Preliminary study of the

MINERAL WATERS of Québec

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INTRODUCTION

Summary

Mineral waters are used in therapeutics to relieve various troubles, affections or allergies.

In Quebec, as well as throughout North America, spas attained the summit of their vogue at the turn of the twentieth century, but none still exist in Quebec. A few springs are exploited on a relatively modest scale. Mineral waters of Quebec are bottled and sold in commerce as a weakly competitive counterpart to imported waters.

This report intends to give the chief characteristics of the known springs in Quebec. It constitutes only a preliminary study, of which the main object is to familiarize the reader with the subject of mineral waters. Part of the information contained in these pages can be found in a report by Elworthy, published in 1918*. The author has examined most of the springs and some proprietors have furnished recent analytical results.

The author has compiled a bibliography on mineral waters and springs which appears at the end of this report.

Definition of mineral water

It is difficult to find a definition of mineral water which is accepted unanimously. For the geologist, a mineral water is a natural spring water containing dissolved mineral substances.

The International Food Congress, held in Paris in 1909, defined mineral water as a natural water proposed for consumption on account of its special therapeutic or hygienic properties.

The present tendency is to restrict the term mineral water to waters endowed with therapeutic properties. In substance, this definition corresponds to that given in "Larousse du XXe siècle". In French legislation, a mineral spring is one which possesses therapeutic properties recognized by the College of Physicians and whose exploitation is authorized by a decree of the minister of Public Health.

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* See reference in bibliography

Mineral spring resorts

Mineral spring resorts, commonly known as spas, are sometimes designated by the name of thermal stations. This inaccuracy, propagated since ancient times, finds justification in the classification of waters according to their temperature. This classification can be summed up as follows:

Cold waters: temperature below 20°C (68°F)
Hypothermal or lukewarm waters: temperature between 20°C and 35°C (95°F)
Mesothermal or warm waters: temperature between 35°C and 50°C (122°F)
Hyperthermal or hot waters: temperature exceeding 50°C

Origin and mode of occurrence

Most mineral waters are waters of meteoric origin which have dissolved mineral elements when percolating through the rocks of the earth crust, but they can also be juvenile waters originating from magmatic masses. When they are not cooled by infiltrating waters, juvenile waters normally spring up at a higher temperature than meteoric waters. Since the majority of Quebec springs occur in sedimentary rocks at a relatively low temperature, they are believed to be of meteoric origin.

Mineral waters can accumulate underground as reservoirs or basins to constitute hydromineral basins. They can also circulate in fissures of the underlying rocks, forming what has been called emergence areas because the springs can be tapped only in rather restricted areas.

In the St. Lawrence Lowlands where the formations have undergone very little deformation, mineral waters accumulate chiefly in basins, whereas in the Appalachian region, where rock formations have been highly tilted and fractured, waters travel chiefly in fractures.

Constituents of mineral waters

The basic elements which, due to their predominance, confer the quantitative characters to a water are generally the anions HCO_3^-, Cl^-, SO_4^{--} and CO_3^{--}, and the cations Ca^{++}, Mg^{++}, Na^+ and K^+.

Other elements, although present in minor amounts, may have a therapeutic influence which bears no relation to their numeric quantity. Included among these elements are: barium, bromine, sulfur, iodine and arsenic. This also applies to gases which may be present in mineral waters and consisting generally of carbon dioxide (CO_2) and hydrogen sulfide (H_2S), or to the radioactivity inherent to certain waters.

The usual content of mineral waters stands generally between 1,000 and 15,000 parts per million of dissolved substances. The weight of the dry residue gives a good approximation of the total ions in solution but it is not exactly equal to their sum because part of them may be volatilized during the process of analysis. The addition of reactives is also a factor which may influence this divergence between the total ions in the solution and the weight of the dry residue.

EXPRESSION OF ANALYTICAL RESULTS

a) Hypothetical combinations

A first method of expressing analytical results is to give results in concentration of hypothetical combinations or reconstituted salts. This empirical method was used in most analyses performed before 1900.

Mineral waters are often thought of as diluted solutions of mineral salts. This notion is far from reality since the elements of mineral salts exist in the ionic form in mineral waters. From this, one should not try to evaluate the therapeutic properties of mineral waters in comparing them to medicamental solutions of true salts.

Since the analysis of a mineral water does not reveal the form of combined salts, the tables showing the tenors of hypothetical salts, although attractive, are completely devoid of scientific significance. It is more adequate to express the results in concentration of disclosed ions, either in parts per million (p.p.m.) or in equivalents per million (e.p.m.). For this reason, the author will refrain as much as possible from reproducing in this report tables of hypothetical combinations so abundant in the literature on mineral waters.

b) Ionic form

In this form, results are reported in terms of anions and cations in parts per million.

The use of parts per million facilitates comparisons with analyses expressed in the metric system. Effectively, in this system, tenors are expressed in milligrams per liter which correspond approximately to parts per million if one assumes that a liter of water weighs a kilogram.

Analyses performed in the United States and the British Commonwealth are sometimes expressed in grains per gallon. Besides adding the difficulty of a system which is not decimal, one must take into account the difference between the U.S. gallon and the Imperial gallon. Fortunately, these awkward units are seldom used in modern analyses.

c) Reacting value

A further refinement in expressing results takes into account the chemical equivalent of the constituents. The reacting value of a constituent is the quotient obtained when one divides the tenor of an ion in parts per million by its chemical equivalent which is the molecular or atomic weight of a constituent divided by its valence. Results are then expressed as equivalents per million (e.p.m.). Since a mineral water is a solution of several substances dissociated into their constituting ions which are in chemical equilibrium, it follows that the sum of the anions, expressed in e.p.m., should be theoretically equal to the sum of the cations, expressed in the same way. The computation of reacting values is a means of verifying the accuracy of an analysis.

d) Concentration value

The concentration value of a mineral water is simply the sum of the reacting values. In Elworthy's tables, the reacting values are omitted and only the concentration value is given. The author has computed these reacting values, and the sum obtained is equal in most cases to the figure given by Elworthy for the concentration value. It happens that a very small difference exists between the author's sum and Elworthy's figure. In these cases the author will retain Elworthy's figure for the concentration value.

CLASSIFICATION OF MINERAL WATERS

Various systems have been proposed to classify mineral waters. Some are based on the chemical composition, others on the physical properties, and still others, on the physiological properties. The systems based on composition are numerous, proving thus that it is not an easy task to find an adequate classification for such a complex assemblage.

George E. Walton, Chase Palmer and G.K. Haywood have proposed the classifications most commonly used in the United States.

Walton's classification

The classification proposed by Walton tries to combine the chemical composition and the medicinal properties. It includes the following classes based on the prevailing element.

I	-	Alkaline	Pure Bicarbonated Saline (muriated sodic)
II	-	Saline (muriated sodic)	Pure Alkaline Iodo-bromated
III	-	Sulfurous	Alkaline Saline (muriated sodic) Calcic
IV	-	Chalybeate	Pure Alkaline Saline (muriated sodic) Calcic Aluminous
V	-	Purgative	Sulfated magnesian (Epsom's salt) Sulfated sodic (Glauber's salt) Alkaline
VI	-	Calcic	Carbonated Sulfated

VII - Thermal	Pure Alkaline Saline (muriated sodic) Sulfurous Calcic

In this classification, it is sometimes difficult to assign a water to a particular class.

Palmer's classification

In Palmer's classification, the radicles are grouped according to their chemical affinity. Thus are grouped sodium (Na^+), potassium (K^+) and lithium (Li^+) which are termed alkalies or primary bases; and calcium (Ca^{++}), strontium (Sr^{++}) and magnesium (Mg^{++}) termed alkaline earths or secondary bases. Hydrogen and the other metals constitute a third series of positive bases. Acid radicles are divided into two groups: strong acids such as hydrochloric (Cl^-) and sulfuric (SO_4^{--}), and weak acids such as bicarbonic (HCO_3^-), carbonic (CO_3^{--}) and metaboric (BO_2^-).

In this classification, only the reacting values of the radicles are used. According to the total reacting values of the groups mentioned above mineral waters can be alloted to one of the following classes:

Class I - Waters in which the reacting value of the strong acids is less than that of the alkalies.
Class 2 - Waters in which the reacting value of the strong acids is equal to that of the alkalies.
Class 3 - Waters in which the reacting value of the strong acids is greater than that of the alkalies but less than that of the alkalies plus the alkaline earths.
Class 4 - Water in which the reacting value of the strong acids is equal to that of the alkalies plus the alkaline earths.
Class 5 - Waters in which the reacting value of the strong acids is greater than that of the alkalies plus the alkaline earths.

