GEOLOGY AND PETROLOGY OF MOUNTS JOHNSON & ST.-HILAIRE
MONTEREGIAN HILLS PETROGRAPHIC PROVINCE

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From

Eby, G. N. (1988) Geology and petrology of Mounts Johnson & St.-Hilaire, Monteregian Hills Petrographic Province. In Olmsted, J. F. (ed.) New York State Geological Association, 60th Annual Meeting, Field Trip Guidebook. New York State Geological Association, State University College, Plattsburgh, NY, pp. 29-43.

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INTRODUCTION

The Monteregian Hills petrographic province consists of a group of small igneous intrusions and associated dikes and sills which lie along a more or less linear East-West trend extending from the Oka carbonatite complex located 30 km west of Montreal to Mounts Shefford and Brome 70 km east of Montreal (Figure 1). These plutons cut a number of terranes: the Precambrian Grenville, the St. Lawrence Lowlands, and the folded rocks of the Appalachian orogen. Mount Megantic lies 100 km east of Mounts Shefford and Brome and its assignment to the Monteregian Hills province is somewhat problematical. Petrographically and chemically Mount Megantic shows stronger affinities with the White Mountain igneous province than with the Monteregian Hills. On this field trip we will visit two plutons located in the central part of the province which are representative of some of the major magmatic trends in the Monteregian Hills.

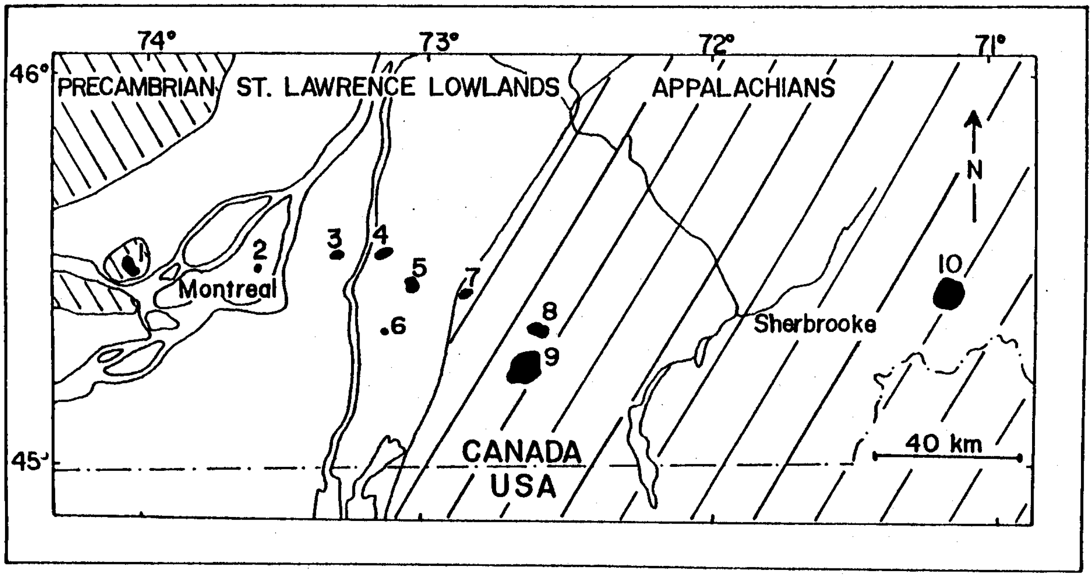


Figure 1. Location and generalized geologic setting of the Monteregian plutons. 1-Oka carbonatite complex, 2-Mt. Royal, 3-Mt. St. Bruno, 4-Mt. St.-Hilaire, 5-Mt. Rougemont, 6-Mt. Johnson, 7-Mt. Yamaska, 8-Mt. Shefford, 9-Mt. Brome, 10-Mt. Megantic

GEOLOGY AND GEOCHEMISTRY OF THE MONTEREGIAN HILLS

Geology and Petrography

Igneous activity in the Monteregian Hills is represented by a variety of magma types ranging from strongly silica undersaturated to silica saturated. There is a geographic pattern to the magmatism in that strongly silica undersaturated rocks are concentrated in the western half of the province while silica saturated rocks generally occur in the eastern half of the province. The general geology of the province has been described by a number of authors (e.g. Philpotts, 1974; Eby, 1987).

The Oka carbonatite complex is located at the western end of the province and consists of a core carbonatite which has been intruded by a variety of strongly silica-undersaturated rocks: okaite, melteigite, ijolite, and urtite. Alnoitic rocks also intrude the complex and the alnoitic phase of magmatism is confined to the Oka area. A recent review of the Oka complex, and a field trip guide for the Oka area, can be found in Gold et al. (1986).

