RP 576(A)

PRELIMINARY REPORT, GEOLOGY OF THE RIVIERE MALBAIE AREA

Documents complémentaires

Additional Files

Licence

License

Énergie et Ressources naturelles
Québec

GOUVERNEMENT DU QUÉBEC

DEPARTMENT OF NATURAL RESOURCES

Honorable PAUL-É. ALLARD, Minister

MINES BRANCH

GEOLOGICAL EXPLORATION SERVICE

Geology

of the

RIVIÈRE MALBAIE AREA

PRELIMINARY REPORT

by

Jehan Rondot

QUÉBEC

1969

P.R. 576

P. R. 576

GOUVERNEMENT DU QUÉBEC

DEPARTMENT OF NATURAL RESOURCES

Honorable PAUL - E. ALLARD, Minister

MINES BRANCH

GEOLOGICAL EXPLORATION SERVICE

Geology

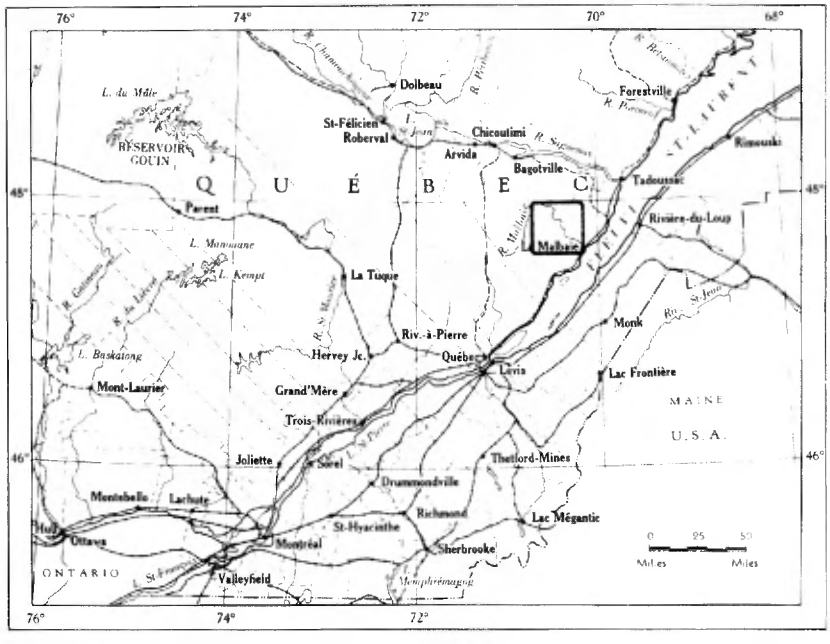
of the

RIVIÈRE MALBAIE AREA

PRELIMINARY REPORT

by

Jehan Rondot



QUÉBEC

1969

P. R. 576

Geology

of

MALBAIE RIVER AREA*

by

Jehan Rondot

INTRODUCTION

The northern and southern parts of the Malbaie River area were mapped at the end of the summer of 1965 and the central part was mapped at the end of the summer of 1966.

Located between longitudes 70°15' and 70°30', latitude 48°00' and the Saint-Laurent river, the area, including Ile aux Coudres, covers about 480 square miles. The southern half supports an agricultural population in several small villages. The town of Baie-Saint-Paul, about 60 miles from Quebec City, is located in the southwest corner of the area.

Highways 15 and 15A, and several secondary roads, provide a means of access to the southern part of the area. The northern part is served by a road which follows Malbaie river. Two fishing-club roads branch off to give access to Foulon lake and to Noir lake. The northeast part of the area is accessible by means of lumber roads which, to the east, join Highway 16 about 10 miles from Saint-Siméon and also lead to the village of Clermont on Malbaie river, one mile from the eastern boundary of the area.

*Translated from the French.

To the north the topography, with an elevation of more than 3,000 feet, represents the edge of a plateau. The terrain is sharply eroded, with deep gorges such as those formed by Malbaie river. The highest point in the area, near the old observation tower, has an elevation of 3,400 feet. Here, the local relief is 2,400 feet in a little more than half a mile.

The southern part of the area is a hummocky plain with an average elevation of 1,200 feet. It is dominated by Éboulements mountain, which rises to an elevation of 2,525 feet. The side of this mountain is precipitous, with a change in elevation from 1,200 feet to zero in one-half to one mile.

GENERAL GEOLOGY

Gneissic and granitic rocks, which are abundant in the La Malbaie area to the east, outcrop only on the south-east corner of the present map-area.

A unique type of migmatite is exposed in the gorge of Malbaie river and to the north of Sainte-Agnès (Nairn) lake. The migmatite contains garnet and, locally, sillimanite, as well as remnants of paragneiss.

Anorthosite outcrops along the western boundary of the area and between Baie-Saint-Paul and Éboulements mountain.

Rocks with a gabbroic appearance, in places porphyritic, represent a transitional phase to the rocks of the charnockitic series. The latter include most of the rocks exposed in the area. Of note are:-

1) Gneissic granodiorite, generally heterogeneous, with inclusions or schlieren of gneiss, particularly a pyroxenic amphibolite.

2) Elongate intrusive masses, coarse grained or porphyritic, which are rich in perthite.

3) A sub-circular granodiorite massif, crossed by Malbaie river.

4) Associated pegmatite and fine-grained dikes.

Rocks of the alaskitic type, in the form of pegmatites, aplites and injections, are present in minor amount and are limited to the vicinity of faults.

A small dike of "diabase" outcrops in the southern part of the area, between Misère and Saint-Joseph-de-la-Rive. Another is exposed to the southeast of Éboulements mountain.

Trenton Limestone (Ordovician) outcrops intermittently along the shore of the Saint-Laurent, as well as to the north and east of Sainte-Agnès lake and at the point where the Gouffre river leaves the area. Where the contact with the underlying Precambrian is exposed and not faulted, about 100 feet of clastic sedimentary rocks, mostly gray-green conglomerate and white quartzitic sandstone, are visible. Argillaceous and sandy rocks have been noted between Saint-Joseph-de-la-Rive and Cap-aux-Oies. They appear to be stratigraphically above, and therefore younger than, the Trenton.

The sedimentary rocks of Ile aux Coudres are related to those of the Appalachian region. The clastics in the northwest part of the island comprise siltstones, with rare arenaceous, shaly or calcareous intercalations. Rocks of the flysch type, made up of narrow bands of varying composition, outcrop to the southeast.

Glacial deposits cover about half of the area, but are most prevalent in the central and southern part, where recessional moraines of the last period of glaciation may be seen.

Evidence of marine encroachment is found in the terraces, abandoned shorelines and stratified clay deposits of the area. Worthy of mention are the clay deposits at Éboulements, where several landslides have occurred.

The tectonics of the area are of considerable interest owing to the fracturing in the south-central part, where "shatter cones" as well as linear fractures may be seen (Shatter cones: particular type of conical fracturing observed only in 17 other places in the world).

Table of Formations

CENOZOIC	Marine and Fluvial Deposits Glacial Deposits	Sand, stratified clay and re-worked material Moraines, eskers and unsorted material
PALEOZOIC	Appalachian-type Rocks	Clastic sedimentaries of Ile aux Coudres; siltstone, flysch
	Rocks of the St. Lawrence Lowlands	Shale and calcareous shale, with beds of sandstone and limestone conglomerate; dark argillaceous and bituminous limestone; light-colored arenaceous or nodular limestone (Trenton)
		Clastic sedimentaries; gray-green conglomerate and white quartzite
PRECAMBRIAN	Basic Dikes	"Diabase"
	Alaskite	Pegmatite, aplite and injected material along faults
	Pegmatites	White biotite pegmatite; radioactive pegmatite
	Granite	Gray Cap-aux-Oies granite
	Charnockitic Series	Green-feldspar pegmatite; fine- to medium-grained dikes Rivière Malbaie granodiorite massif Coarse-grained or granulated syenite and monzonite Coarse-grained quartz monzonite and charnockite Granulated garnetiferous charnockite Gneissic granodiorite, green feldspar migmatites and contact rocks
	Anorthosite-Gabbro Series	Gabbroic rocks bordering the anorthosite Saint-Urbain anorthosite
	Migmatites	Pink garnetiferous migmatites; injected gneiss near the granites
	Gneissic Series	Garnet-sillimanite-cordierite gneiss Fine-grained gneiss (leptynite) (quartzite) or (biotite) Quartzite and impure quartzite Amphibolite and hornblende gneiss

GNEISSIC SERIES

The paragneiss in the extreme southeast corner of the area are similar to those mapped to the east (Rondot, 1966), except that they include a greater proportion of hornblende gneiss and amphibolite. Well-defined zones of injected gneiss have also been noted. These migmatites, either biotite- or hornblende-rich, depending on the composition of the original rock, are in the westward extension of the Cap-aux-Oies granite.

