A LITHOGEOCHEMICAL STUDY OF THE ST. LAWRENCE GRANITE, NEWFOUNDLAND

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by

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ABSTRACT

The St. Lawrence map area is underlain mainly by a sequence of Proterozoic flows, pyroclastics and volcanogenic sediments which are unconformably overlain by a Cambrian sequence of sandstone, siltstone, greywacke, shale and locally nodular limestone and conglomerate. These formations were subsequently intruded (in chronological order) by gabbro, the St. Lawrence fluorite-bearing alaskite granite, and later acidic and basic dykes. The alaskite granite has been dated isotopically by rubidium-strontium at 330 $\pm$ 10 million years.

The St. Lawrence granite is a pink to red granitic rock characterised by a scarcity of ferromagnesian minerals. Petrographic studies show it to be composed essentially of quartz, orthoclase and albite with minor amounts of riebeckite, aegirine, biotite, fluorite, magnetite and hematite. Perthitic and granophyric textures are common.

Two hundred and fifty rock samples were collected in the map area and 140 granitic rocks were analysed for major elements and 220 for trace elements, showing that it is distinctly high in SiO_2 (average 76.7 per cent), Zr (average 516 ppm), Rb (average 295 ppm) and F (average 1308 ppm), and low in Al_2O_3 (average 10.9 per cent), CaO (average 0.36 per cent), Sr (less than 10 ppm) and Ba (average 70 ppm). Mineralogically, it contains relatively sodic plagioclase (average An_{10}) and silica-undersaturated mafic minerals such as riebeckite and aegirine

and this is reflected in normative acmite. These chemical and mineralogical features classify the St. Lawrence granite as peralkaline.

Normative Q-Ab-Or plot of the analyses fall in a field centred on the ternary minimum at 0.5 kb, suggesting a temperature of crystallisation of the granite at about 780°C. It has been considered to be a relatively dry hot melt because of its low P_{H_2O} minimum composition (i.e. a hypersolvus granite) by the presence of tuffisites and the lack of pegmatites, all also suggesting a shallow depth of intrusion. The magma was probably formed by limited fractional melting at the base of the continental crust or by fractionation of a rather uniform and relatively calcalkaline acid parent.

The St. Lawrence granite is mineralogically and chemically very similar to the riebeckite-aegirine-bearing granites of Kudaru and Liruei of Nigeria. Although the Traytown granite of Newfoundland is riebeckite-bearing, there is a distinct difference in its trace elements compared to the St. Lawrence granite.

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CHAPTER 1

INTRODUCTION

1.1. General

The St. Lawrence area is located between latitudes 46° 55'N to 47° 05'N and longitudes 55° 20'W to 55° 35'W on the southern end of Burin Peninsula of southern Newfoundland (Fig. 1). The area under investigation is about 357 square Km (17 x 21 Km), located on parts of National Topographic Series 1:50,000 scale topographic maps Sheet 1, Nos. L/14 West, L/3 West, L/13 East and L/4 East.

Geological mapping, rock sampling and subsequent laboratory work were carried out by the writer during employment with David S. Robertson and Associates. The total time spent in the field was about six weeks beginning August 1st, 1972. Base maps and coloured aerial photographs at a scale of 1:12,000 were provided by David S. Robertson and Associates.

1.2. Purpose of the study

The main aim of this study was to determine why the St. Lawrence pluton is so outstandingly enriched in fluorite compared to the other granitoid rocks of Newfoundland. The approach taken was to try and answer corollary questions concerning the petrogenesis of the granite, based primarily on a detailed study of the bulk chemistry with less detailed studies