These classes may be subdivided further if one considers the nature of the salts formed when the various groups are balanced. Strong acids and bases combine to form salts which confer salinity to water when dissolved. Primary salinity results from the solution of salts derived from strong acids and alkalies, such as the chlorides or sulfates of sodium and potassium, secondary salinity from the solution of salts derived from strong acids and alkaline earths such as the chlorides and sulfates of calcium and magnesium, tertiary salinity from the solution of salts derived from strong acids and metals, such as the chlorides and sulfates of iron and aluminum. Salts derived from weak acids and bases confer to water a property which is termed alkalinity. Primary alkalinity is due to the solution of salts derived from weak acids and alkalies, such as the carbonates and bicarbonates of sodium and potassium, secondary alkalinity to the solution of salts derived from weak acids and alkaline earths, such as the carbonates and bicarbonates of calcium and magnesium, tertiary alkalinity to the solution of salts derived from weak acids and the various groups of positive radicles such as hydrogen and metals.

The following table shows these properties in a concise form:

BASES	ACIDS	
	Strong acids (Cl^-, SO_4^{--}, NO_3^-)	Weak acids (CO_3^{--}, HCO_3^-)
Alkalies (Na^+, K^+, Li^+)	primary salinity	primary alkalinity
Alkaline earths (Ca^{++}, Mg^{++}, Sr^{++})	secondary salinity	secondary alkalinity
Metals (H^+, Fe^{++})	tertiary salinity	tertiary alkalinity

To obtain the numerical value of salinity and alkalinity from analytical results, the reader may refer to Palmer's report or Elworthy's (pages 12 and 13). Although these values are given in Elworthy's tables of analyses, they will not be reproduced in this report because Palmer's classification is no longer in use.

Palmer's classification based on the reacting value of the constituents of a mineral water is of value in a geological point of view because it gives an indication of the nature of the rock in which the water has circulated and that of the solvent. It also reveals the nature and amount of the chief constituents in the water analysed.

Haywood's classification

Haywood's classification distinguishes 4 principal classes of water: alkaline, alkaline-saline, saline and acidic. These classes are subdivided further in sub-classes which are qualified by the name of the radicles of medicinal importance. The classification is as follows:

Thermal or non-thermal water	I- Alkaline	Carbonated Bicarbonated Borated Silicated	Sodic Lithic Potassic Calcic Magnesian Chalybeate Aluminous Arsenical Bromated Iodated Siliceous Borated	Non-gaseous Carbonated Sulfuretted Nitrous Methaniferous Oxygenated
	II- Alkaline-saline	Sulfated Muriated Nitrated		
	III-Saline	Sulfated Muriated Nitrated		
	IV- Acidic	Sulfated Nitrated		

Haywood's classification is of value in a therapeutic point of view because it indicates the chief constituents of a water.

The French classifications follow the same theme as the American. As an example, L. Moret's classification might be mentioned. A few authors take into account the mixed types as in Haywood's classification.

L. Moret's classification

Bicarbonated waters	Sodic Calcic
Sulfurous waters	Sodic Calcic Nitrated
Sulfated waters	Sodic Calcic

Muriated sodic waters
Chalybeate waters
Radioactive waters

A classification of mineral waters based on the total dissolved salts, in parts per million, has been proposed by W.E. Fitch.*

Fitch's classification

Lightly mineralized	80 -	400 p.p.m.
Moderately mineralized	400 -	2,000 p.p.m.
Moderately highly mineralized	2,000 -	10,000 p.p.m.
Highly mineralized	10,000 -	50,000 p.p.m.
Very highly mineralized ..	above	50,000 p.p.m.

The classification currently in use are based on the chemical composition such as those proposed by Haywood and Moret.

MEDICINAL PROPERTIES OF MINERAL WATERS

Because the subject of medicinal properties of mineral waters outreaches the present field of study, the author will restrict discussion to generally known and reported observations.

Bicarbonated sodic waters are used in the treatment of digestive troubles because they increase the biliary secretion and help eliminate

* Author mentioned in Weiss et al (see bibliography).

uric acid. Bicarbonated calcic waters react in the same way but their diuretic action is more rapid.

Besides increasing the chlorhydric secretion, muriated waters also stimulate the biliary secretion and reduce the intestinal flora. They may also stimulate the appetite.

Sulfated waters have a diuretic action bearing chiefly on chlorides and urea. They reduce the arterial pressure and have a mild laxative action. Strong sulfated sodic and magnesian waters are purgative.

Sulfurous waters have a wide variety of therapeutic uses, depending on the degree of oxidation of the sulfur. They are effective in the treatment of respiratory, skin, gynecologic and articular ailments.

Chalybeate waters are reported to be effective in cases of anemia.

The foregoing observations might hold for a water with a prevalent mineralization, but it is difficult to foresee the properties of mixed types of water. It must also be recalled that certain elements, although present in minor amounts, may have a marked influence on the therapeutic properties.

The bio-physiological research undertaken by various European physicians has clearly demonstrated the effectiveness of mineral water in fighting poisons and toxins. Moreover, this effectiveness goes far beyond that of artificial solutions of the same chemical composition.

Mineral water is used in various ways at spas: for drinking, for baths or douches, for injections, for applications on mucous membranes or in natural cavities, and for inhalations. It is generally agreed that mineral waters possess their maximum curative power at the griffin. Although still effective thereafter, the physiological and therapeutic properties are nevertheless altered, and this applies to bottled waters as well.

Despite their various beneficial properties, mineral waters are also reported to have certain counter-indications or deleterious effects with respect to particular ailments. These negative effects are said to be general if they apply to nearly all types of mineral water, or special if they pertain to one particular type of water.

The usual counter-indications are:

1 - Cancer, whatever may be its localization.
2 - Tuberculosis, especially tuberculosis of the lungs in which case the counter-indication is strict.
3 - Acute diseases.
4 - The latter months of pregnancy.
5 - Extra-uterine pregnancy.
6 - Diabetes accompanied with denutrition.
7 - Major hepatic or renal deficiency.
8 - Badly compensated heart lesions.

UTILIZATION OF WATERS FROM QUEBEC

As previously mentioned, spas are not operated at present in Quebec and, to the author's knowledge, Quebec mineral waters have never been the subject of medical research. Health resorts existed at four mineral spring localities in the province since the beginning of this century up until about 1930, but it is doubtful that the cures were effected under strict medical control.

The mineral waters still exploited in the province are bottled. The amounts consumed at the griffin are small. The treatments generally underwent by mineral waters before bottling are filtration and aeration. Some are sufficiently clear to do without filtration.

A few bottlers make artificial mineral water.

DESCRIPTION OF QUEBEC SPRINGS

In the following pages, the author will give, in alphabetical order, a brief description of the principal known springs of the province of Quebec with the available analytical results. The location of these springs is shown on Figure 1. Much could be added to this information and it is hoped to do so in a future report.

ABENAKIS SPRING

Abenakis spring is located on lot 193, Grande-Terre concession, parish of Saint-François du lac, seigniory of Saint-François du lac, Yamaska county.

The name of Abenakis was given in memory of the Indians who discovered the spring about a hundred years ago. They had noticed that deer gathered regularly to drink at the site of the spring which was a muddy and wet spot near the Saint-François river. Tasting it revealed the strongly saline taste of the water and the Indians then used it in their medicinal preparations.

Two springs are presently exploited. Their total flow is said to be about 5,000 gallons per day. The water is a strongly muriated sodic type and its chemical composition would be practically unchanged since the analyses published by Elworthy in 1918, which are the only ones available.

At the time of Elworthy's study, three springs were exploited. They were enclosed in two small houses about a hundred yards apart. Two of them, those still exploited to-day, were located three feet apart in the west house; the other, which no longer exists, was in the east house.