A few bands of paragneiss remain identifiable within the charnockitic rocks in the vicinity of a major zone of pink garnetiferous migmatite, a rock type not recognized in the area to the east.

Amphibolite and hornblende gneiss

Bands of amphibolite and hornblende gneiss outcrop between the village of Éboulements and Jureux creek. These rocks are massive and medium grained. Where they appear within the zone of charnockitic rocks, they contain a certain amount of pyroxene in addition to the usual plagioclase and hornblende.

Quartzite and impure quartzite

A few beds of quartzite and impure quartzite, 50 to 100 feet thick, have been mapped in the southeast part of the area, as well as to the northeast of Long lake and around Pied-des-Monts lake. This rock-type is confined to rare, thin lenses elsewhere.

Fine-grained gneiss (leptynite)

Light gray, fine-grained gneisses, which are so abundant to the east, have been observed only between Moulin and Cap-aux-Oies creeks. They are made up almost entirely of quartz and feldspar.

Garnet-sillimanite-cordierite gneiss

Although sillimanite gneiss is rare in the southeast part of the area, being apparently confined to a 10-foot-wide band, it is well represented between Pied-des-Monts lake and Tonnerre lake. The band which outcrops to the north of Pied-des-Monts lake contains, in addition to garnet, biotite and sillimanite, some cordierite and green spinel.

Migmatites

The migmatites in the southeast part of the area are mainly of the lit-par-lit type. They are made up of lenses of more or less continuous bands rich in ferromagnesian minerals, such as biotite or hornblende, in a matrix of quartz and white feldspar, characteristic of the Cap-aux-Oies granite.

The pink garnetiferous migmatites, observed along the deep cuts formed by the Malbaie river, underlie several square miles between Louison lake and the western boundary of the area. Lenses of this rock, 1/2 to 1 mile long, have been noted to the north, and continuous bands, up to at least half a mile in width, have been mapped to the south, as far as Marais creek.

Anorthosite

The anorthosite which outcrops in places in the Gouffre river, is part of the Saint-Urbain massif. Other anorthositic bodies occur between Cap-au-Corbeau and Éboulements mountain.

The anorthosite is pink, very coarse grained, with feldspars up to 10 cm. long, or semi-granulated in the northern part of the area. It is pink and granulated to semi-granulated farther to the south, and white, granulated and altered elsewhere, particularly at Éboulements mountain. The proportion of ferromagnesian minerals is very low to the west, and slightly higher to the south, varying from 1 to 10%.

To the west, gabbroic rocks separate the anorthosite from the typical charnockites. The contact appears to be sinuous, but is visible in only a few places. To the south, the anorthosite facies is present as irregular inclusions in the charnockitic rocks.

Gabbro and rocks bordering the anorthosite

Between Cap-au-Corbeau, La Terrière lake and Nice lake, in the western part of the area, small bodies of plagioclase-rich rock containing a high percentage of ferromagnesian minerals appear. Varying from less than 100 feet to more than half a mile in width, they are particularly abundant near the Saint-Urbain anorthosite massif. These dioritic-gabbroic rocks contain partly assimilated inclusions of anorthosite in places, especially south of Mine lake.

CHARNOCKITIC SERIES

Gneissic granodiorite, green feldspar migmatite and contact rocks

Gneissic granodiorites and green feldspar migmatites are the most abundant rocks in the area.

They are olive green, equigranular, and fine to medium grained. Some have a well-marked foliation outlining beds or lenses of dark pyroxene-hornblende rock or alternating bands of quartz and feldspar. The more heterogeneous facies contain irregular, but generally elongate, inclusions of pyroxenic amphibolite and, more rarely, paragneiss, quartzite and sillimanite gneiss.

In several places, particularly near the contact with the older rocks, there is a fine-grained, homogeneous facies. It contains a higher proportion of ferromagnesian minerals than the rocks of the other facies.

Syenite, monzonite, charnockite

The coarser grained rocks are found as massifs which are concordant with the foliation of the surrounding rocks. They are characterized by their coarse grain, with feldspars commonly 1 cm. in diameter, and by their homogeneity. Locally, where granulation has reduced the grain size and produced some alteration of the minerals, these rocks contain a fairly high percentage of perthite. Inclusions of medium-

grained heterogeneous charnockite are common in the rocks, and their boundaries are difficult to trace accurately.

A distinctive type of charnockite outcrops in the southern part of the area, two miles north of Sainte-Agnès lake. The grain size is fairly fine, averaging 1 mm., and the rock is light olive green on the fresh surface, altering to a characteristic brown color where weathered. It contains 5 to 10% garnet.

Rivière Malbaie granodiorite

The granodioritic massif in the northern part of the area has a sub-circular or, more precisely, a heart-shaped form, with an average diameter of eight miles. It is clearly defined on the aeromagnetic maps of the region.

The rock is massive and homogeneous, medium to coarse grained and partly granulated. It generally contains 10 to 20% mafic minerals, with gray-green plagioclase, gray quartz and a few phenocrysts of well-twinned, dark plagioclase up to 5 to 10 cm. in length. The southeast quarter of the massif includes a medium-grained facies with a higher content, roughly 20 to 30%, of mafic minerals. The contact of the massif with the enclosing rocks is sharp, but devoid of any fine-grained facies.

Associated dike rocks

Although there are no major dike systems accompanying the charnockitic rocks, mention should be made of a few green-feldspar pegmatites in the southern part of the area as well as rare dikelets, a few centimetres wide, of fine-grained charnockitic material.

Cap-aux-Oies Granite

The Cap-aux-Oies granite of the adjacent La Malbaie area extends for about a mile into the present map-area, south of the village of Éboulements-Est.

It is a typically gray, medium-grained and generally foliated rock, containing quartz, microcline, oligoclase,

biotite, minor garnet, and accessory and alteration minerals. The contact with the enclosing rocks is not too sharp, even with the amphibolites, which are, however, crudely assimilated within the granite.

The small bodies of migmatite to the north and to the west are almost certainly related to the emplacement of the granite, as their injected material is similar to the granite in appearance and composition.

Pegmatites

White pegmatites are quite common in the zone of gneissic rocks between the village of Éboulements and Éboulements-Est. Their composition is essentially the same as that of the previously described granite, except for the absence of garnet and the presence of muscovite.

Alaskites

Exposures of alaskite-type rocks are essentially confined to the major fault zones. They have been noted in the northeast corner of the area, along and in the gorges of the Malbaie river, and in the southern part of the area.

These alaskites appear as pegmatites, aplites, lit-par-lit injections and more or less complete impregnations of the pre-existing rocks. Their grain size is extremely variable, even in thin dikelets. They are composed mainly of quartz and potash feldspar, and cut all of the rocks previously described.

Diabase

A dike of "diabase", a few centimetres wide, trends north-northeast and cuts the alaskitic rocks between Misère and Saint-Joseph-de-la-Rive. The rock is dark gray, fine grained and fractured. It contains laths of calcic plagioclase, a few tenths of millimetres long, in a groundmass of ferro-magnesian minerals such as pyroxene, serpentine and magnetite.

Another dike, a mile southeast of Éboulements mountain, shows similar characteristics. It is coarser grained (1.5 mm.), and of unknown width.