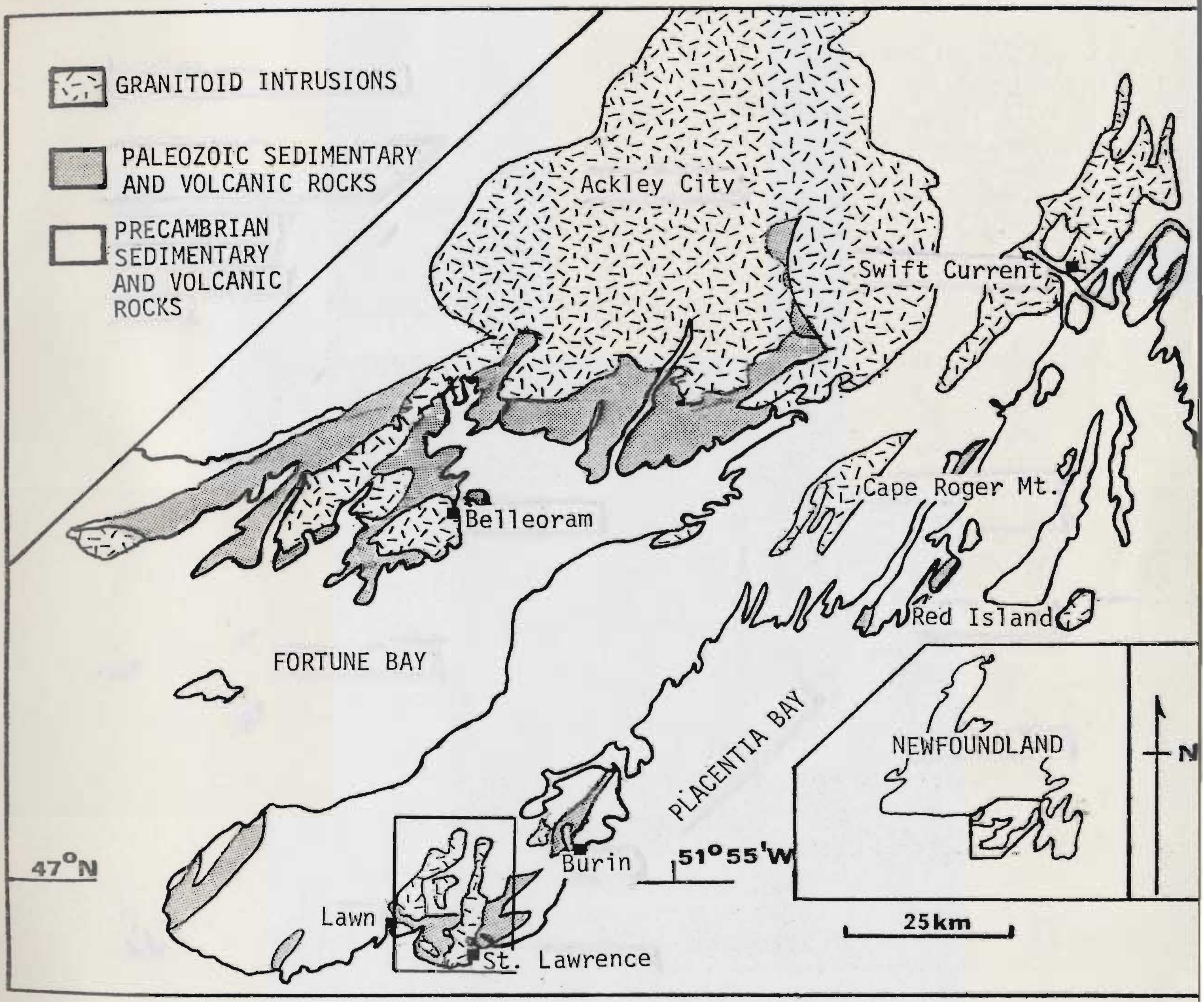

Figure 1: Location map of the study area at St. Lawrence, Newfoundland.

of petrography and mineralogy. It was hoped that the study might also yield information useful in exploration for fluorite on both a local and regional scale and in general.

1.3. Physiography

The topography in the St. Lawrence area is essentially the result of glacial action. The hills are generally bare and, although low, stand out prominently from the surrounding country. The most striking feature of the topography is the lee and stoss profile shown by the hills, a good example shown by Mount Margaret, which has a gentle smooth incline on its north side and a steep precipitous south side (Plate 1). The granite generally occupies the lowlands because of preferential erosion due to intense jointing, while the sedimentary and volcanic rocks form the high hills, except in the Ryan's Hill area where the granite is topographically high. Where geological contacts trend roughly in the same direction as that of the ice movement, i.e. southeasterly, they show no topographic expression of their existence. Where contacts trend approximately at right angles to the direction of ice movement there is generally some topographic expression, provided that there is also a physical difference in rock types on either side of the contact.

The coastline is generally rugged, with steep cliffs mainly in areas composed of rocks other than granite. This is shown in St. Lawrence Harbour where steep cliffs of Chapeau Rouge and Mt. Calapoose (sedimentary rocks) give way to a lower coastline of granite as at Blue Beach and in the harbour (Plate 2).