Mounts Royal, Bruno, Rougemont, and Yamaska are mafic to ultramafic in character. The dominant lithologies are pyroxenite and gabbro, and in the field these two lithologies tend to be interlayered. This interlayering generally occurs at the outcrop scale so that map units show the dominant lithology. Mappable gabbroic units occur in all of these plutons and they often represent the later stages of igneous activity. None of the pyroxenite and gabbro units carry nepheline, although they are often slightly nepheline normative due to locally abundant amphibole, and quartz occasionally occurs in contact zones due to crustal contamination. Layering is often prominent due to the alignment of pyroxenes and plagioclases. This layering is at moderate to steep angles which has led to the conclusion that the rocks represent crystallization of the magma, in a convecting system, from the walls inward. There is occasional evidence for movement of material in the partly molten state, although the bulk of the rocks seem to have crystallized at their current level of emplacement. At Mounts Royal and Yamaska the gabbro-pyroxenite sequence is intruded by essexites and nepheline-bearing syenites which define a late stage, strongly silica undersaturated, period of magmatism. A recent review of the geology of Mounts Royal and Bruno can be found in Eby (1984). Detailed geologic maps for Mounts Bruno and Rougemont were published by Philpotts (1976). Field trip guides for Mounts Royal (Gelinas, 1972) and Rougemont (Philpotts, 1972) were prepared for the 1972 International Geological Congress.

At Mounts St.-Hilaire, Johnson, Shefford, and Brome the dominant mafic lithlogies are gabbro, essexite, and diorite, pyroxenites are either absent or occur as minor components. Syenitic units, either quartz-bearing or nepheline-bearing are important components of these plutons. Mount St.-Hilaire can be conveniently divided into a western half consisting largely of gabbro and an eastern half consisting largely of nepheline- and sodalite-bearing syenites. Mount Johnson largely consists of essexite with an outer annulus of syenite and nepheline-bearing syenite. Mounts Shefford and Brome are found in close proximity and are geologically similar.

Shefford has a large central core which is predominately diorite. The diorites are intruded by arcuate bodies of syenite (pulaskite and foyaite) and quartz-bearing syenite (nordmarkite). The core of Mount Brome is pulaskite. To the south this core is partly surrounded by a large, layered, arcuate gabbro body. The gabbro can be divided into a number of zones which apparently represent cycles of magmatic activity. Quartz-bearing syenites are found along the outer edges of the pluton. The central syenite is intruded by late stage nepheline-bearing diorites and syenites. Recent information on the geology of these plutons can be found in Eby (1984, 1985a) and Currie et al. (1986). Philpotts (1972) and Woussen & Valiquette (1972) have published field trip guides for Mounts Johnson, Shefford, and Brome.

Mount Megantic is located at the extreme eastern end of the province and its assignment to the Monteregian Hills is questionable. The core of the pluton consists of a two-feldspar granite plug which is surrounded by a gabbro-diorite unit and an outer ring dike of nordmarkite. The central granite is very similar in appearance and mineralogy to the "Conway" granite of the White Mountains. The gabbros often carry two pyroxenes, which is common for White Mountain mafic rocks but rare in the case of the Monteregian Hills. A recent review of this pluton can be found in Eby (1985a).

The plutons of the Monteregian Hills are intruded by a variety of mafic and felsic dikes. Dikes are also widely distributed in the country rocks. These dikes tend to lie along a northwest trend. The mafic dikes can be classified as lamprophyres (alnoites, monchiquites, and camptonites), alkali olivine basalts, and basanites. The felsic dikes can be classified as bostonites, solvsbergites, nepheline syenites, and tinguaites. The strongly silica undersaturated dikes are concentrated towards the western end of the province.

Dike nomenclature used in the Monteregian Hills is as follows. By definition, lamprophyres must be porphyritic rocks which do not have feldspar phenocrysts. Alnoites contain melilite and biotite as essential minerals and are feldspar free. Monchiquites have a groundmass of glass, analcime or nepheline, and ferromagnesian silicates. Camptonites have a groundmass of labradorite, amphibole, pyroxene, and subordinate alkali feldspar, nepheline, and/or leucite. In the monchiquites phenocrysts are commonly olivine or pyroxene while in the camptonites phenocrysts are commonly amphibole. The basanites are mineralogically similar to the monchiquites while the alkali olivine basalts are similar to the camptonites, but these dikes do not carry phenocrysts. The bostonites are texturally distinctive felsic rocks which have a trachytic or flow texture in which lath-shaped feldspar grains are arranged in rough parallelism or in radiating patterns. Tinguaites are equivalent to phonolites and in the Monteregian Hills often contain sparse feldspar phenocrysts.