Carbonate-bearing Veins and Veinlets

At Corbeau cape, as well as on the south shore of Baie-Saint-Paul, several veins and veinlets of white calcite and green fluorite have been observed in the continuous exposure which forms the shoreline. Of variable thickness, some are up to 50 cm. across. They have been emplaced within fault breccias.

A veinlet of calcite containing black anthraxolite has been observed in the northern part of Ile aux Coudres.

ROCKS OF THE ST. LAWRENCE LOWLANDS

The clastic sedimentary rocks and limestone overlying the Precambrian are related to the formations of the St. Lawrence Lowlands, and are therefore early Paleozoic in age.

White sandstone and gray-green conglomerate

As in the area to the east, from Saint-Irénée, and as far as Baie-Saint-Paul, clastic sedimentary rocks separate the Trenton Limestone from the Precambrian. Farther to the north in the area, however, the limestone lies directly above Precambrian rocks.

The clastic sedimentary rocks vary from 200 to 300 feet thick. They make their first appearance in the eastern part of the area, where a bed of very pure quartzose, white sandstone is followed by a conglomerate made up of pebbles of quartz and feldspar that may be more than a centimetre in diameter. To the west is a coarse impure sandstone in which individual grains range up to 1 cm. across, but are usually much smaller.

Light-colored arenaceous or nodular limestone

The transition from clastic sedimentaries to Trenton (Ordovician) Limestone is difficult to trace because of a lack of outcrop. The latter rock begins as beds of nodular limestone, 10 to 15 cm. thick, separated by shaly partings.

A clear gray to yellow arenaceous limestone has been mapped near the point where the Gouffre river leaves the area. This highly fossiliferous rock overlies the anorthosite and contains beds of nodular limestone.

Dark argillaceous and bituminous limestone

Dark argillaceous and bituminous limestone outcrops in several places on the coast, as well as along Highway 15A, to the east of Sainte-Marie lake and in three places to the north and west of Sainte-Agnès lake. It is almost everywhere fossiliferous, and there is no marked change in lithology throughout its thickness of about 1,500 feet. Between Saint-Joseph-de-la-Rive and the eastern boundary of the area, however, shales become more evident and alternate with narrow bands of argillaceous limestone.

It is this horizon, with a thickness of about 150 feet, that marks the base of the overlying sequence.

Dark gray shaly-sandy sequence

Above the interlayered limestone and shale is a shaly-sandy sequence, from 200 to 300 feet thick, made up of shaly, silty and sandy beds and, near the base, fossiliferous conglomerate. The sandy rocks consist essentially of rounded quartz grains, 1 mm. in diameter, and siltstone fragments in a cement of clay-carbonate siltstone. It is in this horizon that John Riva* described Climacograptus spiniferus Ruedemann. Several hundred feet of dark gray shale, lying stratigraphically above this shaly-sandy sequence, occur near Éboulements bay.

*Personal communication

Clastic Sedimentaries of Ile aux Coudres

Two sequences of Appalachian-type clastic rocks are represented on Ile aux Coudres: one, to the northwest, is mainly siltstone; another, to the southeast, is made up of rocks of the flysch type.

The best exposures are along the shoreline where the rocks are easily visible. The dips are generally to the southeast, but small anticlinal and synclinal folds have been observed, particularly near the contact between the two sequences, a contact which appears to be a thrust fault.

No fossils were found in these rocks, and their age could not be determined.

Siltstone sequence

The sequence of silty rocks is quite resistant to erosion and underlies the highest parts of Ile aux Coudres, slightly over 300 feet in elevation, as well as the east and west extremities of the island.

From dips and top determinations in some of the beds, this 2,000- to 3,000-foot sequence first appears at Roche Point in the form of red and, farther on, green argillite, accompanied by siltstone and a few beds of glauconitic sandstone. Higher up, the sequence is made up almost entirely of gray-green siltstone, the color being apparently due to the presence of glauconite. A few rare calcareous or arenaceous beds, from a few inches to a few feet thick, have been observed. A 7-foot-thick bed of sandstone, quite glauconitic toward the top, outcrops along the road around the island, a mile and a half east of Saint-Bernard-sur-Mer.

Flysch sequence

Rocks of the flysch type outcrop on the south and southeast shore of Ile aux Coudres. They have been eroded down to sealevel, with the exception of a narrow band which rises about 50 feet above the shore from Roche Pleureuse to Baleine cape.

This sequence, a few thousand feet thick, is made up of 10- to 20-cm.-thick beds of various sedimentary rocks, including shale, siltstone and several types of impure sandstone. They are generally gray, with in places a greenish or reddish tint. Slip folds, noted in some of the beds, give evidence of an initial easterly dip. A 1-metre-thick bed of limestone conglomerate, containing microfossils, outcrops for almost two miles along the shore from Simon point. Toward the top of the sequence, beds of conglomeratic sandstone, up to 100 feet thick and half a mile long, have been mapped east of the village of Saint-Louis-de-l'Ile-aux-Coudres and La Baleine.

Glacial Deposits

Glacial deposits are abundant in the southern half of the area and in the wide valleys of the northern part. In all, they cover about half the area, and give considerable evidence of the last period of glaciation.

Glacial striations

Glacial striations are visible in only a few localities because of overburden and weathering. The striations in the northern part of the area indicate a southeast direction of glacial advance in the valleys of Noir lake and Foulon lake. On the hill north of Milieu-des-Brûlés lake, the striations are oriented south-southwest, whereas north of Sainte-Marie lake they again trend southeast. At Saint-Hilarion, glacial advance was toward the east, as indicated by the striations to the south of the village and by boulder trains which extend for more than half a mile in the lee of two rounded rock hills a mile west of Bois Verts lake. Farther to the south, glacial striations indicate a south-southeast direction of glaciation.

U-shaped valleys

Some valleys have the typical U-shape of glacial troughs. In general, these are the northwest-southeast-trending valleys, such as the upper valley of the Malbaie river, the valleys of lakes Noir, Deuxième des Marais, Tonnerre and Pied-des-Monts, and the upper part of the Gouffre River valley.

Eskers

An esker with a general north-south trend winds its way for more than 10 miles between Panses lake and Marais creek. In places, two crest lines have been noted. This esker lies on a hillside in an area of abundant glacial deposits.

Another esker, trending east-southeast, can be seen to the north of Brûlés lake and in a few other places as far as the Manicouagan power line.

Moraines

Numerous recessional moraines of the last period of glaciation can be seen between Eboulements mountain and Pied-des-Monts lake. Some are well marked, but others have been reduced to a simple hummock a few feet in height and could represent annual features. The most important of the moraines lies to the north of Sainte-Agnès lake. The glacial material is continuous over a length of seven miles, except where it is crossed by the Malbaie river. Here, no glacial deposits have been observed below an elevation of 500 feet, that is the maximum level of marine encroachments in the area.

Marine and Fluvial Deposits

Stratified clay

Well-exposed cuts of stratified clay are found along the lower course of the Snigole river and at certain places along the Malbaie river. Clay deposits can also be seen east of Sainte-Marie lake, along Highway 15A. Along the coast, between Corbeau cape and Oies cape, and along the shore of Prairie bay on Ile aux Coudres, the stratified clay deposits are less extensive and cling to the sides of the escarpment. An exception is at Eboulements, where a bay, protected on the seaward side by Martin cape, has retained large quantities of clay.

Landslides

Several landslides have occurred in the vicinity of Éboulements, of which four were relatively large. The two main ones combined to shift the clay for more than half a mile into the river, thus forming Saint-Joseph cape. Another landslide occurred at Éboulements-Centre (Station). It is 2,000 feet long and has a typically regular form, with a sharp semi-circular scarp and a hummocky lower portion which is only slightly eroded.

Terraces and abandoned shorelines

With the exception of a terrace at an elevation of more than 700 feet in the northern part of the area, the highest terraces, which are also the most abundant, are found at elevations of about 560 feet. Ile aux Coudres was entirely covered by the Champlain Sea, and periods of stability during its submergence are marked by abandoned shorelines, particularly at elevations of approximately 220, 110, 80 and 50 feet.