The main drainage system runs from north to south with all the streams apparently controlled by jointing and the direction of glacial movement. Nearly all the streams are in the youthful stage, characterised by rapids, waterfalls and pot-holes. The area is poorly drained because of high precipitation, low relief, and the presence of an 0.5 to 2 meters thick peat layer in the boggy areas.

Owing to the scarcity of good soil, and poor drainage, strong wind and lack of sunshine, vegetation is sparse and trees only grow in favourable well-drained valleys. Eighty per cent of the area is treeless. The general impression of the area is one of boggy terrain spotted with numerous ponds and very little rock exposure.

Evidence of ice movement, e.g. the lee and stoss profile of Mount Margaret, indicates that the glacial action was in a generally south-east direction. Further evidence of a southeast direction of ice movement is shown by striae and deep grooves on the bare hill tops. Other striking glacial features are the elongated ponds (Fig. 2) and the distribution of eskers and erratics in the north-south direction. The glacial drift ranges from 2 to 12 meters thick east of Church vein and is 24 meters

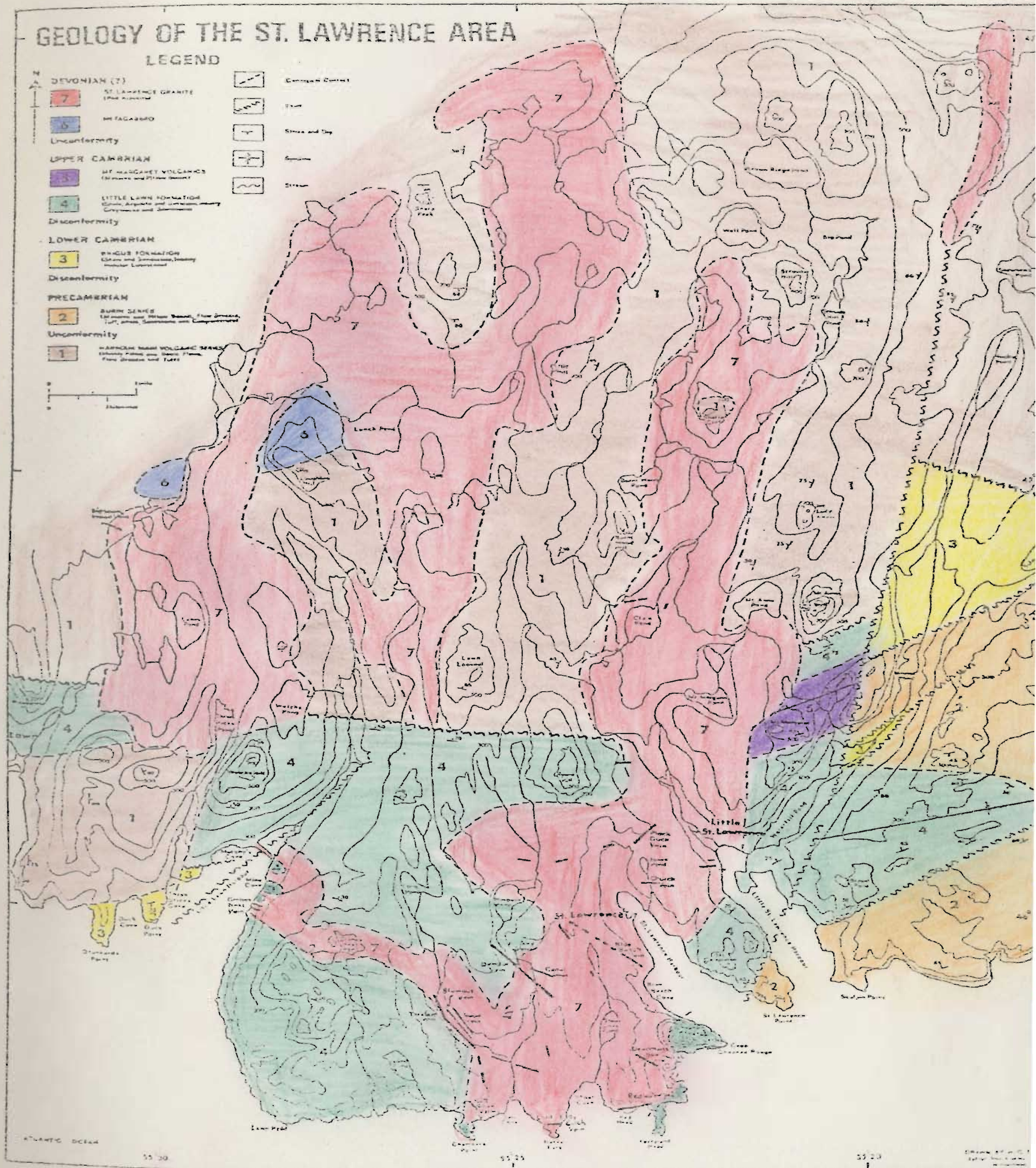

Figure 2: General Geology of the study area. (Enlargement in back pocket).