Geochronology, Geochemistry, and Isotope Geology

A number of geochronologic techniques have been applied to the dating of Monteregian igneous activity. Ages determined by Rb-Sr whole-rock methods, conventional K-Ar biotite and amphibole methods, and fission-track methods (apatite and sphene) for the main plutons and dikes are summarized in Eby (1987). These data indicated that there were two distinct periods of igneous activity in the Monteregian province, one centered around 132 Ma and the other around 120 Ma. These ages also seemed to have a petrogenetic significance in that strongly silica-undersaturated rocks were confined to the younger period of igneous activity. Recently Foland et al (1986) have reported the results of Ar-40/Ar-39 geochronology on several of the Monteregian plutons which indicate that the plutons had a short emplacement history centered around 125 Ma. These data, while internally consistent, are at variance with the data obtained from other radiometric methods. Further work is required to rationalize these apparent discrepancies.

Chemically the rocks of the Monteregian Hills, with the exception of some cumulates, plot in the alkali field on a total alkalis versus silica diagram. Most of the rocks are nepheline normative, although the nepheline normative character of the cumulate rocks is due to the presence of abundant amphibole, rather than the occurrence of nepheline. In the strongly undersaturated series of rocks there is a strong enrichment trend in total alkalis with respect to silica which is mirrored by the occurrence of abundant modal nepheline. REE abundance patterns show moderate to strong enrichment in the LREE with respect to the HREE, with the strongly silica undersaturated rocks showing the greatest enrichment. In agreement with alkaline rocks from other parts of the world, the Monteregian rocks are relatively enriched in alkalis and high-charge-density cations.

Both Sr and Pb isotopic data have been reported for the various Monteregian plutons by Eby (1985b) and Grunenfelder et al (1985). These data suggest the presence of a depleted subcontinental lithosphere which served as the source of the Monteregian magmas. During the ascent of the magmas to their level of crystallization interactions occurred with the country rocks. The nature of the isotopic contamination was quite varied since in some cases the country rocks were of Grenville age whereas in other cases they were Lower Paleozoic in age. As a general rule, the rocks emplaced last in any particular pluton show the most primitive isotopic signatures, an observation which is generally explained by the earlier formed magmas coating the magma conduits and isolating the later magmas from the country rocks.

Petrogenesis

A variety of magmatic sequences can be identified in the Monteregian Hills and the details of their petrogenesis can be found in Eby (1984, 1985a, 1987). In brief the following sequences are delineated:

1. Carbonatite and possibly related (through liquid immiscibility) nepheline-rich rocks plus alnoitic dike rocks.

2. Pyroxenite - gabbro - diorite sequences which occur as significant components in a number of the plutons. These rocks are largely cumulate in nature, and calculated magma compositions indicate that they formed from alkali picrites.

3. Gabbro - diorite - syenite sequences and chemically similar camptonitic dikes. These rocks apparently represent the crystallization products of alkali olivine basalts.

4. Nepheline-bearing diorites and syenites and chemically similar mochiquite dikes. These rocks were apparently derived from basanitic magmas.

5. Quartz-bearing syenite and granite.

Chemical, isotopic, and experimental data have been used to outline possible petrogenetic histories for each of these sequences. The carbonatites and related rocks are inferred to have been derived from a carbonated garnet lherzolite mantle. The alkali picrite magmas are inferred to have arisen by moderate degrees of partial melting of a garnet lherzolite mantle. The basanitic and alkali olivine basalt magmas are believed to have arisen by increasing degrees of partial melting of a spinel lherzolite mantle. Given the strong enrichment in incompatible elements found for the initial melts, and the depleted mantle signature shown by the isotopic systems, it is concluded that mantle metasomatism occurred either immediately before, or during, melting. During ascent these magmas underwent various degrees of interaction with the crust producing residua enriched in silica. Some of the quartz-bearing syenites and the granite appear to have a crustal origin. In general, increasing degrees of silica saturation (or decreasing silica undersaturation) are marked by increasing initial strontium isotopic ratios, indicating the degree of crustal interaction.

GEOLOGY OF MOUNTS JOHNSON AND ST-HILAIRE

Mount Johnson

Mount Johnson, the smallest of the Monteregian plutons, is roughly circular in plan with an approximate diameter of 680 meters (Figure 2). The bulk of the pluton consists of essexite with an outer annulus of syenite. The major lithologies can be subdivided into a number of units which are arranged concentrically around the core. Pajari (1967) divided the pluton into a core series (370 m in diameter) and a peripheral series. The central part of the core series consists of a fine-grained essexite which grades into a coarser-grained essexite carrying sparse pyroxene and plagioclase phenocrysts. The mineralogy and bulk chemistry of the core series is essentially constant with the exception of the disappearance of olivine in the outer portion of the series. Pajari (1967) concluded that the contact of the core series with the peripheral series is erosive in nature, indicating the intrusion of the core series into the pre-existing peripheral series. A small arcuate body of kaersutite-rich essexite, found within the core series, may represent the pre-existing material. The peripheral series passes outward through an essexite with abundant cumulus oligoclase, melanocratic essexite, transitional essexite, anhedral feldspar porphyry, biotite pulaskite porphyry, and nepheline syenite prophyry. In the peripheral series pyroxene is largely replaced by amphibole, presumably indicating elevated water pressure during the crystallization of this series. Sphene is also found as an accessory in the peripheral series, but is absent in the core series. The surrounding Ordovician Lorraine silstones have been metamorphosed to the hornblende hornfels facies and near the