Fossils

Two marine fossil locations are shown on the accompanying map. There are probably many more.

TECTONICS

Structure

The gneisses and granitic rocks in the southeast corner of the area have a northeasterly trend. Dips are variable, folds are numerous and a westerly direction of lineation has been noted. The contact with the charnockites also has a northeast trend, as do the various charnockitic bands themselves, changing to north-northeast near the village of Rochette.

The structure of the formations in the central and southwest part of the area is more complex, and is made even more difficult to define by a scarcity of outcrop.

In the northern part of the area, the gneissic charnockitic rocks and the conformable intrusive bodies form an irregular dome, elongated southeast and centered approximately one mile south of Bazile lake.

The emplacement of the Rivière Malbaie granodiorite massif was accompanied by folding of the enclosing formations, particularly the pink garnetiferous migmatites. These rocks are folded into anticlines and synclines to the northwest and southwest of the massif, but are only pushed back and lie parallel to the borders of the massif to the northeast and southwest.

Faults and joints

Faults and joint systems are abundant in the area. The best known are those to the north, where the overburden is less extensive. The most important have a north-northeast direction and extend well beyond the map-area. Rapid local erosion has occurred along these fracture zones and has resulted in the formation of deep gorge-like valleys, such as those of the Malbaie river and another farther to the east. A second system of faults and joints, apparently more recent, has a northeast direction, and still another trends east-west. Numerous northeast-trending faults have been mapped in the southern part of the area. In places, they form the contact between the Precambrian rocks and the Paleozoic formations.

The faults and joints which radiate from the northeastern part of the Rivière Malbaie granodiorite massif could be due to the overturning which affected the southern part of the map-area, with the massif acting as an immovable and rigid body.

Semi-circular "Charlevoix" Structure

The rocks of the southern part of the area, as well as those of adjacent areas to the east and to the west, have been subjected to a particular type of fracturing. It was not only local (breccia, pseudotachylite), but affected the whole rock assemblage of the area, either following straight

surfaces (in anorthosite) or a curving pattern ("shatter cones" in the charnockitic rocks and limestones).

Topographic appearance

This zone forms a semi-circular depression, with an average elevation of 1,200 feet, centered around Éboulements mountain, which has an elevation of more than 2,500 feet.

To be more specific, several circular or semi-circular zones, corresponding to topographic lows or highs, can be distinguished. The first, at Éboulements mountain, has a radius of $1\frac{1}{2}$ to 2 miles. It is the zone which shows the most alteration. The second, with a radius of about six miles, roughly follows the shoreline between Éboulements-Centre (Station) and Saint-Irénée to the east. The third, a semi-circular graben type of depression, includes the lower part of the Gouffre River valley, Brochet, Sainte-Agnès and Sainte-Marie lakes, and the lower Malbaie River valley. The outer boundary of the basin, 16 miles in diameter, describes a half circle, which lies largely outside the limits of the area.

Alteration

The rocks which are the most altered mineralogically are those of the Éboulements Mountain massif. The alaskites are cream-colored, and contain milky white quartz. The charnockitic rocks are highly fractured, but have retained their primary foliation. The feldspars are opaque, and show a weak but very distinctive anisotropism. Crystal segments that are alternately clear and extinguished in polarized light form curved outlines which are independent of the twinning or other crystallographic direction. The quartz and feldspars are, in places, partially isotropic. The feldspars are the most highly altered, particularly the plagioclase of the anorthosite. Small dikelets of pseudotachylite regularly cut all of these rocks.

Recrystallization

In some of the altered rocks, recrystallization has occurred in the interstices between the early grains. This recrystallization has not gone beyond the cryptocrystalline

stage for quartz and feldspar. Nevertheless, there are several occurrences of zeolites (probably prehnite), either as whitish or greenish growths or as crystals formed at the expense of plagioclase in a hornblende-bearing rock.

Lamellar deformation in quartz

The quartzose rocks near Éboulements mountain, both the recrystallized and sedimentary varieties, contain quartz which displays a unique type of deformation. Here, the deformation planes and cleavages have, within the same crystal, more than five different directions, in places accentuated by very fine included material. The number of deformation planes decreases rapidly with increasing distance from Éboulements mountain, although some have been noted locally quite far away from the massif.

Breccias, pseudotachylites

Breccias are abundant throughout the structure, but are best exposed along the coast where they outcrop continuously. They are from a few millimetres to several metres thick, and are generally made up of rock fragments or crystals of all sizes in a gray or greenish cement.

Pseudotachylitic dikelets are abundant on Éboulements mountain, but are also found at a fair distance from the summit. Their contacts with the enclosing rocks are sharp, even under the microscope. The rock appears to be aphanitic, but is actually made up of very small fragments of crystals, mostly about a micron in diameter, in a dark, isotropic matrix.

Impactite

The term "impactite" is used here to designate a particular rock that crops out 6 miles west of Monts Éboulements. This rock is black and very hard, and fractures angularly. Its weathered surface is pale owing to a thin layer of alteration.

It is composed of two minerals or groups of minerals. One consists of very thin plates up to 1 cm. long (probably pigeonite); the other forms an almost amorphous mass (quartz, feldspars?).

"Shatter Cones"

The term "shatter cone" designates a highly fractured rock, with the fractures forming curved, fan-shaped, intersecting surfaces which have no preferential direction. These fractures are characterized by highly irregular, curved, sub-parallel or branching striations. In places, particularly in the limestones, one or several of the fracture surfaces form the outline of a cone.

These structures can be seen 3/4 mile south-southeast of Saint-Hilarion, on the road between Sainte-Marie-de-Charlevoix and Rochette, and in the limestones along the coast.

Other types of fracture

Farther away from Éboulements mountain, and right to the base of the outer hills at the edge of the depression, another type of fracture pattern can be seen. It affects almost all of the rocks, even outside the fault zones, but is most prominent in the anorthosite. The fractures are straight and cut both the crystalline and granular anorthosite in all directions. There was practically no movement along these fractures, but a thin coating of greenish material has been observed in places. The rock breaks easily into sharp-angled fragments.

Conclusion

Most of the fracture patterns or alteration phenomena described above are typically known to be the result of an explosive force. A volcanic origin is suggested by the location of the fracture zone near the major faults which follow the north shore of the Saint-Laurent and by the fact that this area is one of the most earthquake-prone in the Province. However, the absence of volcanic rocks and fumarolic alteration lead away from a volcanic origin and point to a meteoritic origin for this fracture zone. The central height of land which makes up Éboulements mountain could be the result of uplift after impact, and the presence of limestone on the plateau before impact would date this activity as post-Ordovician.

MINERALIZATION

Sulfides

Traces of copper, molybdenum and zinc mineralization have been noted within the area. About 3/4 mile south of Éboulements-Est, and along the coast between Chaud creek and Diable cape, specks of molybdenite, chalcopyrite and light brown sphalerite are very sparsely disseminated in a quartz gangue, the quartzose material being in the form of irregular masses rather than well-defined veins. This mineralization occurs near the major northeast-trending faults of the area.

Small accumulations of massive sulfides, mainly pyrite and pyrrhotite, have been observed in the central part of the area. Rusty-weathering anorthosite, containing a small amount of sulfide, has been mined along Highway 15A to the south of Mine lake.

Graphite

Half a mile south of Bazile lake, specks of graphite, one to two millimetres across, appear in a coarse-grained charnockitic rock made up mainly of mesoperthite, augite and stilpnomelane. Graphite has also been observed in fault breccias and in some of the gneissic rocks, particularly at Éboulements-Est.

Ilmenite

No important concentrations of ilmenite were noted in the Saint-Urbain anorthosite which outcrops in the area, although this mineral is prominent among the mafic constituents of the rock.

Radioactive pegmatites

The white pegmatites which outcrop in the south-eastern part of the area are, for the most part, slightly radioactive, but no major concentration of dark minerals has been noted.