thick south of Mount Margaret. This thick glacial drift greatly hinders field observations, with outcrops only exposed along the coast, in road cuts, and on hills.

1.4. Previous work

Fluorite has long been known to occur at St. Lawrence, it being reported that the Portuguese mined the fluorite veins for their galena content as long ago as the 18th century (Murray and Howley, 1881). Except for private reports of the mining companies, all geological work in the St. Lawrence area has been done by the Geological Survey of Newfoundland.

Jukes (1843) first mentioned the presence of fluorite in the St. Lawrence area. Murray and Howley paid a visit to St. Lawrence between 1864 and 1880 and mention the area in their report (1881).

Commercial production started in 1933 when the St. Lawrence Corporation of Newfoundland Limited mined the Black Duck vein, located 1.5 km northeast of the town of St. Lawrence. These operations were followed in 1940 by the Newfoundland Fluorspar Company Limited, a wholly owned subsidiary of the Aluminium Company of Canada Limited, which opened the Director mine, about 2 km east of St. Lawrence.

It was not until 1936 that Kauffmann (1936) carried out reconnaissance geological mapping of 65 square km of the area north and east of St. Lawrence. He included a brief description of the fluorite deposit. Howse and Fischer (1935) produced a more detailed map of the area covering 100 square km west and north of St. Lawrence, and they later published a report on the fluorite deposit of St. Lawrence (1939). Kelleher (1940) presented a paper dealing chiefly with the mining methods employed at St. Lawrence. The most comprehensive geological mapping of the area was carried out by Van Alstine and his assistants in the years 1939, 1940 and 1941, and published in a Bulletin of the Newfoundland Department of Mines in 1948. Baird (1953) described some aspects of the geology of the area. Williamson (1956) described the Geology of the St. Lawrence area giving a thorough descriptive account of the rock types present.

Considerable exploration and prospecting was carried out throughout this period, principally by the Aluminium Company of Canada. David S. Robertson and Associates, in conjunction with Combustion Engineering of New York (CERA), have been involved in prospecting for fluorite in the area since 1971. Field work for the present study was carried out while the writer was employed on the CERA program.

1.5. Method of investigation

Initial mapping of the area was carried out using enlarged coloured aerial photographs at a scale of 1:12,000, and with base maps drawn from a mosaic of these photographs.

All the accessible granite was visited and special attention was focussed on the granite-country rock contacts. Since the granite generally occupies the boggy and vegetated lowland, contacts were only rarely seen and thus had to be approximated. This could be done in some cases by means of subtle colour differences in vegetation shown on the aerial photographs, with confirmation in the field wherever possible. An aerial magnetic survey was carried out over the area by CERA in 1973, which allowed contacts between the granite and the volcanic rocks to be readily distinguished although the contacts between granite and sedimentary rocks were less clearly defined.

Rock samples were collected at all possible outcrops, with the best exposures occuring on the coast, in road cuts, stream beds and on barren hills. Although there was a concerted attempt to collect fresh samples, in some places the outcrops were so weathered that it was impossible to collect a fresh sample,especially in stream beds and on barren hills. Nevertheless, weathered samples were taken in order to provide complete areal coverage, with the hope that allowances for alteration effects might be possible. Although some areas were completely devoid of outcrops, no till or boulder samples were taken because of a lack of information on distances of glacial transport. At randomly chosen localities two rock samples were taken so as to provide an idea of sample variation on the outcrop scale (i.e. to evaluate sampling errors) as suggested by Garrett (1969).

1.6. Acknowledgements

The writer is most grateful to Dr. D. F. Strong for his invaluable supervision and guidance and to faculty members of Memorial University for advice and suggestions.