SPRING IN WEST HOUSE

Date of sampling:	August, 1914
Temperature:	11.5°C (48°F)
Taste:	Strongly saline
Reaction:	Alkaline
Specific gravity at 15°C:	1.0106
Radioactivity:	Emanation: 62 units*
	Dissolved radium: 0.5 unit

Constituents	Tenor		Reacting value	
	p.p.m.	% of total	e.p.m.	% of total
Sulfuric acid (SO_4)	754.	5.34	15.70	3.32
Bicarbonic acid (HCO_3)	588	4.16	9.63	2.03
Nitric acid (NO_3)	2.5	0.02	0.05	--
Nitrous acid (NO_2)	0.01	--	--	--
Phosphoric acid (PO_4)	0.17	--	--	--
Metaboric acid (BO_2)	trace	--	--	--
Chlorine (Cl)	7,522.	53.30	212.13	44.62
Bromine (Br)	15.0	0.11	0.18	0.04
Iodine (I)	0.5	--	--	--
Oxygen for Fe_2O_3 and Al_2O_3	21.62	0.15	--	--
Silica (SiO_2)	19.22	0.14	--	--
Iron (Fe)	5.0	0.03	--	--
Aluminum (Al)	21.8	0.15	--	--
Manganese (Mn)	0.5	--	--	--
Calcium (Ca)	479.	3.40	23.91	5.04
Strontium (Sr)	5.8	0.04	0.13	0.03
Magnesium (Mg)	292.7	2.07	24.07	5.06
Lithium (Li)	1.0	0.01	0.14	0.03
Potassium (K)	95.1	0.67	2.43	0.51
Sodium (Na)	4,285.	30.36	186.30	39.23
Ammonium (NH_4)	7.65	0.05	0.42	0.09
Total:	14,116.57	100.00	475.09	100.00

Dry residue at 110°C:	14,298 p.p.m.
Carbon dioxide (CO_2):	3.3 p.p.m. or 1.7 c.c. per liter
Concentration value:**	474.93 e.p.m.

* Units are micro-micro-curies or 1 x 10^{-12} curies.

** As explained previously, the concentration value reported by Elworthy may differ slightly from the sum of e.p.m. that the author has calculated.

SPRING IN EAST HOUSE

Date of sampling:	August, 1914
Temperature:	11.5°C (48°F)
Taste:	Saline
Specific gravity at 15°C:	1.0108
Radioactivity:	Emanation: 62 units
	Dissolved radium: 0.5 unit.

Constituents	Tenor		Reacting value	
	p.p.m.	% of total	e.p.m.	% of total
Sulfuric acid (SO_4)	722.13	5.25	15.03	3.24
Bicarbonic acid (HCO_3)	558.8	4.06	9.16	1.97
Nitric acid (NO_3)	1.4	0.01	--	--
Nitrous acid (NO_2)	0.48	--	--	--
Phosphoric acid (PO_4)	0.17	--	--	--
Metaboric acid (BO_2)	trace	--	--	--
Chlorine (Cl)	7,360.0	53.53	207.56	44.71
Bromine (Br)	30.0	0.22	0.38	0.08
Iodine (I)	0.8	0.01	--	--
Oxygen for Fe_2O_3 and Al_2O_3	16.08	0.12	--	--
Silica (SiO_2)	11.35	0.08	--	--
Iron (Fe)	3.75	0.03	--	--
Aluminum (Al)	16.20	0.12	--	--
Manganese (Mn)	0.40	--	--	--
Calcium (Ca)	485.3	3.53	24.22	5.21
Strontium (Sr)	7.12	0.05	0.16	0.04
Magnesium (Mg)	293.7	2.14	24.15	5.21
Lithium (Li)	1.3	0.01	0.19	0.04
Potassium (K)	68.92	0.50	1.76	0.38
Sodium (Na)	4,169.3	30.22	181.27	39.09
Ammonium (NH_4)	2.55	0.02	0.14	0.03
Total:	13,749.75	100.00	464.02	100.00

Dry residue at 110°C:	14,195 p.p.m.
Carbon dioxide:	20.1 p.p.m.
Concentration value:	463.90 e.p.m.

In the early 1900's Abenakis spring was the site of a flourishing health resort.

The water from Abenakis spring has been compared to those of many European springs, namely Homburg and Kissingen in Germany, Sebes in Hungary and Harrowgate in England.

A publicity tract distributed by the proprietor mentions an article by Dr. George Thomas Palmer published in the "Chicago Clinic and Pure

Water Journal" in which it is written that the Abenakis water could be used in the treatment of catarrhal diseases of the intestine, scrofulous and glandular diseases, gout, rheumatism and cirrhosis of the liver.

Muriated sodic waters such as Abenakis water are diuretic but their stimulating action on the kidneys is attenuated by their more pronounced action on the digestive tract.

Saline waters are more effective if they are used both internally and externally, namely to treat nervous ailments, articular or muscular rheumatism. Inhalations of sprayed saline waters are effective in the treatment of chronic inflammations of the larynx, the pharynx or the bronchia.

The following table taken from Elworthy's report shows the comparison between the compositions of the waters from Abenakis spring and Elizabeth spring in Homburg, Germany.

Constituents	Tenor in p.p.m.	
	Elizabeth spring	Abenakis spring
Sodium chloride ($NaCl$)	11,307.4	10,896.33
Magnesium chloride ($MgCl_2$)	1,113.1	1,087.12
Ferrous carbonate ($Fe\ CO_3$)	65.1	---
Calcium carbonate ($CaCO_3$)	1,570.3	769.34
Sodium sulfate (Na_2SO_4)	52.7	---
Magnesium carbonate ($MgCO_3$)	286.8	---
Silica (SiO_2)	45.7	19.22
Calcium sulfate ($CaSO_4$)	---	983.40
Other salts		361.15
Total:	14,441.3	14,116.56

CHAMBORD SPRING

Chambord spring, exploited by "L'eau naturelle purgative de Chambord Ltée," is located on lot 43, range I, Métabetchouan township, Roberval county. It occurs under the waters of Lake Saint-Jean, about 350 feet from the present shoreline.

The spring was discovered when it was noticed that farm animals drank at the site of the spring when the level of the lake was lower prior to the building of dams at Alma.

The spring is now enclosed in a reinforced concrete well ten feet square and 18 feet high, accessible during low waters in the Spring season.

The underlying rocks consist of Utica shales weathering to a more or less rusty color according to their pyrite content.*

The temperature of the spring water is appreciably lower than that of Lake Saint-Jean and is not contaminated by it. Its chemical composition would be practically unchanged since it was analysed by Monsignor Vachon of Laval university in 1927.

The water from Chambord spring, sold under the brand name of "Eau Ternal", is very clear even if is not filtrated. When bottled in its natural state, it keeps indefinitely. It has a very bitter saline taste. For internal use, it is generally diluted, under which form it is recommended for the relief of stomach troubles, rheumatism and laryngitis, acting at the same time as a mild purgative. In its natural state, it is used externally as an application for skin diseases, particularly eczema.

The following analytical results are those reported by Monsignor Vachon in 1927. It is the only analysis available on the Chambord spring.

Constituents		Per cent
Sulfites		4.73
Silica, aluminum and iron oxide		0.01
Lime	(CaO)	1.64
Magnesia	(MgO)	0.075
Sodium oxide	(Na_2O)	0.225
Sulfur trioxide	(SO_3)	0.02
Chlorine	(Cl)	2.4

COULOMBIA SPRING

Coulombia spring occurs on lot 259, Bas de l'Achigan concession, l'Epiphanie parish, seigniory of Saint-Sulpice, l'Assomption county, near l'Achigan river.

An inspection report dated 1929 mentions that the water rises in a well 35 feet deep. The place is now deserted and the equipment in ruins. Only a few persons draw some water occasionally.

The only available analysis is that carried out around 1925 by Rev. Father C.P. Choquette, professor of chemistry at Saint-Hyacinthe seminary.

* Dresser, J.A. Part of the Lake St. John area, Quebec; Geol. Surv. of Can. Memoir 92, 1918.

Analysis of water from Coulombia spring

Specific gravity 1.0040

Constituents		Tenor in p.p.m.
Sodium chloride	($NaCl$)	10,330.0
Potassium chloride	(KCl)	103.0
Calcium chloride	($CaCl_2$)	91.7
Magnesium chloride	($MgCl_2$)	682.4
Magnesium iodide	(MgI_2)	24.3
Magnesium bromide	($MgBr_2$)	27.0
Calcium sulfate	($CaSO_4$)	38.0
Calcium carbonate	($CaCO_3$)	554.3
Magnesium carbonate	($MgCO_3$)	35.4
Strontium carbonate	($SrCO_3$)	20.1
Barium carbonate	($BaCO_3$)	trace
Iron Carbonate	($FeCO_3$)	3.1
Manganese carbonate	($MnCO_3$)	trace
Silica	(SiO_2)	29.5
Alumina	(Al_2O_3)	1.3
Total		11,940.1

OKA SPRING

Oka spring occurs ¾ of a mile northeast of Oka monastery, probably on lot 173, Cote Saint-Isidore (North) range, l'Annonciation parish, Deux-Montagnes county.

The flow of the spring is abundant and would be around 600 gallons an hour.