Mine workings at Pied-des-Monts lake

A small-scale mining venture was undertaken in 1939 on the eastern peninsula of Pied-des-Monts lake. Although the buildings are now in ruins, a chimney still stands to mark the spot. Here, and for half a mile to the east, following the river, several pits and stripped areas have been noted over a pink pegmatite, of variable width, which cuts the amphibolite and gneisses. Plates of biotite and muscovite mica, several inches in diameter, have been found, and the pegmatite also contains, locally, small amounts of uraninite and beryl. Some consideration was also given to the production of potash feldspar.

Fluorite

Veins and veinlets of calcite and fluorite can be seen on the coast and along the railroad cut, particularly at Corbeau cape and south of Baie-Saint-Paul. They range from a few millimetres to more than 50 centimetres thick, and have been emplaced in fault breccias. The green, or rarely violet-colored, fluorite is later than the calcite and contains a small amount of undetermined mineral matter. It makes up only about 10%, by volume, of the veins.

Peat

A peat-bog, which extends for more than a square mile, is now being worked on Ile aux Coudres. A mill processes the peat, which is then loaded into trucks for shipment.

Limestone

Limestone outcrops at Baie-Saint-Paul and at Éboulements. The natural jointing of the rock at the latter locality would make it particularly amenable to quarrying for use as fill.

Gravel

Many gravel companies make use of the morainic material as fill.

Geochemistry

A total of 628 samples of stream sediments, taken at regular intervals throughout the area in 1965 and 1966, were analysed in the field and in the laboratory of the Quebec Department of Natural Resources.

The "parts-per-million" content of metallics was twice as high in the northern part of the area as in the southern part. Most of the lead values came from the outlets of lakes and represent a contamination due to hunting and fishing activity, and most of the anomalous zinc values were obtained from a stream which ran alongside the new power transmission line. Other anomalous values are few and far between.

Unexplained, however, are a few high molybdenum values obtained along the major faults, such as those of the Malbaie River valley, and small concentrations of copper, lead and zinc at the outlet of Scott lake, on the northwest border of the granodiorite massif and south of Panses lake. The anomalous values obtained along Highway 15A, between Éboulements and Bouchard, could be due to contamination.

BIBLIOGRAPHY

MAWDSLEY, J.B. - 1927 - St-Urbain Area, Charlevoix District, Quebec; Memoir 152, Geological Survey of Canada.

RONDOT, Jehan - 1966 - Geology of La Malbaie Area (Preliminary Report); Quebec Dept. of Natural Resources, P.R. No. 544.

RONDOT, Jehan - 1967 - Geology of l'Anse Saint-Jean Area (Preliminary Report); Quebec Dept. of Natural Resources, P.R. No.556.

Results of analyses in p.p.m

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
1	7050	12	80	6	0	8	6		
2	7051	8	85	8	0	8	0.5		
3	7049	14	35	12	0	5	6		
4	7004	6	45	16	0	10	-		
5	7003	6	30	4	0	8	10		
6	7002	4	20	20	0	13	3		
7	7001	4	15	4	0	25	2		
8	8003	12	75	10	3	13	0.5		
9	8002	14	90	24	2	25	2		
10	8001	8	55	8	0	8	3		
11	6005	8	20	10	0	13	4		
12	6006	4	10	6	0	5	1		
13	7012	6	20	24	0	8	1		
14	7011	8	30	6	0	13	1		
15	6042	8	55	16	2	18	6		
16	7005	6	10	20	0	8	1		
17	6001	4	65	24	0	8	2		
18	6004	6	65	14	0	13	2		
19	6007	12	115	20	0	13	2		
20	7010	6	30	20	1	10	1		
21	6043	12	90	8	2	23	6		
22	6041	10	15	14	0	8	1		
23	6002	6	60	20	1	-	2		
24	8008	10	35	22	1	5	2		
25	8004	6	35	20	4	13	0		
26	7007	8	10	6	0	8	2		
27	7009	8	35	8	0	8	4		
28	7048	22	440	60	0	18	6		
29	6039	20	65	14	10	15	10		
30	6040	12	45	10	1	13	1		
31	6038	12	40	18	4	8	12		
32	0187	10	85	14	3	8	0.5		
33	6003	10	30	14	0	8	2		
34	8007	8	25	26	2	8	1		
35	8005	8	90	34	4	15	2		
36	8006	6	125	60	1	10	2		
37	7008	10	30	36	0	8	-		
38	8009	12	70	8	4	5	1		
39	8051	32	110	24	0	35	8		
40	0188	22	115	22	0	18	0.5		
41	0189	26	80	10	0	45	2		

Results of analyses in p.p.m.

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
42	7038	14	35	56	0	10	-		
43	0176	12	15	6	0	8	0.5		
44	7019	10	15	10	0	8	1		
45	8010	10	35	10	10	8	1		
46	8011	6	30	22	1	8	1		
47	8050	22	10	16	1	8	6		
48	0190	12	85	12	0	25	1		
49	6030	6	35	8	1	3	1		
50	7037	16	30	20	0	10	0.5		
51	6029	26	85	6	20	20	1		
52	0175	10	10	10	0	8	1		
53	0177	12	35	18	0	8	4		
54	0178	8	15	8	2	5	1		
55	6028	24	80	24	1	20	0.5		
56	6031	8	30	10	4	8	1		
57	7040	12	20	16	0	8	6		
58	0174	10	10	6	0	3	1		
59	0179	8	10	6	1	8	2		
60	6011	6	70	34	0	10	4		
61	8016	34	90	4	1	30	20		
62	7020	6	110	6	1	13	8		
63	8049	16	50	56	2	13	8		
64	0191	12	70	16	10	13	0.5		
65	6032	34	70	22	12	13	4		
66	6027	12	40	20	3	10	0		
67	0180	6	10	4	0	20	0		
68	0181	10	15	8	0	25	1		
69	7016	10	20	4	1	8	2		
70	8019	12	80	20	4	10	1		
71	8017	4	10	16	1	8	0.5		
72	7021	12	50	20	1	10	4		
73	7022	8	20	8	0	8	0		
74	6045	10	10	12	1	8	2		
75	8035	14	35	12	1	3	10		
76	6033	16	85	14	1	10	8		
77	8034	16	40	16	0	8	8		
78	0173	6	10	6	1	8	1		
79	0182	10	65	16	2	13	4		
80	7015	-	-	-	2	25	-		
81	7014	14	125	36	1	10	4		
82	7013	12	40	8	0	13	2		

Results of analyses in p.p.m

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
83	8018	8	60	10	3	10	1		
84	7039	6	15	6	0	3	0		
85	6046	12	15	28	3	10	4		
86	0194	6	10	8	0	8	-		
87	7042	12	40	16	0	13	4		
88	7043	10	75	4	0	13	8		
89	7041	12	80	24	0	20	8		
90	7044	16	150	24	0	13	4		
91	7018	12	90	8	0	8	3		
92	8020	10	55	16	3	8	0.5		
93	7046	8	35	10	0	5	4		
94	6010	16	50	16	0	45	10		
95	7017	14	150	22	1	13	4		
97	7045	12	115	8	0	8	2		
98	6034	10	60	16	1	10	6		
99	6035	22	360	40	1	10	4		
100	0195	8	40	18	0	13	2		
101	6036	26	1500	30	10	8	2		
102	7047	10	50	12	0	13	6		
103	0161	12	40	14	1	8	0.5		
104	0162	14	85	14	0	8	0.5		
105	0163	14	125	16	1	18	0.5		
106	6009	10	140	26	1	13	3		
107	6057	20	105	46	0	13	0		
108	6058	26	360	56	1	53	3		
109	8012	8	100	26	4	13	2		
110	0160	12	35	10	4	10	0.5		
111	0159	10	140	24	4	13	1		
112	0158	10	20	16	3	-	0.5		
113	6037	24	320	36	3	20	16		
114	0192	10	65	6	0	18	0.5		
115	8044	10	40	16	15	5	8		
116	8045	12	40	14	3	8	2		
117	8046	8	30	8	2	8	4		
118	8047	12	60	14	1	8	1		
119	8037	14	65	14	0	8	0		
120	8032	8	35	8	1	5	8		
121	0166	10	90	10	0	10	0.5		
122	0165	6	30	12	0	8	0.5		
123	8015	10	100	20	3	18	4		
124	8014	10	150	22	10	13	2		

Results of analyses in p.p.m.