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CHAPTER 2

GENERAL GEOLOGY

2.1. General statement

The main work of the present study was concerned with the granite, with only reconnaisance observations on the country rocks. Thus the following section is based primarily on the work of Van Alstine (1948) and Williamson (1956).

The area lies on the southwestern flank of the Avalon Platform, in Zone H of the Canadian Appalachian Structural Province (Williams, et al., 1972). It is underlain mainly by a sequence of Proterozoic flows, pyroclastics and volcanogenic sediments which are unconformably overlain by a Cambrian sequence of sandstone, siltstone, greywacke, shale and locally nodular limestone and conglomerate. These formations were subsequently intruded (in chronological order) by gabbro, the St. Lawrence fluorite-bearing alaskite granite, and later acidic and basic dykes. The alaskite granite has been dated isotopically by rubidium-strontium at 330± 10 million years (K. Bell, pers. comm., 1974). The various interpretations of the stratigraphy of the area are given in Table 1.

Van Alstine (1948) described a sequence of basic lava flows, pyroclastics and argillaceous sediments e.g. Burin Series, Little Lawn Formation and Mount Margaret volcanics, which he

TABLE 1

STRATIGRAPHIC SUCCESSION IN THE ST. LAWRENCE AREA

PERIOD	VAN ALSTINE 1948	WILLIAMSON 1956
Recent		Stratified sand & gravel, stream deposits.
Pleistocene		Glacial till & outwash deposits
		UNCONFORMITY
Devonian	Lamprophyre dykes	Basic dykes
	Rhyolite porphyry	Acidic dykes
	St. Lawrence granite	St. Lawrence batholith
	Diabase & metagabbro	Basic intrusive rocks
Ordovician	Mount Margaret Volcanics	
	Little Lawn Formation	
	Burin Series	
	UNCONFORMITY	
Cambrian U		Mount Margaret Volcanics
		Little Lawn Formation
M	Kelligrews Brook, Long Pond, & Chamberlain Brook Formations	Kelligrews Brook & Long Pond Formations
		DISCONFORMITY
L	Brigus Formation Smith Point Member	Brigus Formation
	UNCONFORMITY	DISCONFORMITY
Late Protero-zoic		Burin Series
		UNCONFORMITY
Early Protero-zoic	Harbour Main Volcanic Series	Harbour Main Volcanic Series

interpreted to be of Ordovician age on the basis of structural and stratigraphic evidence and lithological similarities with other formations outside the Burin Peninsula. These Ordovician rocks were thought to be faulted against Precambrian rocks in the St. Lawrence area.

Middle Cambrian fossils (Paradoxides davidis) were found in the argillaceous sediments of the Little Lawn Formation by Williamson (1956) who thus concluded that the Little Lawn Formation and the overlying Mount Margaret Volcanics are of Cambrian age rather than Ordovician postulated by Van Alstine (see Table 1). He further suggested that these Cambrian rocks were not all faulted against the Precambrian rocks. In particular the contact to the west of Little Lawn was interpreted by him as an unconformity and not a fault because rocks of the Little Lawn Formation were found at the same topographic level across the supposed fault valley, in the vicinity of the Pinnacles.

The writer accepts Williamson's succession and deals only with the rocks found in the St. Lawrence map area of Fig. 2.

2.2. Description of formations in the study area

2.2.1. Harbour Main Volcanic Series

The oldest rocks in the St. Lawrence area consist mainly of acid and intermediate lava flows with minor basaltic flows. These flows are mineralogically and texturally similar to those of the Hadrynian Harbour Main Volcanic rocks on the Avalon Platform. Excellent exposures of these rocks are seen on the coast near Lawn Harbour.

Felsic flows are chiefly rhyolite, quartz porphyry, feldspar porphyry and dacite with spherulitic and perlitic structures developed in most cases (Plate 3). They range from red to purple, pale green, grey and black in colour. Mafic flows are chiefly fine grained structureless basalt having a black or greenish black colour. Pillow structures are uncommon and where present have small amounts of chert locally interbedded with them. Massive andesite occurs locally in the vicinity of Lawn. It is lighter in colour than the basalt.

Thick pyroclastic deposits range from fine-grained tuff to very coarse-grained agglomerate. Flow breccias are common in dacite and andesite, whilst the rhyolite and feldspar porphyries are seldom free of inclusions of sedimentary rocks.