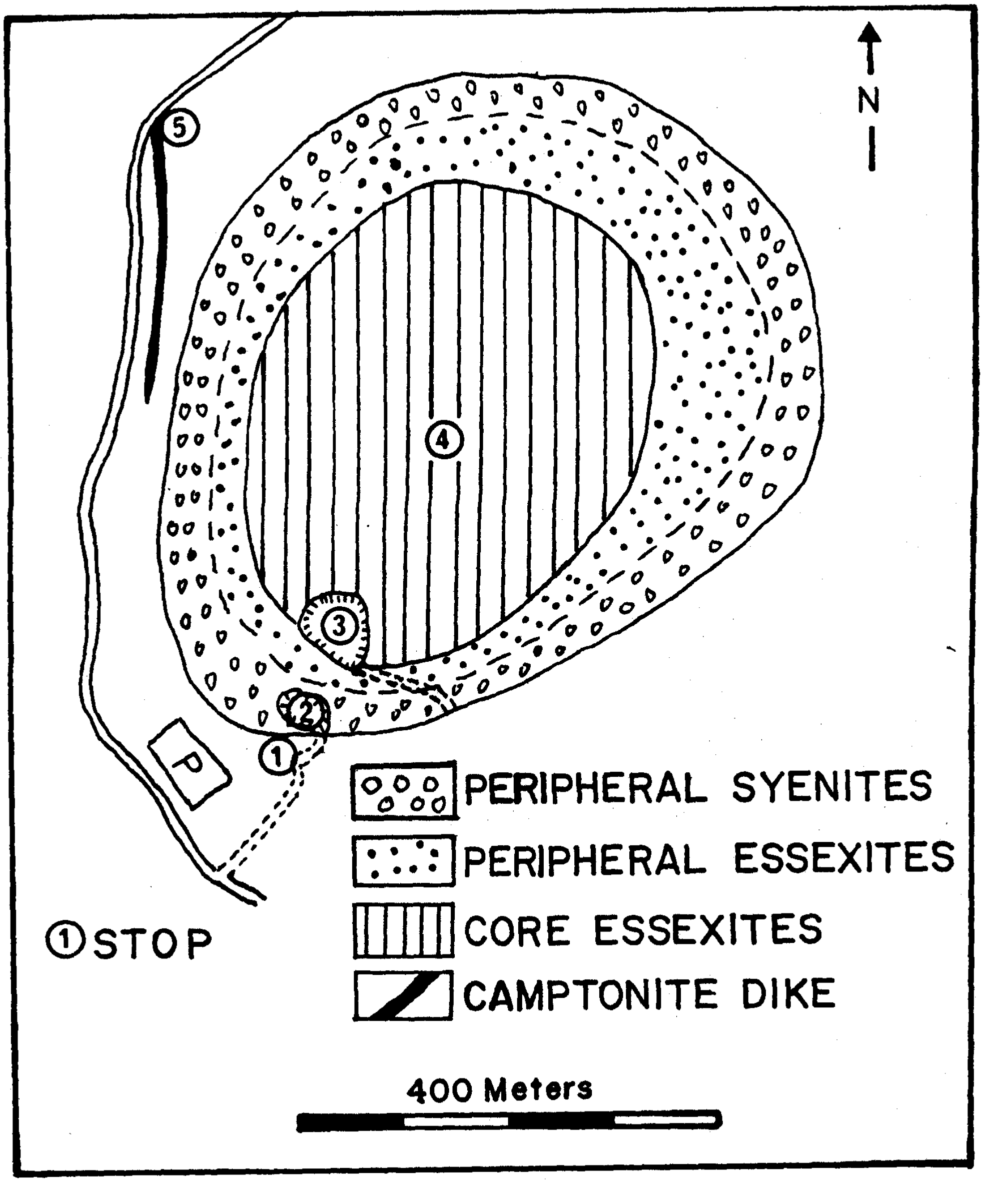


Figure 2. Geologic map (after Philpotts, 1972) showing field trip stops.

intrusion the hornfels dips in toward the contact.

All of the units of the pluton show a well-developed fabric. This fabric consists of vertically aligned feldspar laths, concentric layering, and cross-bedding in the essexites. These features indicate that the pluton consists of a series of vertical shells centered about the core, and that crystallization proceeded from the margins inward. Locally the essexite contains feldspar crystals which dip toward the center of the intrusion giving an imbricate structure. This structure may be due to the flow of magma down the walls of the magma chamber. Except for the anhedral feldspar porphyry, in which fractured feldspar crystals show evidence of movement in the solid state, all of the units appear to have been passively emplaced. The fine-grained nature of the central portion of the core unit suggests that the magma chamber may have been vented to the surface during the emplacement of this unit.