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
125	8013	12	110	24	4	13	2		
126	6059	22	85	18	2	8	4		
127	8059	14	75	16	0	10	1		
128	6060	16	100	16	2	8	3		
129	8057	14	45	10	0	5	2		
130	8058	12	40	14	0	8	2		
131	0214	12	75	4	0	10	6		
132	8027	14	65	14	0	8	-		
133	8025	10	55	6	1	8	2		
134	8026	12	30	4	0	5	1		
135	8024	8	90	6	0	8	6		
136	6050	12	40	6	1	8	1		
137	8022	12	60	6	0	8	6		
138	8023	10	400	10	0	5	8		
139	8021	12	70	4	0	5	4		
140	8033	8	25	20	0	8	6		
141	8033	14	10	6	0	5	2		
142	8031	8	15	4	0	3	3		
143	8043	20	55	24	3	5	0.5		
144	8038	6	10	8	0	5	0		
145	8039	12	30	14	2	8	0		
146	8040	12	20	16	0	8	1		
147	8041	8	35	24	2	8	1		
148	8042	10	45	14	0	5	0.5		
149	8048	10	40	12	0	8	1		
150	0172	8	45	4	0	10	0.5		
151	0171	12	60	26	0	10	1		
152	0167	10	10	6	0	8	0.5		
153	0186	8	25	6	1	8	0		
154	0185	6	30	8	2	8	0.5		
155	0184	8	15	4	1	8	0		
156	0183	12	20	10	0	10	0.5		
157	8029	6	35	4	0	5	2		
158	8028	10	10	4	0	5	0		
159	0213	12	45	6	2	8	1		
160	0212	10	35	8	3	8	1		
161	0211	10	55	4	0	8	1		
162	0210	12	80	12	0	10	1		
163	0215	14	60	10	0	8	0		
164	8060	16	60	50	0	5	16		
165	8062	10	100	12	0	8	1		

Results of analyses in p.p.m

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
166	8061	12	90	14	0	8	8		
167	7027	8	60	10	0	8	2		
168	7026	26	125	12	4	10	0.5		
169	7025	6	50	8	0	8	1		
170	7023	6	10	10	0	8	0		
171	6045	10	10	12	1	8	2		
172	6047	10	25	8	1	8	2		
173	6021	8	60	8	1	8	0		
174	6020	8	10	6	1	8	0		
175	8036	10	15	10	0	8	0		
176	6019	12	15	14	1	5	2		
177	6018	6	10	10	2	3	0		
178	0168	8	10	12	1	8	0		
179	0170	6	60	26	0	10	1		
180	0169	4	15	6	2	8	1		
181	6017	10	65	20	11	8	0.5		
182	6016	26	50	16	4	13	1		
183	0204	8	75	6	0	10	2		
184	7033	12	60	4	0	8	8		
185	7032	14	60	14	0	8	8		
186	0206	6	40	10	0	8	0.5		
187	0205	10	40	4	0	8	1		
188	7028	8	60	4	0	8	2		
189	0207	10	50	8	10	8	1		
190	7030	12	35	4	0	8	1		
191	7031	8	55	6	0	5	2		
192	7029	10	50	12	0	8	4		
193	0208	8	40	6	0	-	0.5		
194	0209	8	45	8	0	-	0		
195	6061	10	110	20	0	8	2		
196	7024	10	75	4	0	8	0		
197	0200	4	55	8	1	20	-		
198	8053	8	33	14	0	2	0.5		
199	8054	8	20	8	0	5	0.5		
200	0201	6	10	8	0	8	0		
201	0199	10	40	6	0	8	0.5		
202	0198	6	35	6	0	8	1		
203	6022	6	30	12	0	8	0		
204	6023	8	35	6	2	5	0.5		
205	6024	14	125	10	0	8	1		
206	6062	14	115	20	0	10	2		

Results of analyses in p.p.m.

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
207	6063	8	65	12	0	10	0		
208	0217	8	60	12	0	10	0.5		
209	0216	16	80	34	0	13	6		
210	0302	6	8	60	0.4	22	4		
211	0301	4	16	60	1	25	6		
212	0303	6	8	80	0.4	20	1		
213	0304	4	10	70	0.4	23	1		
214	6025	10	45	12	1	10	0		
215	8056	8	50	12	0	5	1		
216	7036	8	90	10	0	45	1		
217	7034	8	15	4	1	8	0		
218	7035	10	50	14	0	5	0		
219	0203	10	55	8	1	8	1		
220	8055	10	45	16	0	13	0.5		
221	0202	6	35	10	1	8	0.5		
222	8052	20	75	30	1	18	0		
223	6052	32	90	16	2	18	1		
224	9007	6	40	18	0.4	-	1		
225	0315	4	8	55	0.4	21	2		
226	0316	6	8	110	0.4	22	2		
227	0197	8	25	8	1	8	1		
228	0196	8	50	12	3	13	0.5		
229	9009	6	60	24	0.4	18	2		
230	0305	4	6	50	0.4	20	0.5		
231	0306	4	8	60	0.4	20	1		
232	0307	4	16	55	2	-	8		
233	0309	6	20	150	2	-	4		
234	0310	4	14	50	0.4	18	1		
235	0308	4	4	25	0.4	15	1		
236	0320	6	14	60	0.4	30	-		
237	0321	4	4	80	0.4	28	1		
238	0322	6	6	125	0.4	-	2		
239	0319	4	4	35	0.4	21	0.5		
240	0318	8	46	230	0.4	-	-		
241	9013	4	20	12	0.8	20	1		
242	9008	4	30	10	0.4	20	1		
243	9006	8	40	10	0.4	20	0.5		
244	9005	6	35	16	0.4	-	4		
245	9010	6	50	14	0.4	20	0.5		
246	0328	4	8	60	0.4	18	10		
247	0327	4	14	50	0.4	21	2		

Results of analyses in p.p.m

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
248	0326	4	16	110	4	24	4		
249	0317	6	6	90	0.4	26	2		
250	0325	6	6	110	1	26	8		
251	0323	4	8	140	0.4	-	8		
252	0349	4	6	40	0.4	20	0		
253	0364	6	15	4	0	0	0.5		
254	9047	6	40	6	0.4	20	2		
255	0353	4	6	60	0.4	20	0.5		
256	9052	6	30	4	0.4	20	0.5		
257	9051	6	35	8	0.4	20	2		
258	9050	6	55	2	0.4	22	4		
259	9011	6	55	8	0.8	26	10		
260	9012	8	65	16	0.4	28	8		
261	0348	6	4	20	0.4	18	0.5		
262	0347	4	4	45	0.4	20	0.5		
263	0329	4	10	65	2	22	2		
264	0330	4	14	60	0.4	21	8		
265	0331	6	10	140	6	23	10		
266	9007	6	40	18	0.4	-	1		
267	0334	12	36	65	2	31	-		
268	9002	8	125	24	0.4	30	4		
269	9033	6	90	26	0	-	-		
270	9034	4	35	6	1	25	0		
271	9003	6	40	6	0.4	20	0.5		
272	9040	8	90	18	0.4	-	-		
273	9039	6	80	8	0.4	30	1		
274	9038	6	50	4	0.4	18	1		
275	9037	6	45	6	0.4	23	1		
276	9036	8	60	4	0.4	23	1		
277	9035	6	55	4	0.4	18	0.5		
278	0342	4	4	45	0.8	31	4		
279	0341	4	30	40	0.4	-	-		
280	0344	4	6	25	0.4	28	4		
281	0313	4	4	45	0.4	22	1		
282	0312	4	4	50	0.4	23	1		
283	0311	4	4	50	0.4	-	1		
284	9053	6	40	6	0.4	20	0.5		
285	9004	6	35	20	0.4	18	0.5		
286	9049	8	60	4	5	20	4		
287	9048	6	50	4	6	-	4		
288	0366	2	20	2	0	5	0		

Results of analyses in p.p.m.