The water from Oka spring is clear and has a pleasant mildly alkaline taste. A little carbon dioxide is added for bottling. This water, in great demand on the Montreal market, is recommended to persons suffering from diseases of the kidneys, the liver, the digestive or urinary tract.

The results of a chemical analysis performed in 1961 by F. Corminboeuf, chemist, are given as follows in a publicity leaflet distributed by "La Cie Eau-Vive d'Oka Ltée".

Dry residue at 105°C:	506.0 p.p.m.
Temperature of the water at the griffin:	10°C (50°F)
Specific gravity at 15.5°C:	1.0005
Reaction:	slightly alkaline

Constituents		Tenor in p.p.m.
Sodium bicarbonate	($NaHCO_3$)	159.5
Sodium sulfate	(Na_2SO_4)	147.3
Sodium chloride	($Na\ Cl$)	114.5
Calcium sulfate	($Ca\ SO_4$)	33.8
Magnesium carbonate	($MgCO_3$)	13.5
Calcium bicarbonate	($Ca\ (HCO_3)_2$)	12.7
Silica and alumina	(SiO_2, Al_2O_3)	5.4
Potassium chloride	(KCl)	2.5
Other elements	(K, Li, etc.)	16.8

PHILUDOR SPRING

The Philudor spring occurs in a ravine, near the viaduct built above the new part of Highway 9, on the farm of Napoléon Solis which occupies lot 50, northwest range of Yamaska river, Saint-Hyacinthe-le-Confesseur parish, Saint-Hyacinthe seignory, Saint-Hyacinthe county.

The water from Philudor spring has an agreeable mildly saline taste. Although it is said to contain hydrogen sulfide, this could not be verified either by tasting or smelling. The water issues from a metal pipe about 3 feet above the ground and falls into a wooden basin.

There is no protected area around the basin of the spring and the field where it is located serves as a pasture for animals.

The spring is not exploited at present but was in recent years.

The table of analytical results given below is based on Elworthy's report.

Date of sampling:	September, 1914
Temperature of the water:	8.6°C (47.5°F)
Flow:	One gallon per minute
Taste:	Slightly saline with indications of hydrogen sulfide.
Reaction:	Alkaline
Specific gravity at 15°C:	1.0046
Radioactivity:	Emanation - 106 units Dissolved radium - 46 units.

Constituents		Tenor		Reacting value	
		p.p.m.	% of total	e.p.m.	% of total
Sulfuric acid	(SO_4)	19.5	0.41	0.41	0.27
Bicarbonic acid	(HCO_3)	1,130.	23.59	18.52	12.50
Nitric acid	(NO_3)	15.8	0.33	0.25	0.17
Nitrous acid	(NO_2)	trace	--	--	--
Chlorine	(Cl)	1,943.0	40.57	54.79	37.00
Bromine	(Br)	7.0	0.15	0.09	0.06
Silica	(SiO_2)	14.5	0.30	--	--
Iron	(Fe)				
Aluminum	(Al)	4.68	0.10	0.17	0.11
Manganese	(Mn)	0.6	0.01	0.02	--
Calcium	(Ca)	54.6	1.14	2.73	1.84
Strontium	(Sr)	trace	--	--	--
Magnesium	(Mg)	64.1	1.34	5.27	3.56
Potassium	(K)	50.5	1.05	1.29	0.87
Sodium	(Na)	1,485.4	31.01	64.58	43.62
Ammonium	(NH_4)	0.002	--	--	--
Total		4,789.68	100.00	148.12	100.00

Concentration value: 148.12 e.p.m.

POTTON SPRING

Potton spring is located near the village of South Bolton, on lot 28, range VI, Potton township, Brome county.

The water flows from a crevice in the mountain side. Water seeps out of the ground at two spots within a hundred feet to the north.

It is a sulfur spring where the presence of hydrogen sulfide is easily detected by the taste and smell.

The spring is no longer exploited. Only occasional visitors draw water from it. The present proprietor also mentions that two health studios take their supply of water from the spring.

Potton spring was once the site of a health resort. The hotel burned in 1934 and was never rebuilt. This started the decline of the spring.

At the griffin, the water accumulates in a small natural basin, where gas bubbles burst at the surface, and overflows in a reservoir located downhill. Two or three days after bottling, this water loses its taste and smell of hydrogen sulfide.

The following table is based on analytical results reported by Elworthy.

Date of sampling:	September, 1914
Flow:	One gallon per minute
Temperature of water:	10°C (50°F)
Taste:	Slight taste of hydrogen sulfide
Reaction:	Alkaline
Specific gravity:	1.0002
Radioactivity:	Emanation 280 units

Constituents		Tenor		Reacting value	
		p.p.m.	% of total	e.p.m.	% of total
Sulfuric acid	(SO_4)	3.7	1.84	0.08	1.55
Bicarbonic acid	(HCO_3)	123.0	61.30	2.02	40.35
Nitric acid	(NO_3)	1.3	0.65	0.02	0.41
Chlorine	(Cl)	13.6	6.78	0.38	7.69
Silica	(SiO_2)	9.9	4.93	--	--
Iron and Aluminum		1.3	0.65	0.05	0.92
Calcium	(Ca)	23.6	11.75	1.18	23.53
Magnesium	(Mg)	6.1	3.04	0.50	10.05
Lithium	(Li)	0.01	--	--	0.02
Potassium	(K)	0.96	0.48	0.02	0.48
Sodium	(Na)	17.16	8.56	0.75	14.94
Ammonium	(NH_4)	0.05	0.02	--	0.06
Total		200.68	100.00	5.00	100.00

Dry residue at 110°C:	135 p.p.m.
Carbon dioxide (CO_2):	33.0 p.p.m. or 14.4 c.c./ liter
Hydrogen sulfide (H_2S)	1.0 p.p.m. or 0.6 c.c./ liter
Concentration value:	5.00 e.p.m.

RADNOR SPRING

Radnor spring occurs on the right bank of Lard river, in Sainte-Marguerite range, southeast side, Saint-Maurice parish, Champlain county, a few hundred feet off the rural road. The land is located in the former village of Fermont. It would appear that the spring is on lot 14.

Radnor spring, discovered in 1894, was originally the property of Canada Iron Furnace Co. Ltd. This company exploited the iron ore of the region to treat it in Radnor ironworks. A subsidiary company named Radnor Water Co. was formed to exploit the spring.

In 1905, Radnor Water Co. was recognized as supplier of mineral water to the Prince of Wales, which permitted the use of the royal coat-of-arms on labels. Today, the trademark still includes the royal crown.

The water rises from a drill hole 12 feet deep and spills into a basin whence it flows by gravity to the bottling plant and is then pumped into tanks.

The water from Radnor spring is used to combat dyspepsia and kidney diseases.

The following table is derived from analytical results reported by Elworthy.

Date of sampling:	September, 1914
Temperature of water:	9°C (48°F)
Flow:	20 gallons per minute
Taste:	pleasantly saline
Reaction:	alkaline
Specific gravity at 15 C:	1.0015
Radioactivity:	Emanation: 345 units Dissolved radium: 0.3 unit

Constituents		Tenor		Reacting value	
		p.p.m.	% of total	e.p.m.	% of total
Sulfuric acid	(SO_4)	105.0	5.56	2.19	3.58
Bicarbonic acid	(HCO_3)	224.0	12.92	3.67	6.50
Nitric acid	(NO_3)	3.9	0.21	0.06	0.10
Phosphoric acid	(PO_4)	0.01	--	--	--
Chlorine	(Cl)	869.0	46.01	24.51	39.78
Bromine	(Br)	1.7	0.09	0.02	0.04
Oxygen for Al_2O_3		2.4	0.13	--	--
Silica	(SiO_2)	11.8	0.62	--	--
Iron	(Fe)	2.0	0.11	0.07	0.11
Aluminum	(Al)	2.7	0.14	--	--
Calcium	(Ca)	97.0	5.14	4.84	7.89
Magnesium	(Mg)	57.0	3.02	4.69	7.62
Potassium	(K)	13.9	0.74	0.36	0.58
Sodium	(Na)	478.0	25.31	20.78	33.80
Ammonium	(NH_4)	0.02	--	--	--
Total		1,888.43	100.00	61.19	100.0

Dry residue at 110°C:	1,841 p.p.m.
Carbon dioxide (CO_2):	6.3 p.p.m. or 3.2 cc. per litre
Concentration value:	61.50 e.p.m.

Analyses of the Radnor water were also effected by J.T. Donald in 1894, and by J.T. Donald & Co. in 1953. The results, expressed as hypothetical combinations, agree with those of Elworthy.