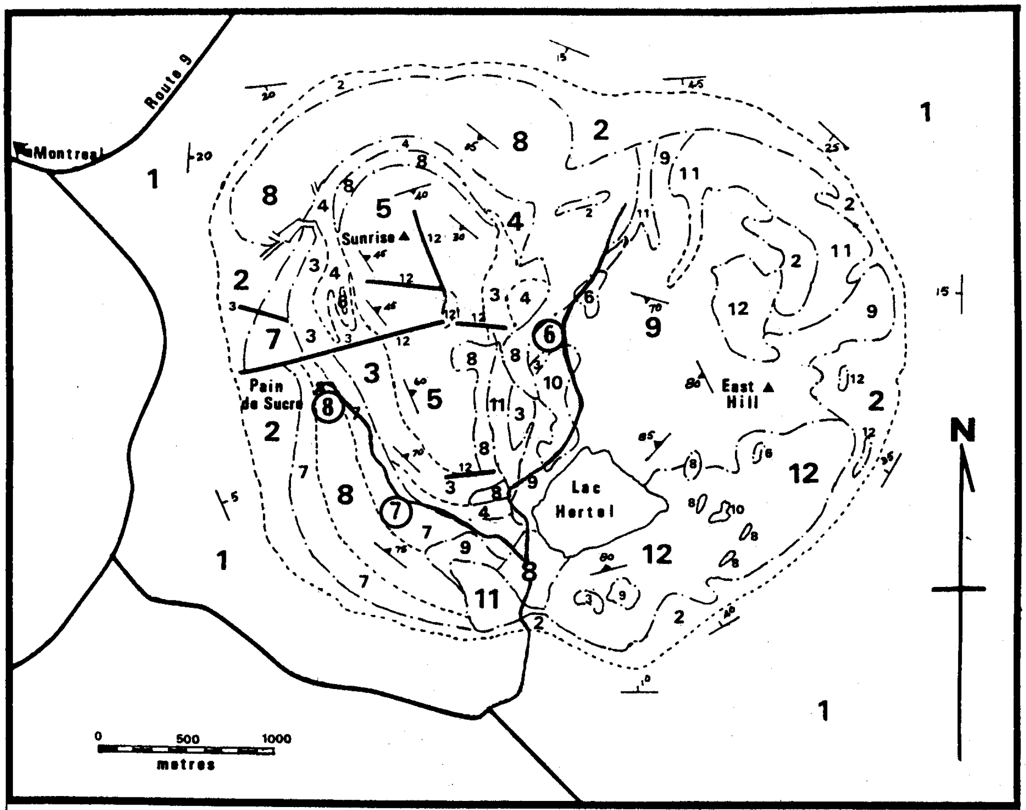
Despite its small size and apparent geologic simplicity, the Mount Johnson pluton has spawned a number of petrogenetic models. Wahl (1946) suggested that the pulaskite resulted from the diffusion of felsic components of the magma towards the cooler wall of the intrusion. Bhattacharji (1966) suggested that the operative process was flowage differentiation with the early crystallizing phases migrating towards the center of the conduit forming the olivine essexite core. Pajari (1967) envisioned the presence of two magmas, one which underwent crystal fractionation in the conduit to produce the syenites and essexites of the peripheral series and a second magma, of similar composition to the first, which formed the core series rocks. Philpotts (1968) suggested that the two major lithologies, essexite and syenite, were the result of the movement of two immiscible liquids up the conduit, the mafic liquid being preceded by the felsic liquid. Eby (1979) suggested that trace element data would support a silicate-liquid immiscibility process, although he envisioned two magmas being involved in the formation of the pluton. The first magma behaved immiscibly forming the syenites and essexites of the peripheral series while the second magma formed the core series. In the field sharp contacts are not seen between the various units, an observation which creates difficulties for most of the above petrogenetic models.

Mount St.-Hilaire

The Mount St.-Hilaire pluton (Figure 3) intrudes upper Ordovician shales, silstones, and limestones. The pluton is surrounded by a narrow biotite hornfels aureole. The low grade of contact metamorphism is somewhat anomalous considering the apparently high temperatures of the magmas. Near the contact the hornfels dips inward at moderate to steep angles suggesting passive emplacement of the magmas into collapsed material.

Currie (1983) and Currie et al (1986) divided the rocks of the pluton into several suites. The Sunrise and Pain de Sucre suites consist of mafic to intermediate rocks and form the western half of the pluton while the East Hill suite consists of peralkaline syenites and forms the eastern half of the pluton. The contact between the western and eastern halves consists of a variety of breccias including igneous and diatreme-like breccias.

