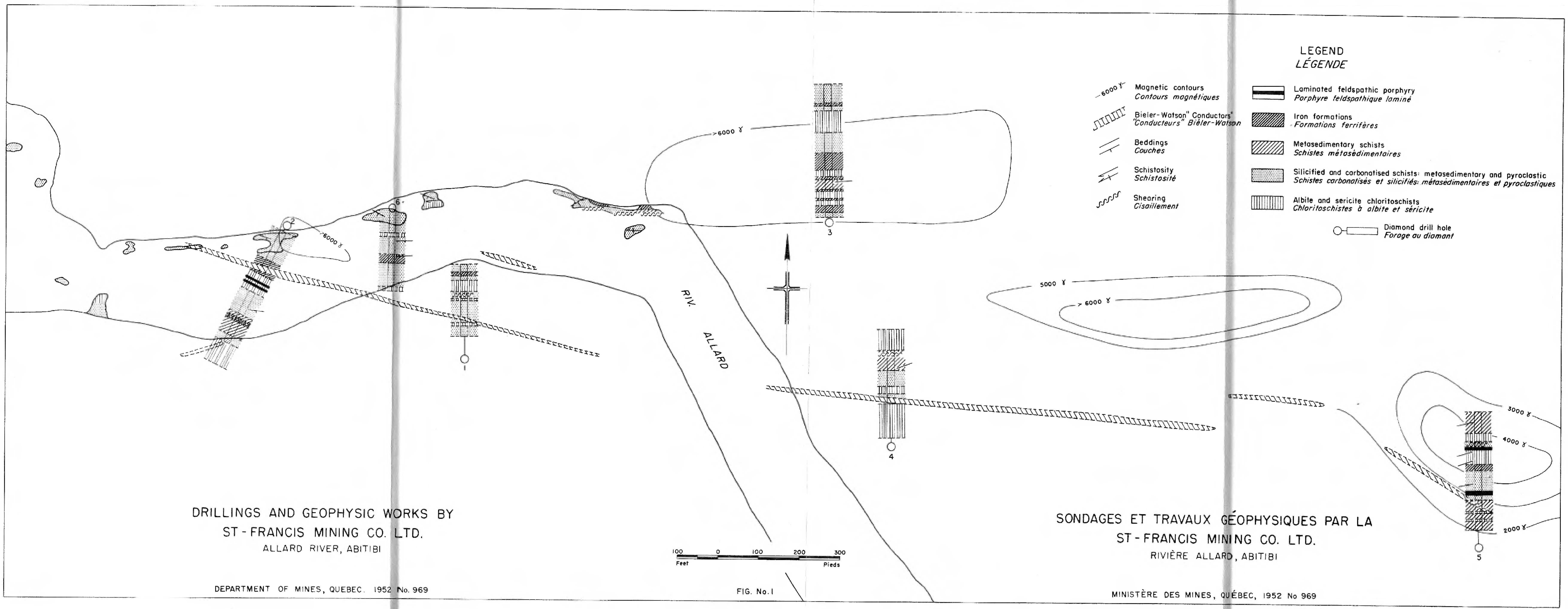
Tenors in gold are very erratic in the mineralized exposures examined in 1946 by the Dome Exploration Company (Quebec), Limited, on the bank of Allard river, four miles north of the St. Francis ground. Sections in two drill holes across a small albitite dyke gave low assays for gold.

The Dome Exploration Company explored another group of claims, six miles farther west. Six holes were drilled in schistose greenstones of volcanic origin and consisting chiefly of agglomerates and tuffs. Assay results show the presence of gold, copper, and zinc. The locality is structurally interesting: the schistosity, which strikes southwest, may represent a subsidiary 'break' connecting two main shear zones. It has been common experience in northern Ontario and Quebec that some of the richest deposits have been found along such subsidiary breaks rather than along the main fault zones.

The shear zone exposed at the rapids of Gizzard river is well mineralized. Interesting quartz-carbonate veinlets contain much pyrite and in places, as at the southernmost rapid, chalcopyrite. A chip sample taken over a length of three feet across the shear zone gave 'traces' of gold and silver.

Prospecting

The most promising mineralized exposures so far discovered



LEGEND
LÉGENDE
Magnetic contours
Contours magnétiques
"Bieler-Watson" Conductors"
"Conducteurs" Bieler-Watson
Beddings
Couches
Schistosity
Schistosité
Shearing
Cisaillement
Laminated feldspathic porphyry
Porphyre feldspathique laminé
Iron formations
Formations ferrifères
Metasedimentary schists
Schistes métasédimentaires
Silicified and carbonatised schists: metasedimentary and pyroclastic
Schistes carbonatisés et silicifiés: métasédimentaires et pyroclastiques
Albite and sericite chloritoschists
Chloritoschistes à albite et séricite
Diamond drill hole
Forage au diamant
6000 γ
5000 γ
4000 γ
3000 γ
2000 γ
RIV. ALLARD
1
2
3
4
5
6
100 0 100 200 300
Feet
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DRILLINGS AND GEOPHYSIC WORKS BY
ST-FRANCIS MINING CO. LTD.
ALLARD RIVER, ABITIBI
SONDAGES ET TRAVAUX GÉOPHYSIQUES PAR LA
ST-FRANCIS MINING CO. LTD.
RIVIÈRE ALLARD, ABITIBI
DEPARTMENT OF MINES, QUEBEC. 1952 No. 969
FIG. No. 1
MINISTÈRE DES MINES, QUÉBEC, 1952 No 969

have been explored, and it is unlikely that better, or even as good, ones will be found by the usual methods of prospecting. If ore deposits exist in the area, they are well hidden by overburden, and geophysical techniques must be employed to locate them. Because of the scarcity of rock exposures, a geological map prepared by the ordinary methods leaves much to be desired and a more complete map would probably be obtained if, in an area such as this one, the work that has been done were supplemented by geophysical investigation.

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