RICHELIEU SPRING

The Richelieu spring occurs at Chambly, on lot 263, Grand Coteau range, Saint-Joseph de Chambly parish, Chambly seigniory, Chambly county.

This spring has been known for more than a hundred years, having been mentioned in reports of the Geological Survey of Canada for 1851 and 1852.

The water from Richelieu spring is a bicarbonated and muriated sodic type similar to that of the Vichy basin in France. It is bottled under the brand name of Montclair-Richelieu.

The water rises in a cement pit with a capacity of about 3,000 gallons. The flow is approximately one gallon per minute. Following a study made in 1913, professor G.H. Baril of Laval University stated that the water from Richelieu spring could be of value in the treatment of urinary diseases and diseases of the digestive organs, as well as for biliary or renal lithiasis, chronic rheumatism, gout and obesity.

The mineral water seems to constitute an underground basin of unknown extent. The author believes that the water obtained from Saint-Joseph spring located about 500 feet southwest of Richelieu spring, is of the same type. The water from Saint-Joseph spring is pumped manually through a drill hole 85 or 90 feet deep.

The following three tables give the analytical results of the water from Richelieu spring.

Analyses by T. Sterry Hunt

Constituents	p.p.m.		
	(1851)	(1852)	(1853)
Potassium chloride	--	32.4	18.2
Sodium chloride	868.9	838.7	884.6
Sodium carbonate	1,029.5	1,060.4	982.0
Calcium carbonate	54.0	38.0	25.3
Magnesium carbonate	90.8	76.5	65.0
Strontium carbonate	--	4.5	--
Iron carbonate	--	2.4	--
Alumina and phosphate	--	6.3	--
Silica	122.0	73.0	16.6
Borates, iodides and bromides	traces	traces	traces
Total	2,165.2	2,132.2	1,991.7

Analysis by Elworthy (1914)

The table also includes the analytical results obtained by G.H. Baril, chemist, Laval University, in 1913.

Date of sampling:	August, 1914
Temperature of water:	9.4°C (49°F)
Flow:	small
Taste:	slightly sweet and pleasant
Reaction:	alkaline
Specific gravity at 15°C:	1.0028
Radioactivity:	emanation: 104 units.

Constituents		Tenor			Reacting value (2)	
		p.p.m.		% of total	e.p.m.	% of total
		Baril (1)	Elworthy (2)	(2)		
Sulfuric acid	(SO_4)	--	0.89	0.03	0.02	0.03
Bicarbonic acid	(HCO_3)	569.00	1,228.00	47.80	20.13	28.90
Nitric acid	(NO_3)	--	1.50	0.06	0.02	0.03
Phosphoric acid	(PO_4)	1.86	0.17	--	--	--
Metaboric acid	(BO_2)	2.66	--	--	--	--
Chlorine	(Cl)	505.00	518.9	20.23	14.63	21.00
Bromine	(BN)	0.74	2.5	0.10	0.03	0.04
Iodine	(I)	0.58	trace	--	--	--
Oxygen for Al_2O_3		--	5.14	0.20	--	--
Silica	(SiO_2)	36.88	22.30	0.87	--	--
Iron	(Fe)	1.35	1.25	0.05	0.05	--
Aluminum	(Al)	0.53	5.80	0.23	--	--
Manganese	(Mn)	3.64	trace	--	--	--
Calcium	(Ca)	10.87	10.34	0.40	0.52	0.74
Strontium	(Sr)	1.22	1.02	0.04	0.02	0.03
Magnesium	(Mg)	22.37	18.89	0.74	1.55	2.23
Lithium	(Li)	0.44	0.58	0.02	0.08	0.12
Potassium	(K)	13.61	1.95	0.08	0.05	0.07
Sodium	(Na)	712.20	748.72	29.15	32.55	46.81
Ammonium	(NH_4)	--	0.03	--	--	--
Carbon dioxide	(CO_2)	532.43	--	--	--	--
Total		2,435.08	2,567.98	100.00	69.65	100.00

Dry residue at 110°C:	2,077 p.p.m.
Concentration value:	69.65 e.p.m.

Analysis by J.T. Donald & Co. Ltd. (July, 1963)

Constituents		p.p.m.
Suspended matter		37.6
Total iron		2.1
Silica	(SiO_2)	15.6
Calcium	(Ca)	9.6
Magnesium	(Mg)	18.7
Alkalies calculated as sodium	(Na)	775.8
Sulfate	(SO_4)	4.8
Chlorine	(Cl)	505.3
Bicarbonate	(HCO_3)	1,234.2
Carbonate	(CO_3)	35.0
Total		2,601.01

Suspended matter: 37.6 p.p.m.
Dry residue: 2,007.0 p.p.m.
pH : 8.3

The following table, showing the basic elements, compares the waters from Celestins spring, Vichy, and Richelieu spring.

Constituents		Vichy		Richelieu	
		p.p.m.	% of total	p.p.m.	% of total
Bicarbonate	(HCO_3)	2,980.0	60.58	1,234.2	48.13
Chlorine	(Cl)	241.0	4.90	505.3	19.71
Sulfate	(SO_4)	137.0	2.78	4.8	0.19
Silica	(SiO_2)	39.4	0.80	15.6	0.61
Calcium	(Ca)	102.0	2.07	9.6	0.37
Magnesium	(Mg)	7.0	0.14	18.7	0.73
Sodium	(Na)	1,329.0	27.02	775.8	30.26
Potassium	(K)	84.0	1.71	--	--
Total		4,919.4	100.00	2,564.0	100.00
Dry residue		3,668.) (180°C)		2,007.0 (110°C)	

SAINTE-GENEVIEVE DE BATISCAN SPRING

The Sainte-Geneviève de Batiscan spring is located on lot 551, concession south of Batiscan river, Sainte-Geneviève de Batiscan parish, Batiscan seigniory, Champlain county.

Many saline springs occur along the Batiscan river and they are all related to natural gas wells. The water from Sainte-Geneviève spring is sold under the brand name of "Eau Minérale Etoile".

This water issues from a drill hole about 200 feet deep. It flows naturally at the surface and is accompanied by natural gas.

At the griffin, the water has a very saline taste but this salinity is reduced to about 30% by diluting with pure water when bottling.

The following table, which includes results obtained by C.P. Choquette, Saint-Hyacinthe, is taken from Elworthy's report.

Date of sampling:	September, 1914
Temperature of water:	8.3°C (47°F)
Flow:	8 gallons per minute
Taste:	Very saline and bitter
Reaction:	Alkaline
Specific gravity at 15°C:	1.0220
Radioactivity:	Emanation: 14.5 units Dissolved radium: 0.8 unit

Constituents		Tenor p.p.m. Choquette (1)	Tenor p.p.m. Elworthy (2)	Tenor % of total (2)	Reacting value (2) e.p.m.	Reacting value (2) % of total
Sulfuric acid	(SO_4)	--	2.95	0.01	0.06	--
Bicarbonic acid	(HCO_3)	--	1123.	3.91	18.41	1.76
Carbonic acid	(CO_3)	464.3	--	--	--	--
Nitric acid	(NO_3)	--	0.6	--	0.01	--
Nitrous acid	(NO_2)	--	trace	--	--	--
Metaboric acid	(BO_2)	--	trace	--	--	--
Chlorine	(Cl)	14677.0	16850.0	58.77	475.18	48.20
Bromine	(Br)	--	34.0	0.12	0.43	0.04
Iodine	(I)	39.8	7.0	0.02	0.06	--
Oxygen for $Al_2 O_3$		--	9.1	0.03	--	--
Silica	(SiO_2)	26.0	11.0	0.04	--	--
Iron	(Fe)	5.4	17.2	0.06	0.62	0.06
Aluminum	(Al)	8.5	10.2	0.03	--	--
Manganese	(Mn)	--	0.02	--	--	--
Calcium	(Ca)	696.4	289.6	1.01	14.45	1.46
Strontium	(Sr)	203.0	7.32	0.02	0.17	0.02
Magnesium	(Mg)	909.5	891.0	3.11	73.27	7.42
Lithium	(Li)	0.2	1.01	--	0.15	0.01
Potassium	(K)	3.3	282.0	0.98	7.21	0.73
Sodium	(Na)	7829.0	9090.0	31.70	395.22	46.00
Ammonium	(NH_4)	--	55.0	0.19	3.05	0.30
Barium	(Ba)	84.2	--	--	--	--
Total		24,946.6	28,680.99	100.00	988.28	100.00

Dry residue at 110°C:	29,260 p.p.m.
Concentration value:	988.28 e.p.m.