The Sunrise suite is apparently the oldest of the igneous groups and consists of pyroxenites and gabbros, with gabbro as the dominant lithology. The rocks are strongly foliated, medium grained, and consist of poikilitic amphibole, clinopyroxene, calcic plagioclase, and accessory minerals. Although the rocks are nepheline normative, nepheline is not found in any of the units. There is a regular variation in the mineralogy marked by the



CRETACEOUS

MONT SAINT HILAIRE PLUTON (Units 3-12)

East Hill suite (units 9-12, not necessarily in order of emplacement)

12 Fine grained nepheline syenite, nepheline syenite porphyry and phonolite with trachytoid feldspar, nepheline and sodalite phenocrysts and xenocrysts; locally contains inclusions of units 3-8 and 11; grades to unit 9 by increase in proportion of inclusions

11 Coarse grained peralkaline nepheline syenite and pegmatite with feldspar, nepheline and sodalite phenocrysts; interstitial phonolite

10 Breccia, predominantly of units 2-8 with minor amounts of 9, 11 and 12; fragments well rounded, and locally somewhat altered

9 Igneous breccia; rounded to contorted fragments and xenocrysts of units 3-12 in a trachytoid, opaque-charged matrix similar to 12

Pain de Sucre suite (units 7-8)

8 Nepheline diorite and monzonite; medium- to coarse-grained rocks with tabular to granular plagioclase rimmed by alkali feldspar, interstitial nepheline, and mafic clots containing titanaugite, kaersutite, biotite and olivine

7 Biotite, trachygabbro; lath-like plagioclase with minor alkali feldspar rims, intergrown titanaugite and biotite, olivine and kaersutite

Sunrise suite (suites 3-6)

6 Anorthositic gabbro and leucogabbro; labradorite-rich, foliated titanaugite-magnetite gabbro

5 Amphibole gabbro: strongly foliated coarse grained rocks with minor titanaugite and biotite

4 Amphibole-pyroxene gabbro; moderately to weakly foliated granoblastic rocks with subequal amounts of kaersutite and titanaugite

3 Pyroxene melagabbro and jacupirangite; strongly to moderately foliated medium grained rocks with colour index greater than 60 and abundant magnetite; pyroxenite and perknite

2 Hornfels and metasomatic hornfels; fine grained to aphanitic grey to black quartz-rich, commonly containing abundant dykes

ORDOVICIAN

RICHMOND GROUP

1 Calcareous siltstone and shale, silstone, minor limestone

Strike and dip of bedding

Strike and dip of igneous foliation

Geological contact, defined-approximate, gradational

Geology by K.C. Rajasekeran 1966, H.M. Aarden 1970, K.L. Currie 1971, 1972

Figure 3. Geologic map of Mount St.-Hilaire from Currie (1983) showing field trip stops and paths of the Gault Estate.

replacement of pyroxene by amphibole. These rocks are obviously cumulates and originally occurred as a funnel-shaped mass near the center of the pluton. Currie (1983) defined an igneous stratigraphy for this suite on the basis of a regular decline in color index with distance from the contact.

The Pain de Sucre suite occurs as thick ring dike intruding the Sunrise suite. The rocks are massive, slightly laminated, nepheline gabbros (essexites), diorites, and monzonites. Variations within the suite are gradational. Nepheline and occasional olivine occur along with amphibole, biotite, pyroxene, sodic to intermediate plagioclase, and alkali feldspar.

The East Hill suite consists of peralkaline nepheline syenites and porphyries. An early phase of this suite was a coarse-grained nepheline-sodalite syenite which is now found as xenoliths in the younger, flow-banded, nepheline syenites and phonolites. Acmitic pyroxenes and Na-rich amphiboles are the major mafic phases. Ilmenite and magnetite are rich in Mn, and both nepheline and/or sodalite are significant minerals, locally comprising as much as 40% of the rock. Elpidite, eudialite, and astrophyllite have been identified in a few specimens.

Currie et al. (1986) outlined a petrogenetic history for Mount St.-Hilaire which required two separate magmatic events. The first magma was believed to be an alkali picrite from which crystallized the cumulus rocks of the Sunrise suite. The second magma was hypothesized to be basanitic in composition and the nepheline gabbro - monzonite sequence was formed from this magma through fractional crystallization of pyroxene, magnetite, apatite, and plagioclase. For the East Hills suite they made the rather provocative suggestion that these rocks were the result of the interaction of a basanitic magma with a saline brine at crustal depths. This brine would be rich in Na and Cl, which would explain why nepheline and sodalite are abundant in the syenites. Because their age data indicated a significant hiatus between the emplacement of the Sunrise suite and the other suites, they hypothesized that the magmas were derived by successive melts formed in response to the upward progression of a thermal anomaly.

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ROAD LOG FOR MOUNTS JOHNSON AND ST.-HILAIRE

Note: To avoid unnecessary delay at Canadian customs, foreign nationals in the United States should be sure to have credentials to reenter the United States.