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
289	0351	4	4	15	0.4	23	0.5		
290	0352	4	4	65	0.4	20	1		
291	0362	4	30	4	0	0	0.5		
292	0363	2	40	2	0	13	2		
293	0350	4	12	15	0.4	18	0		
294	0361	6	40	2	0	3	0.5		
295	0365	4	40	8	0	2	0		
296	0367	6	35	2	0	2	0		
297	9054	6	15	4	0.4	18	0.5		
298	9055	8	15	4	0.4	15	1		
299	0314	4	6	40	0.4	18	2		
300	9042	10	65	6	0.4	26	4		
301	0346	8	26	65	0.4	26	8		
302	0345	4	6	35	0.4	18	1		
303	0333	4	8	115	1	22	-		
304	0334	4	4	50	0.4	-	4		
305	0335	4	4	60	0.4	23	2		
306	0332	4	6	75	4	-	10		
307	0336	6	4	60	0.8	25	1		
308	9020	6	60	8	0.4	18	4		
309	0108	8	60	12	1	-	2		
310	9019	6	40	6	0.4	18	10		
311	9044	4	30	4	0.4	15	1		
312	9043	8	35	4	0.4	30	1		
313	9046	4	15	2	0.4	18	1		
314	9041	8	25	4	0.4	25	2		
315	9045	4	60	16	0.4	-	-		
316	0338	4	4	30	0.4	28	1		
317	0337	4	4	40	0.4	17	1		
318	9064	6	20	2	0.4	30	2		
319	9063	4	25	2	0.4	30	1		
320	0354	6	6	65	0.4	18	1		
321	9058	6	15	4	0.4	20	0.5		
322	9057	6	10	2	0.4	20	1		
323	9056	6	10	6	0.4	26	0.5		
324	0368	4	25	2	0	3	0		
325	0357	2	15	4	0	13	0.5		
326	9095	6	30	2	0.4	12	0.5		
327	9094	6	20	4	0.8	10	0		
328	9059	6	15	2	0.4	18	0.5		
329	9062	4	30	6	0.4	22	2		

Résultats d'analyse en p.p.m.

No de l'éch. sur la carte	No de code de l'échant au fichier du minist.	Cu	Zn	Pb	Mo	Ni	U		
330	9061	6	10	2	0.8	20	0.5		
331	0340	6	8	40	0.4	26	0.5		
332	0341	4	30	40	0.4	-	-		
333	9014	6	35	10	0.8	18	2		
334	9018	4	25	4	0.4	28	2		
335	9017	4	35	4	0.4	20	4		
336	9016	6	40	8	0.4	-	8		
337	0127	14	60	44	0	-	1		
338	9027	4	50	6	0.4	18	2		
339	0110	12	65	6	0	-	1		
340	0109	12	80	10	0	-	6		
341	9023	4	35	4	0.4	22	2		
342	9022	6	50	12	0.8	23	2		
343	9021	4	35	16	0.4	23	8		
344	9015	4	25	4	0.4	25	2		
345	0339	4	6	60	0.4	28	1		
346	9066	4	30	2	0.8	18	2		
347	9065	6	25	4	0.4	18	2		
348	9060	6	20	6	0.4	20	0.5		
349	9096	6	40	2	0.4	10	0.5		
350	9097	6	40	2	0.4	10	0.5		
351	9098	6	50	4	0.4	8	0.5		
352	9099	8	40	4	0.4	10	0.5		
353	9092	6	30	8	0.4	10	0		
354	9093	8	35	12	0.4	13	1		
355	9067	4	35	4	0.4	26	2		
356	9068	8	40	4	0.8	18	1		
357	9069	6	35	4	0.4	22	2		
358	0417	6	60	2	0	8	0		
359	0416	4	50	2	0	6	0		
360	9024	4	35	4	0.8	28	6		
361	9025	4	55	2	1	30	4		
362	9026	4	30	4	0.4	22	2		
363	9032	6	40	4	0.4	28	4		
364	0107	4	50	8	1	-	1		
365	0113	10	30	4	1	-	1		
366	9031	4	20	6	0.4	18	2		
367	9030	6	100	4	0.4	17	1		
368	9029	4	30	6	0.4	20	1		
369	9028	6	40	4	0.4	20	2		
370	9071	4	10	2	0.4	20	0.5		

Résultats d'analyse en p.p.m.

No de l'éch. sur la carte	No de code de l'échant au fichier du minist.	Cu	Zn	Pb	Mo	Ni	U		
371	9076	12	35	4	0.8	8	2		
372	9077	8	25	2	0.4	6	0.5		
373	9078	4	25	4	0.4	8	0		
374	9070	8	45	4	0.4	22	2		
375	9089	10	20	20	0.4	8	0.5		
376	9090	6	15	4	0.4	10	0		
377	9091	6	35	8	0.4	8	0		
378	9100	8	55	4	0.4	12	0.5		
379	9101	8	50	6	0.4	10	1		
380	0356	4	6	80	0.4	26	0.5		
381	0413	6	50	2	0.4	8	0		
382	0415	6	50	2	0	0	0		
383	9073	6	40	4	0.8	26	1		
384	9113	4	35	8	0.4	-	4		
385	9112	2	20	4	0.4	2	0		
386	9072	6	30	4	0.4	18	2		
387	9111	4	40	8	0.4	6	0.5		
388	9123	6	35	4	0.4	5	1		
389	0371	2	40	2	0	2	0.5		
390	0372	4	30	8	0	5	1		
391	9079	8	30	4	0.4	8	2		
392	9080	6	30	4	0.4	8	1		
393	9081	6	10	2	0.4	6	0		
394	0114	10	40	8	1	-	4		
395	9082	6	25	4	0.4	6	0.5		
396	9083	6	20	2	0.4	5	0.5		
397	0115	14	140	6	0	-	2		
398	9084	4	15	4	0.4	5	0.5		
399	9085	6	25	2	0.4	5	0.5		
400	0116	12	25	6	0	-	1		
401	9087	4	15	2	0.4	7	0.5		
402	9088	6	25	2	0.4	7	0.5		
403	5022	6	15	4	0.8	1	1		
404	5021	10	20	8	0	-	2		
405	0379	6	35	2	0	7	0		
406	0374	4	40	4	0	5	0		
407	0373	6	50	4	0	6	0		
408	9125	4	15	14	1	-	-		
409	9124	4	35	6	0.4	4	2		
410	9127	4	35	8	0.4	2	1		
411	0355	6	14	70	2	23	1		

Résultats d'analyse en p.p.m.

No de l'éch. sur la carte	Node code de l'échant au fichier du minist.	Cu	Zn	Pb	Mo	Ni	U		
412	9116	4	30	8	0.4	-	1		
413	9115	2	10	6	0.4	2	0		
414	9114	4	40	10	0.4	5	2		
415	9074	4	50	4	0.4	8	0.5		
416	9075'	6	30	2	0.4	10	0.5		
417	0414	8	25	2	0	0	0		
418	9128	4	40	6	0.4	5	0.5		
419	0360	4	8	65	0.4	18	0		
420	9129	8	30	4	0.4	5	0.5		
421	0412	6	30	4	0	0	0		
422	0411	4	75	4	0	6	0		
423	9117	6	30	12	0.4	6	2		
424	9118	4	65	4	0.4	5	0.5		
425	9126	2	65	22	0.4	5	1		
426	0375	4	65	4	0	0	0		
427	5024	4	10	6	0	8	1		
428	0376	4	35	4	0	0	0.5		
429	5023	6	15	6	0	10	10		
430	0380	4	30	2	0	0	0		
431	9086	6	20	4	0.4	10	1		
432	0130	10	20	8	0	-	0		
433	0129	12	35	10	0	-	1		
434	0131	10	15	6	0	-	2		
435	0132	12	45	8	0	-	10		
436	0377	10	50	2	0	2	0		
437	0123	6	35	10	2	-	0.5		
438	5025	10	10	8	2	5	1		
439	5026	14	50	34	1	25	1		
440	5027	6	10	6	0	5	0.5		
441	0384	2	40	4	0	0	0		
442	0383	14	50	2	0	16	0		
443	0409	10	40	6	0	4	0		
444	9119	2	10	6	0.4	6	0		
445	0410	6	35	2	0.4	0	0		
446	9132	2	35	6	0.4	5	0.5		
447	0358	4	10	75	0.4	20	0		
448	9130	2	40	4	0.4	5	1		
449	9131	6	10	4	0.4	4	0.5		
450	0408	6	30	6	0	6	0		
451	0407	8	50	4	0	6	0		
452	9120	4	10	4	0.4	2	0		

Résultats d'analyse en p.p.m.