SAINT-GERMAIN DE KAMOURASKA SPRING

Saint-Germain de Kamouraska spring occurs on lot 59, Saint-Louis de Kamouraska parish, Grandville and Lachenaye seigniory, Kamouraska county. Mining Concession 111, issued in 1918, covers lots 54 to 59 included.

The water rises from the rock at the foot of a steep cliff, along the shore of St. Lawrence river, in a well 5 feet square and 15 feet deep. It flows into a concrete basin 25 feet long, 6 feet wide and about 10 feet deep.

The spring is not exploited presently and its water appears to be contaminated by that of St. Lawrence river since a bottling plant has been built over the site of the spring.

No analysis of this water is available although the spring was exploited around 1920.

SAINT-JUSTIN SPRING

Saint-Justin spring is located on lot 193, l'Ormiere range, Saint-Justin parish, Carufel seigniory, Maskinongé county. The water issues from a well 75 feet deep, flows into a basin and is then pumped to the bottling plant. It appears that water of the same type is found in various wells bored in the surroundings.

Water from this spring is said to be mildly laxative. In Elworthy's report, this spring is described under the name of Maskinongé. Analytical results are as follow:

Date of sampling:	September, 1914
Temperature of water:	8.0°C (46.4°F)
Flow:	small
Taste:	pleasantly saline
Reaction:	alkaline
Specific gravity at 15°C:	1.0044
Radioactivity:	emanation: 79 units
	dissolved radium: 0.5 unit
	emanation in gas evolved: 250 units

Constituents		Tenor		Reacting value	
		p.p.m.	% of total	e.p.m.	% of total
Sulfuric acid	(SO_4)	2.7	0.04	0.06	0.03
Bicarbonic acid	(HCO_3)	1075.1	17.38	17.62	8.98
Nitric acid	(NO_3)	49.3	0.80	0.80	0.40
Nitrous acid	(NO_2)	1.35	0.02	0.03	0.01
Phosphoric acid	(PO_4)	0.07	--	--	--
Chlorine	(Cl)	2826.	45.68	79.70	40.55
Bromine	(Br)	6.0	0.09	0.08	0.03
Iodine	(I)	0.4	--	--	--
Oxygen for Al_2O_3		4.23	0.06	--	--
Silica	(SiO_2)	19.2	0.31	--	--
Iron	(Fe)	0.45	0.07	0.02	0.01
Aluminum	(Al)	4.30	0.08	--	--
Calcium	(Ca)	49.6	0.80	2.48	1.26
Magnesium	(Mg)	122.8	1.99	10.10	5.15
Lithium	(Li)	0.3	--	0.04	0.02
Potassium	(K)	145.2	2.34	3.71	1.89
Sodium	(Na)	1872.1	30.25	81.40	41.51
Ammonium	(NH_4)	5.7	0.09	0.32	0.16
Total		6,184.80	100.00	196.36	100.00

Dry residue at 100°C:	5,586 p.p.m.
Hydrogen sulfide:	0.6 p.p.m. or 0.4 cc/liter
Concentration value:	196.20 e.p.m.

A sample of Saint-Justin water, as sold in commerce, was analysed by F. Corminboeuf, chemist, in 1962. The results he obtained differ notably from the values published by Elworthy as can be seen from the following table of hypothetical combinations. Corminboeuf's figures are taken from a document supplied by the proprietor of the spring.

Constituents		Tenor in p.p.m.	
		Corminboeuf	Elworthy
Sodium nitrite	($NaNO_2$)	--	2.0
Sodium nitrate	($NaNO_3$)	--	67.6
Ammonium chloride	(NH_4Cl)	--	17.1
Potassium iodide	(KI)	--	0.6
Potassium bromide	(KBr)	--	9.0
Lithium chloride	(LiCl)	--	1.8
Potassium chloride	(KCl)	--	271.4
Sodium sulfate	(Na_2SO_4)	trace	4.0
Sodium chloride	(NaCl)	310.	4423.0
Sodium bicarbonate	($NaHCO_3$)	465.	411.0
Magnesium bicarbonate	($Mg(HCO_3)_2$)	96.	747.0
Calcium bicarbonate	$Ca(HCO_3)_2$)	49.	201.0
Ferrous bicarbonate	$Fe(HCO_3)_2$)	- --	1.5
Calcium phosphate	($Ca_3(PO_4)_2$)	--	0.1
Alumina	(Al_2O_3)	--	8.5
Silica	(SiO_2)	--	19.2
Total		920.	6,184.8

SAINT-LEON SPRING

Saint-Léon spring occurs on lot 59, Des Ambroises concession, Saint-Léon parish, Rivière-du-Loup en haut seigniory, Maskinongé county.

The water rises in a well 37 feet deep bored a few feet from the shore of Du Loup river. It flows naturally into a basin from where it is pumped to the bottling plant.

Saint-Léon spring was once the site of a health resort.

Many springs occur in the vicinity along the banks of Du Loup river and one of them, known as Lupien spring, located a mile upstream, was tapped in the past.

The following table is based on Elworthy's analysis.

Date of sampling:	September, 1914
Temperature of water:	8.7°C (48°F)
Flow:	1½ gallons per minute
Taste:	saline
Specific gravity at 15°C:	1.0106
Radioactivity:	emanation: 39 units
	dissolved radium: 2.2 units
	emanation in gas evolved: 140 units

Constituents		Tenor		Reacting value	
		p.p.m.	% of total	e.p.m.	% of total
Sulfuric acid	(SO_4)	2.37	0.02	0.05	0.01
Bicarbonic acid	(HCO_3)	1675.00	12.00	27.45	5.94
Nitric acid	(NO_3)	0.75	0.01	0.01	--
Nitrous acid	(NO_2)	trace	--	--	--
Phosphoric acid	(PO_4)	trace	--	--	--
Chlorine	(Cl)	7215.00	51.70	203.47	43.98
Bromine	(Br)	26.00	0.18	0.33	0.07
Iodine	(I)	3.00	0.02	0.02	--
Oxygen for Al_2O_3 and Fe_2O_3		12.14	0.08	--	--
Silica	(SiO_2)	31.5	0.23	--	--
Iron	(Fe)	3.0	0.02	0.11	--
Aluminum	(Al)	12.2	0.08	--	--
Manganese	(Mn)	0.1	--	--	--
Calcium	(Ca)	125.6	0.90	6.27	1.35
Strontium	(Si)	2.75	0.02	0.06	0.02
Magnesium	(Mg)	423.3	3.03	34.81	7.54
Lithium	(Li)	0.57	0.01	0.08	0.02
Potassium	(K)	154.9	1.11	3.96	0.86
Sodium	(Na)	4250.2	30.45	184.79	39.97
Ammonium	(NH_4)	20.0	0.14	1.11	0.24
Total		13,958.38	100.00	462.52	100.00

Dry residue at 110°C: 13,796 p.p.m.
Hydrogen sulfide (H_2S): 1.9 p.p.m.
Concentration value: 462.22 e.p.m.

T.S. Hunt analysed the Saint-Léon spring water and his results were published in the Report of Progress for 1863 of the Geological Survey of Canada. They are expressed as hypothetical combinations. The results are given in the following table with those of Elworthy, thus enabling the reader to judge the value of analytical results expressed as hypothetical combinations.

Constituents		Tenor in p.p.m.	
		Elworthy	Hunt
Sodium nitrite	($NaNO_2$)	trace	--
Sodium nitrate	($NaNO_3$)	1.2	--
Ammonium chloride	(NH_4Cl)	59.44	--
Potassium iodide	(KI)	3.98	--
Magnesium iodide	(MgI_2)	--	4.6
Potassium bromide	(KBr)	39.68	--
Magnesium bromide	($MgBr_2$)	--	9.1
Lithium chloride	(Li Cl)	3.44	--
Potassium chloride	(K Cl)	269.91	183.2
Sodium chloride	(NaCl)	10,809.45	11,496.8
Magnesium chloride	($Mg\ Cl_2$)	650.42	663.6
Calcium chloride	($CaCl_2$)	--	71.8
Strontium chloride	($SrCl_2$)	--	1.9
Barium chloride	($BaCl_2$)	--	1.9
Magnesium sulfate	($MgSO_4$)	2.95	--
Calcium bicarbonate	($Ca(HCO_3)_2$)	508.68	--
Magnesium bicarbonate	($Mg(HCO_3)_2$)	1,544.70	--
Strontium bicarbonate	($Sr(HCO_3)_2$)	6.81	--
Calcium carbonate	($CaCO_3$)	--	349.3
Magnesium carbonate	($MgCO_3$)	--	938.8
Iron carbonate	($FeCO_3$)	--	14.5
Calcium phosphate	($Ca_3(PO_4)_2$)	trace	--
Ferric oxide	(Fe_2O_3)	4.29	--
Alumina	(Al_2O_3)	23.00	14.5
Silica	(SiO_2)	31.50	86.5
Manganese oxide	(Mn_3O_4)	0.15	--
Total		13,958.39	13,836.5

VARENNES SPRING

Varennes spring is located about a mile north of the village of Varennes and 500 yards from the shore of St. Lawrence river, in Cap Saint-Michel seigniory, Verchères county.