CUMULATIVE MILEAGE	MILES FROM LAST POINT	ROUTE DESCRIPTION
0.0	0.0	Leave Holiday Inn assembly point. Turn right on Rt. 3.
0.05	0.05	Turn right into entrance ramp north of Rt. I-87.
7.25	7.3	Exit 40 N. Y. Rt. 345, Spellman Road. Continue on I-87.
16.5	23.8	Canadian Customs, I-87 becomes P. Q. Rt. 15.
13.1	36.9	Exit 21. Leave Rt. 15.
0.4	37.3	Turn right on P. Q. Rt. 219 toward Napierville.
2.6	39.9	Turn left in Napierville and continue on Rt. 219.
12.2	52.1	Enter St. Jean and continue east on Rt. 219, St. Jacques Street.
2.0	54.1	Turn right on Richelieu Street.
0.1	54.2	Turn left on St. Georges Street.
0.1	54.3	Turn left on Place du Quai.
0.1	54.4	Turn onto bridge crossing Richelieu River.
0.3	54.7	Enter Iberville.
0.1	54.8	Turn left at first traffic light off bridge onto 1st Street.
0.2	55.0	Turn right (east) onto 9th Avenue.
0.7	55.7	Turn left, cross RR, then right onto Rt. 104 (east). (You will see Rt. 104 signs in about 1/4 mile.)
0.4	56.1	Pass under P. Q. Rt. 35. Continue east on Rt. 104.

3.9	60.0	Village of Mont. St. Gregoire. Rt. 104 turns east. Continue straight (north).
1.1	61.1	Turn left on road that runs along the south and west sides of Mount Johnson (Mt. St. Gregoire).
0.4	61.5	STOP 1: Turn right into small parking lot across road from Vasseur Campground. Please note that this is private property that is made available to the public through the generosity of the owners. Walk up the marked trail to the right of the information booth.

STOP 1. EXPOSURES OF HORNFELS COLLAR

Walk up the trail to the base of the waste-rock pile. Along the trail are numerous exposures of the Lorraine siltstone, now metamorphosed to the hornblende hornfels facies. The hornfels dips northward into the intrusion with increasing steepness as the base of the waste-rock pile is approached. Climb up the waste-rock pile to the first quarry.

STOP 2. QUARRY IN PULASKITE

Excellent exposures of the pulaskite are found in this small quarry. The strong vertical foliation is clearly evident in the quarry wall. Climb up through this quarry to a slightly larger quarry located at higher elevation. Note the increase in the amount of amphibole in climbing from the first to second quarry. The rock apparently grades from pulaskite to essexite.

STOP 3. QUARRY IN RHYTHMICALLY LAYERED ESSEXITE

This quarry is located in the coarse-grained, layered essexite, that comprises the outer edge of the core series. Along the road leading into this quarry are outcrops of hornblende-rich essexite which are typical of the essexite found in the peripheral series. This hornblende-rich essexite contains sphene while the essexite in the quarry does not carry sphene. In the quarry are found excellent exposures of rhythmically layered essexite with cross-beds and trough-like structures. Climbing up out of the quarry note the disappearance of the rhythmic layering. Continue on to the summit. Note the decrease in grain size as the summit is approached.

STOP 4. SUMMIT OF MOUNT JOHNSON

At the summit the fine-grain size makes it difficult to distinguish the foliation which was clearly visible on the climb from Stop 3 to Stop 4. With the exception of the presence of olivine, the essexite at the summit and in the quarry at Stop 3 is petrographically and chemically identical. To the north of the summit is found an arcuate body of coarse-grained, amphibole-rich essexite. On a clear day the summit of Mount Johnson provides an excellent view of the Monteregian Hills. Return by the same route to the parking lot. It is once again worthwhile to look at the rocks to see if it is possible to distinguish any clear breaks between the various petrographic units.

0.6	62.1	STOP 5. Turn right out of the parking lot and continue northwesterly along the road to a lamprophyre dike cutting the Lorraine siltstone. Park on the west side of the road.

STOP 5. CAMPTONITE DIKE

The dike trends north-south along the western margin of Mount Johnson. It is of somewhat older age than the main pluton but may be petrogenetically related to the Mount Johnson magmas. The dike consists of phenocrysts of titanaugite, partly altered to a mixture of green amphibole, brown biotite and chlorite, and kaersutite in an intergranular groundmass of plagioclase, biotite, kaersutite, opaques, apatite, and trace sphene.