No de l'éch. sur la carte	Node code de l'échant au fichier du minist.	Cu	Zn	Pb	Mo	Ni	U		
453	0378	8	40	10	0	0	0		
454	0382	2	30	6	0	0	0		
455	0381	4	50	50	0	0	0.5		
456	0124	14	25	12	0	-	0		
457	0151	10	800	4	0	-	0		
458	0122	4	20	8	0	-	0		
459	0128	8	50	4	0	-	1		
460	0121	10	40	4	1	-	0.5		
461	0119	10	40	4	0	-	1		
462	0120	12	25	4	0	-	0.5		
463	0133	10	15	6	0	-	1		
464	0117	22	65	16	1	-	1		
465	0118	20	140	14	0	-	2		
466	0134	12	35	12	0	-	0.5		
467	0135	12	40	4	0	-	0		
468	0136	8	40	14	1	-	0		
469	5035	12	25	10	0	8	4		
470	0125	20	70	18	0	-	1		
471	0154	14	30	6	1	-	0		
472	0126	16	55	6	1	-	0		
473	0385	6	50	6	0	0	0		
474	5028	12	15	10	0	8	2		
475	5029	8	15	4	0	8	0		
476	0405	6	75	8	0	7	0		
477	9122	4	10	12	0.4	6	0		
478	9121	2	30	4	0.4	8	0		
479	5030	14	65	30	1	-	1		
480	5031	10	20	4	0	10	0		
481	0403	2	20	4	0	0	0.5		
482	0404	8	35	4	0	8	0		
483	0386	4	30	2	0	2	0		
484	0387	6	50	2	0	5	0		
485	0388	6	50	4	0	0	0		
486	0389	6	25	2	0	0	0		
487	0153	8	20	6	0	-	1		
488	0140	8	60	12	1	-	1		
489	0139	10	80	16	0	-	1		
490	0138	10	35	12	0	-	0		
491	0137	8	20	8	0	-	0		
492	0141	12	40	10	0	-	0		
493	5036	10	15	8	0	8	0.5		

Results of analyses in p.p.m

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
494	5038	12	15	6	0	-	1		
495	5037	10	35	34	0	-	1		
496	0020	6	40	8	0	8	1		
497	5040	6	30	8	0	13	1		
498	0143	8	35	6	0	-	0.5		
499	0144	10	30	6	1	-	1		
500	0149	8	25	8	1	-	1		
501	0150	6	85	4	2	-	2		
502	0148	12	75	18	0	-	1		
503	0145	14	35	6	1	-	2		
504	0146	14	65	14	13	-	2		
505	0147	8	50	10	1	-	2		
506	0397	2	65	4	0	0	0.5		
507	0398	4	30	4	0	8	0		
508	0399	6	35	4	0	0	0		
509	0370	8	40	4	0	0	0.5		
510	0400	2	25	4	0	0	0.5		
511	0157	10	50	14	0	-	1		
511-A	0402	6	25	2	0	2	0		
511-B	0401	6	35	2	0	3	0		
511-C	0369	6	30	4	0	0	0.5		
512	0396	4	40	2	0	6	0		
513	0156	12	40	8	0	-	1		
514	0395	6	50	26	0	0	0.5		
515	0155	6	35	6	0	-	0		
516	0390	6	35	6	0	0	0		
517	5044	10	20	6	0	5	1		
518	5045	14	35	8	0	15	0		
519	0017	10	55	14	0	13	1		
520	0018	10	50	6	0	8	0.5		
521	5039	12	30	12	0	13	2		
522	0392	4	65	10	0	0	1		
523	0002	10	85	4	3	18	14		
524	0003	14	80	16	0	25	8		
525	0004	14	50	6	0	13	8		
526	0007	16	45	10	0	13	6		
527	0001	12	20	4	0	30	0		
528	5034	12	25	12	1	13	6		
529	5033	14	45	8	0	13	8		
530	5032	10	15	6	0	5	3		
531	5041	8	20	8	0	8	0.5		

Results of analyses in p.p.m.

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
532	5046	16	85	140	0	-	1		
533	5043	8	10	6	1	5	2		
534	5051	6	60	26	0	10	0.5		
535	5052	8	20	16	0	5	0.5		
536	0044	10	45	4	1	10	0.5		
537	0043	8	40	4	0	13	1		
538	0045	10	35	6	0	8	1		
539	0041	8	25	10	0	8	0.5		
540	0040	12	25	6	0	8	1		
541	0039	20	45	14	0	8	0.5		
542	5054	6	15	10	0	5	1		
543	5055	12	15	14	0	5	1		
544	5053	8	15	12	0	5	2		
545	5030	14	65	30	1	-	1		
546	5008	10	40	12	0	13	1		
547	5007	6	30	24	0	8	0		
548	5006	16	25	10	0	8	0		
549	5005	12	30	36	0	8	0		
550	5004	24	340	50	0	10	-		
551	5003	8	15	8	0	13	2		
552	0010	8	80	14	1	10	14		
553	5001	18	45	34	0	13	1		
554	5002	20	60	36	0	13	6		
555	0005	8	65	10	0	45	1		
556	0006	10	60	8	0	13	6		
557	0042	10	35	8	1	8	0.5		
558	5012	6	10	6	0	5	0		
559	5011	8	20	8	0	5	1		
560	5055	4	10	18	0	5	2		
561	5049	8	40	14	0	5	4		
562	5010	10	15	4	0	8	1		
563	5009	14	25	12	0	5	1		
564	0016	6	40	4	1	8	0.5		
565	0014	14	45	4	0	15	1		
566	0013	6	50	4	0	18	1		
567	0015	12	40	6	0	18	0.5		
568	0012	22	60	12	0	13	1		
569	0011	12	45	12	0	13	1		
570	5047	14	35	6	0	8	2		
571	5048	10	20	10	0	5	2		
572	5013	8	10	10	0	5	1		

Results of analyses in p.p.m

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		
573	5014	10	10	6	0	5	2		
574	5015	8	25	8	0	13	2		
575	5016	14	20	6	0	8	2		
576	0035	8	35	6	0	8	1		
577	0034	6	30	14	0	8	0.5		
578	5017	12	55	6	0	8	1		
579	0032	10	50	12	0	8	2		
580	0036	10	50	12	0	8	0.5		
581	5018	12	25	8	0	18	1		
582	5019	6	10	6	0	8	0		
583	5020	12	30	8	0	23	1		
584	0031	8	30	10	0	8	3		
585	0030	16	40	10	0	8	1		
586	0033	6	45	8	1	8	1		
587	0102	6	80	26	0	-	1		
588	0101	6	90	16	0	-	1		
589	0100	26	100	20	0	-	1		
590	0038	14	45	8	1	10	5		
591	0106	8	85	12	2	-	2		
592	0105	4	50	6	0	-	1		
593	0104	8	60	12	0	-	1		
594	0103	6	60	8	0	-	0.5		

N.B. A dash in the listing indicates the absence of a determination.

Results of analyses in p.p.m.

Sample No. on the map	Code No. of sample in files of Dept.	Cu	Zn	Pb	Mo	Ni	U		