The water of this spring is sold under the brand name of "Vee de Vee".

The flow of the spring has been modified to yield about 4,000 gallons per hour.

The following table is based on Elworthy's analytical results. An analysis made by T.S. Hunt was published in the report of Progress of the Geological Survey of Canada for 1863, but since the results were expressed as hypothetical combinations which, as shown in the preceding table, are devoid of comparative value, they will not be reproducted.

Date of sampling:	October, 1915
Temperature of water:	8.6°C (47.5°F)
Flow:	about 180 gallons per hour
Taste:	saline
Reaction:	alkaline
Specific gravity at 15°C:	1.009
Radioactivity:	emanation: 224 units dissolved radium: 9.2 units emanation in gas evolved: 810 units

Constituents		Tenor		Reacting value	
		p.p.m.	% of total	e.p.m.	% of total
Sulfuric acid	(SO_4)	1.5	0.01	0.03	0.01
Bicarbonic acid	(HCO_3)	1,285.0	11.05	21.06	5.48
Nitrous acid	(NO_2)	0.5	--	0.01	--
Chlorine	(Cl)	6,060.5	52.08	170.91	44.45
Bromine	(Br)	18.0	0.15	0.23	0.06
Iodine	(I)	0.7	--	--	--
Oxygen for Al_2O_3		3.28	0.03	--	--
Silica	(SiO_2)	15.8	0.14	--	--
Iron	(Fe)	0.7	--	0.03	0.01
Aluminum	(Al)	3.7	0.03	--	--
Manganese	(Mn)	0.06	--	--	--
Calcium	(Ca)	99.5	0.86	4.97	1.30
Strontium	(Sr)	1.2	0.01	0.03	--
Magnesium	(Mg)	200.0	1.72	16.45	4.28
Lithium	(Li)	4.6	0.04	0.66	0.17
Potassium	(K)	84.5	0.73	2.16	0.56
Sodium	(Na)	3,858.2	33.15	167.75	43.68
Ammonium	(NH_4)	--	--	--	--
Total		11,634.01	100.00	384.29	100.00

Dry residue at 110°C:	11,220 p.p.m.
Concentration value:	384.09 e.p.m.

SPRING IN THE CITY OF JOLIETTE

The spring in the city of Joliette occurs in a municipal park, near the bridge across l'Assomption river. The water rises in a 65-foot deep well drilled in 1890. The flow is abundant enough to feed three large taps used to fill jugs, and four fountains. The temperature of the water is constant at 45°F.

Reports found in the archives of the city mention that the water from Joliette spring contains salts of calcium and iron, polysulfides of sodium and potassium, and carbonates. The dry residue would amount to 298 p.p.m. and the tenor of hydrogen sulfide would be 11.5 p.p.m. The water has a marked taste of hydrogen sulfide.

This water is used abundantly by the citizens of Joliette.

COMPARISON BETWEEN A FEW SPRINGS IN QUEBEC AND FRANCE

In the following tables, the author has summarized the chemical composition of some French mineral water. In the table hereafter, it can be seen that the water from Abenakis, Sainte-Geneviève, Saint-Léon and Varennes springs bears some similarity with that of Uriage, Salins (Jura) and Salins (Savoie). The Uriage water contains hydrogen sulfide and for this reason is used to combat skin diseases. The hydromineral health resorts of Salins (Jura) and Salins (Savoie) specialize in the treatment of children and gynecologic diseases.

Constituents	QUEBEC					
	Abenakis		St. Léon		Varennes	
	p.p.m.	e.p.m.(%)	p.p.m.	e.p.m.(%)	p.p.m.	e.p.m.(%)
HCO_3	588.	2.03	1675.00	5.94	1285.0	5.48
Cl	7522.	44.62	7215.00	43.98	6060.5	44.45
SO_4	754.	3.32	2.37	0.01	1.5	0.01
SiO_2	19.22	--	31.5	--	15.8	--
Ca	479.	5.04	125.6	1.35	99.5	1.30
Mg	292.7	5.06	423.3	7.54	200.0	4.28
Na	4285.	38.23	4250.2	39.97	3858.2	43.68
K	95.1	0.51	154.9	0.86	84.5	0.56
Concentration value		474.93		462.22		384.09
Dry residue	14,298.		13,796		11,220.	

Constituents	FRANCE					
	Uriage		Salins (Jura)		Salins (Savoie)	
	p.p.m.	e.p.m.(%)	p.p.m.	e.p.m.(%)	p.p.m.	e.p.m.(%)
HCO_3	597.	2.6	--	--	1033.	3.3
Cl	4265.	33.0	14,549.	46.6	7025.	38.6
SO_4	2520.	14.4	1,373.	3.3	2036.	8.2
SiO_2	30.	--	--	--	32.	--
Ca	473.	6.5	418.	2.4	774.	7.6
Mg	115.	2.6	222.	2.0	146.	2.3
Na	3383.	40.5	8965.	44.3	4661.	39.6
K	49.	0.4	450.	1.4	76.	0.4
Concentration value		363.2		880.		513.
Dry residu	11,160.		26,000.		15,350	

The following table shows that Saint-Justin and Philudor springs have a chemical composition near that of La Bourboule.

Constituents	QUEBEC				FRANCE	
	St. Justin		Philudor		La Bourboule	
	p.p.m.	e.p.m.%	p.p.m.	e.p.m.%	p.p.m.	e.p.m.%
HCO_3	1075.	8.98	1130.	12.50	1758.	16.9
Cl	2826.	40.55	1943.0	37.00	1919.	31.6
SO_4	3.	0.03	19.5	0.27	140.	1.7
SiO_2	19.2	--	14.5	--	105.	--
Ca	49.6	1.26	54.6	1.84	43.	1.2
Mg	122.8	5.15	64.1	3.56	11.	0.5
Na	1872.1	41.51	1485.4	43.62	1831.	46.6
K	145.2	1.89	50.5	0.87	101.	1.5
Concentration value		196.		148.12		171.
Dry residue	5,586.		4790.		5,038.	

However, it should be noted that the water from La Bourboule contains arsenic, and for this reason, is used in the treatment of children and skin diseases, and affections of the respiratory tract.

Potton water can be compared to that of many weakly mineralized French springs such as Alet, Evian and La Roche-Posay. These waters could probably all be used for the same purposes but due to the specialization now aimed at in the French health resorts, the Alet water is used in cases of gastro-intestinal troubles, that of Evian for kidney diseases, and that of La Roche-Posay for skin diseases. It is likely that the Potton water possesses the curative properties of French springs of comparable composition, but due to its tenor of hydrogen sulfide, it should be suitable in the treatment of skin diseases.

Constituents	QUEBEC		FRANCE					
	Potton		Alet		Evian-les-Bains		La Roche-Posay	
	p.p.m.	e.p.m.(%)	p.p.m.	e.p.m.(%)	p.p.m.	e.p.m.(%)	p.p.m.	e.p.m.(%)
HCO_3	123.0	40.35	464.	41.5	383.	45.3	385.	39.0
Cl	13.6	7.69	40.	6.0	tr.	--	18.	3.2
SO_4	3.7	1.55	26.	2.7	32.	5.0	52.	7.0
SiO_2	9.9	--	28.	--	--	--	29.	--
Ca	23.6	23.53	103.	27.3	83.	30.2	126.	39.9
Mg	6.1	10.05	27.	12.2	32.	18.7	7.	3.8
Na	17.16	14.94	42.	9.8	3.	0.7	20.	5.7
K	0.96	0.48	5.	0.5	--	--	5.	0.6
Concentration value		5.00		18.3		13.9		15.8
Dry residue	135.		500.		304.		448.	