2.0	64.1	Continue northerly to the Juncture of P. Q. Rt. 227. Turn left onto Rt. 227 north.
1.9	66.0	Cross P. Q. Rt. 10. Continue on Rt. 227. Mount St.-Hilaire is directly ahead.
1.5	67.5	Marieville. Continue on Rt. 227.
0.5	68.0	Stop sign. Continue on Rt. 227.
0.5	68.5	Juncture P. Q. Rt. 112. Continue straight across Rt. 112 on Rt. 227.
5.9	74.4	Juncture P. Q. Rt. 229. Rougemont Road to the right. Continue north on Rtes. 227 & 229 toward Mount St.-Hilaire.
0.6	75.0	Turn left on Rt. 229. Proceed west along Rt. 229 toward Mt. St.-Hilaire
0.3	75.3	Rt. 229 turns right. Continue straight (westerly).
1.7	77.0	Road turns sharply left with side road to the right. Turn right.
0.1	77.1	Take second road to left. Note sign indicating this is the Gault Estate, Center for Nature Conservation, McGill University. Park on left. Admission is $1.00 Canadian

NOTE: The Gault Estate is a nature preserve and the eastern half of the mountain is closed to the general public. Permission for any collecting on the Estate should be obtained from: Executive Director, Gault Estate, 422, rue des Moulins, Mont-Saint Hilaire, Quebec, J3G 4S6, Canada.

STOP 6. EXPOSURES OF IGNEOUS AND DIATREME BRECCIAS

Proceed north along the main trail which follows the valley between the two halves of the mountain. Pass Lac Hertel. On the left (west side) of the trail are scattered outcrops and boulders of both the igneous and diatreme-like breccias. Most of the lithologies of the pluton can be found as blocks and fragments in these breccias.

STOP 7. GABBROS AND DIORITES OF THE SUNRISE SUITE

Retrace your path southwards to the intersection with the Pain de Sucre trail. Proceed up this trail (west) towards the summit of Pain de Sucre. Outcrops of gabbro and diorite of the Sunrise suite are exposed along this trail. In places the rocks are extremely coarse-grained and outcrops are found to carry clots of large radiating amphiboles. Foliation is generally poorly developed in this part of the suite.

STOP 8. NEPHELINE DIORITES AND MONZONITES OF THE PAIN DE SUCRE SUITE

Continue on to the summit of Pain de Sucre. In the immediate vicinity of the summit is an almost continuous exposure of relatively leucocratic coarse-grained rocks of the Pain de Sucre suite. The rocks usually have a bluish cast and visible laths of alkali feldspar. Olivine is present locally and nepheline occurs as an interstitial phase. Return to the parking lot.

0.1	77.2	The following road log guides you around the north side of Mt. St.-Hilaire to a quarry presently owned by R. Poudrette. Earlier literature referred to this as the Unimix Quarry. The remainder of the route will return you to Plattsburgh via routes P. Q. Rt. 15 and I-87 without retracing the route through Iberville and St. Jean. Care must be exercised or you will end up in downtown Montreal via the Victoria Bridge. Turn right as you leave the Gault Estate.
0.1	77.3	Turn left (easterly).
1.0	78.3	Sharp right then left, continue easterly.
0.9	79.2	Turn left onto Rt. 229 north.
3.2	82.4	Bear left and continue northwesterly on Rt. 229.
2.3	84.7	Left on road into Poudrette Quarry.
0.7	85.4	Quarry gate. Obtain permission to enter quarry.
0.7	86.1	Turn left onto Rt. 229.

0.6	86.7	Intersection with P. Q. Rt. 116. Turn left (west) on Rt. 116 toward Montreal through the village of Mont St.-Hilaire.
3.9	90.6	Cross Richelieu River. Continue west on Rt. 116 (Blvd. Laurier) through the villages of Beloeil and Basile.
8.5	99.1	Village of St. Bruno. Mt. St. Bruno on right.
0.8	99.9	Jct. with Rte. 30. Continue on Rt. 116.
3.0	102.9	Jct. Rt. 112 east. Continue west on Rt. 116.
0.6	103.5	Rt. 112 west merges with Rt. 116. Continue west on Rts. 112 & 116.
2.3	105.8	Rt. 116 ends. Keep right for Rt. 112.
0.6	106.4	City of St. Lambert. Continue on Rt. 112.
0.6	107.0	Keep right for Rt. 132 north. If you want to go into Montreal continue on Rt. 112 to the Victoria bridge.
0.1	107.1	Right on Riverside Street. Must go north for about two blocks to get Rt. 132 south towards the U.S.A.
0.75	107.85	Turn left on Notre Dame under the bridge.
0.1	107.95	Turn left beneath bridge for ramp to Rts. 132 & 20 south.
0.15	108.1	Enter Rts. 132 & 20 south.
2.4	110.5	Jct. with Rt. 15 south. Rts. 10, 15, & 20 cross Champlain bridge for Montreal. Continue south on Rts. 15 & 132 for U.S.A. and I-87.
34.6	145.1	No stop at Canadian Customs. Continue south about 1/4 mile for U. S. Customs. South on I-87 about 24 miles to Plattsburgh.