The following table shows that Radnor water compares to that of Luxeuil-les-Bains and Bourbon-Lancy. The Luxeuil spa specializes in the treatment of gynecologic troubles and affections of the blood vessels whereas Bourbon-Lancy specializes in the treatment of articular diseases: rheumatism, gout, arthritis, etc.

	QUEBEC		FRANCE			
	Radnor		Luxeuil-les-Bains		Bourbon-Lancy	
	p.p.m.	e.p.m.(%)	p.p.m.	e.p.m.(%)	p.p.m.	e.p.m.(%)
HCO_3	224.0	6.50	103.	5.4	261.	7.8
Cl	869.0	39.78	401.	36.2	748.	38.5
SO_4	105.0	3.58	100.	6.7	77.	2.9
SiO_2	11.8	--	86.	--	73.	--
Ca	97.0	7.89	26.	4.2	78.	6.9
Mg	57.0	7.62	2.	0.6	3.	0.5
Na	478.0	33.80	321.	44.9	528.	42.0
K	13.9	0.58	24.	1.9	33.	1.5
Concentration value		61.50		31.2		54.8
Dry residue	1,841.		1,038		1,715.	

The last table shows that the water from Richelieu spring compares to that of Mont-Doré which is used especially in the treatment of the respiratory ducts.

Constituents	QUEBEC		FRANCE	
	Richelieu		Momt Dore	
	p.p.m.	e.p.m.(%)	p.p.m.	e.p.m.(%)
HCO_3	1,228.0	28.90	998.	35.2
Cl	518.9	21.00	218.	13.1
SO_4	0.9	0.03	40.	1.7
SiO_2	22.3	--	171.	--
Ca	10.3	0.74	90.0	9.7
Mg	18.9	2.23	29.	5.2
Na	748.7	46.81	351.	32.8
K	1.9	0.07	41.	2.4
Concentration value		69.95		46.6
Dry residue	2,077.		1,438.	

ECONOMIC ASPECT

Mineral waters of Quebec contribute a very minor part to the economy of the province as evidenced by the following figures. The table hereunder gives the production of mineral water in Quebec and Canada since 1888 as well as imports for the corresponding period. These production figures apply to bottled water and do not include water consumed at the spring. For many years, Quebec has contributed the majority of the Canadian production.

In federal statistics, the import figures for mineral water are included with those of nonalcoholic beverages since 1962, so that it is now impossible to evaluate the amount of imported mineral water. However, it should be noted that France contributes more than half and sometimes nearly the totality of imports.

Export figures have not been compiled because they amount to a very small percentage compared to imports and the Canadian production.

COMPARISON OF THE QUEBEC PRODUCTION OF MINERAL WATER

with

THE CANADIAN PRODUCTION AND IMPORTS

Year	Quebec Amount (gallons)	Quebec Value $	Canada Amount (gallons)	Canada Value $	Imports
1888	--	--	124,850	11,456.	$ 54,891.
1889	--	--	424,600	37,360.	66,331.
1890	--	--	561,165	66,031.	71,521.
1891	--	--	427,485	54,268.	15,721.
1892	--	--	640,380	75,348.	17,913.
1893	--	--	725,096	108,347.	27,909.
1894	--	--	767,460	110,040.	28,130.
1895	--	--	739,382	126,048.	27,879.
1896	--	--	706,372	111,736.	32,674.
1897	--	--	749,691	141,477.	22,142.
1898	--	--	555,000	100,000.	33,314.
1899	--	--	--	100,000.	38,046.
1900	--	--	--	75,000.	30,343.
1901	--	--	--	100,000.	40,802.
1902	--	--	--	100,000.	91,871.
1903	--	--	--	100,000.	108,130.
1904	--	--	--	100,000.	137,304.
1905	--	--	--	100,000.	161,790.
1906	--	--	--	100,000.	178,639.
1907	--	--	--	136,020.	143,416.
1908	--	--	--	151,953.	153,851.
1909	32,537	17,246.	--	175,173.	184,071.
1910	216,600	68,155.	--	199,563.	202,306.
1911	168,489	65,648.	--	223,758.	229,367.
1912	99,452	39,854.	--	172,465	273,698.
1913	77,313	31,728.	--	173,677.	257,153.
1914	115,580	23,569.	--	134,111.	199,327.
1915	358,275	33,084.	--	115,274.	126,569.
1916	115,210	18,574.	--	127,806.	130,933.
1917	--	6,553.	--	145,814.	108,444.
1918	--	6,111.	--	154,468.	105,967.
1919	30,519	12,608.	--	71,015.	113,743.
1920	20,811	9,962.	--	24,582.	178,511.
1921	14,621	5,339.	328,273	21,716.	159,092.
1922	12,161	3,692.	221,433	14,220.	156,420.
1923	5,499	2,450.	232,451	16,455.	169,473.
1924	7,683	2,288.	209,353	15,421.	181,107.
1925	5,222	9,302.	190,134	28,413.	186,543.

Year	Quebec Amount (gallons)	Quebec Value $	Canada Amount (gallons)	Canada Value $	Canada Imports
1926	6,956	2,244.	215,356	29,721.	$187,353.
1927	10,330	1,813.	303,530	14,624.	216,793.
1928	12,591	3,038.	269,045	33,498.	209,714.
1929	12,205	2,488.	321,905	16,139.	253,940.
1930	12,941	3,727.	227,141	24,481.	195,257.
1931	19,868	4,746.	217,408	13,234.	154,971.
1932	15,506	4,697.	76,714	7,170.	110,040.
1933	9,024	3,094.	38,818	5,441.	77,552.
1934	75,665	16,116.	97,440	17,738.	87,618.
1935	126,616	15,113.	146,516	16,590.	85,514.
1936	131,186	17,399.	154,286	18,516.	89,505.
1937	198,319	19,697.	225,019	20,586.	88,607.
1938	159,893	19,033.	188,309	21,619.	61,928.
1939	104,629	17,503.	123,769	19,105.	69,525.
1940	109,025	18,466.	140,663	20,892.	37,175.
1941	144,441	58,062.	181,064	72,531.	20,108.
1942	129,062	60,316.	157,085	74,505.	6,369.
1943	125,605	61,793.	139,611	67,541.	8,075.
1944	148,965	88,113.	156,159	88,918.	15,121.
1945	236,476	148,714.	244,761	149,690.	7,239.
1946	211,842	121,526.	217,842	122,404.	42,798.
1947	195,452	116,840.	198,952	117,440.	36,628.
1948	190,136	109,789.	192,539	110,259.	56,822.
1949	304,216	145,830.	306,691	146,240.	61,757.
1950	316,654	158,457.	318,829	158,897.	86,611.
1951	322,800	146,521.	325,300	146,971	103,049.
1952	309,125	165,593.	311,495	166,033.	138,710.
1953	309,285.	165,334.	309,585	165,484.	169,715.
1954	282,078	147,307.	284,078	148,057	219,783.
1955	303,110	158,495.	306,683	160,510.	249,780.
1956	290,526	148,167.	292,526	149,867.	302,928.
1957	346,210	183,155.	348,710	185,167.	315,798.
1958	314,294	170,622.	316,737	172,568.	408,194.
1959	366,088	201,033.	369,113	202,968.	503,818.
1960	372,799	199,874.	375,425	201,764.	620,373.
1961	357,948	205,923.	364,933	208,709.	429,862.
1962*			367,000	212,800.	

* Figures for 1962 are preliminary estimates.

CONCLUSION

The 14 springs described in this report do not constitute an exhaustive list of the known springs in Quebec. If the exploitation of the presently known springs expands due to a better knowledge of their properties, no doubt many others will be added to the list. In fact, 5 of the springs described here are not mentioned in Elworthy's report.

Except for Russia, 577 hydromineral health resorts are known in Europe, about a hundred located in France. Russia has nearly 150 health resorts with 165,000 beds. France alone has more than 1,800 mineral springs in operation.

It does not fall within the competence of the author to judge the therapeutic value of mineral waters and hydromineral cures. However, the following facts, which deserve consideration, may help the reader. A great number of specialized physicians devote their time and knowledge to the French spas. The medical memento of French spas for 1963 gives a list of 142 physicians, including 42 specialists, for the Vichy station alone. Moreover, in France, medical care and treatments are paid by Social Security. There are even establishments reserved for war veterans in that country. In the case of Russia, it is doubtful that so many health resorts (150) would be maintained only for their tourist value.

The chemical and physical properties of mineral waters of Quebec compare to those of numerous European springs. Even though it cannot be asserted outright that Quebec waters possess the same therapeutic properties, it is only natural to foresee comparable applications. Only medical research could establish positively the therapeutic value of mineral waters in the province.

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