Van Alstine (1948) reported that at Shatter Cliff grey shale and tuff interbedded with the flows have been metamorphosed to a conchoidally fracturing hornfels which could be confused easily with some volcanic rocks of the Little Lawn Formation. Shatter Cliff is a high hill whose precipitous southeast slope rises abruptly from the flat ground in front of it. A thick talus slope surrounds the base of Shatter Cliff and except on the east side it is surrounded by granite outcrops. For this reason, it is considered to be a roof pendant within the St. Lawrence granite.

On the southeast part of Shatter Cliff, the rocks are dark grey to black in colour and resemble the Little Lawn Formation. Microscopic examination shows them to be a fine grained basalt. Sedimentary rocks are absent. Around the base of Shatter Cliff and especially on the north side near the granite contact, veinlets of granite and rhyolite porphyry cut the volcanic rocks. This mass of volcanic rocks, if not a roof pendant, was all but engulfed by the granite intrusion.

A definite Precambrian age for this volcanic series is determined at Duck Point along the western side of Little Lawn Harbour, where a conglomerate at the base of fossiliferous Lower Cambrian rocks rests unconformably on the rhyolite flows.

2.2.2. Burin Series

Within the present map area, the Burin Series rocks are exposed only to the east of Little St. Lawrence. They consist mainly of massive and pillowed basalt, flow breccia, tuff, shale, sandstone, conglomerate and limestone with sedimentary rocks predominant near the base of the series (Plate 4). Basic volcanic rocks range in composition from andesite to olivine basalt. The andesites are generally red or purple in colour, and the basalts are some shade of dark greenish grey.

There is no direct evidence for the age of the Burin Series. Van Alstine believed that the Burin Series, along with the Little Lawn Formation and the Mount Margaret Volcanics, were of probable Ordovician age, a conclusion based on presumed structural and lithological similarities with the Ordovician section of Notre Dame Bay. East of Little St. Lawrence, the Middle Cambrian Little Lawn Formation occupies an east-west syncline apparently conformably underlain by rocks of the Burin Series. However, a sequence of rocks ranging continuously from Middle to Lower Cambrian in age were recognised by Van Alstine (1948) in Little Salmonier, Burin Bay Arm (outside the map area). None of these Middle to Lower Cambrian rocks have any resemblance to those of the Burin Series. We might thus assume that the Burin Series is older than Lower Cambrian although it is possible that a distinct change in facies occurs between these two localities. In Little St. Lawrence the Burin Series rocks display a difference in metamorphism compared to the Little Lawn Formation, the latter showing only a contact type of metamorphism whereas the Burin Series have a regional type. Van Alstine (1948, p. 22) records that ... "these rocks (Burin Series) are locally schistose, phyllitic or slaty and the basalts are commonly metamorphosed to the greenstone facies". These observations are taken as indicative of a disconformable relationship between the Little Lawn Formation and the Burin Series, and it may thus be justifiable to consider the Burin Series of Proterozoic age.

2.2.3. Cambrian rocks

Most of the map area is underlain by Cambrian rocks. Van Alstine (1948) described Cambrian rocks of the region very carefully, but most of them are not found in the present map area. As the writer is concerned only with the Cambrian formations found in the map area, it is necessary to mention the other Cambrian rocks to establish the stratigraphy and age relationships.

2.2.3.1. The Brigus Formation

The Brigus Formation occurs in the map area only on the west of Little Lawn Harbour. It consists mainly of a thick sequence of red, green and grey siltstone and sandstone with minor conglomerate and pink nodular limestone at the top of the sequence (Plate 5). The formation represents a gradual encroachment of the sea with accompanying shallow water conditions shown by the presence of numerous mud cracks, ripple marks and cross-bedding. Most of the arenaceous sediments are thin bedded. The siltstones contain a few grey or buff coloured limestone nodules which increase in number and change to pink or red in colour toward the top of the formation. Fossils were found in these limestone nodules including various hyolithid worm burrows which, according to Van Alstine (1948), is Callavia broggeri, a species of Lower Cambrian age.

The Brigus Formation is in fault contact with the Little Lawn Formation to the north, and the Harbour Main Volcanic Series to the west at Three Stick Pond. The Brigus Formation in Murphy Cove is likewise in fault contact with fossiliferous grey and black shale of the Little Lawn Formation. At the contact there is a change in lithology from unfossiliferous purple siltstone with limestone nodules of the Brigus Formation to the thinly bedded grey shale of the Little Lawn Formation (Plate 6). It appears that at Three Stick Cove the contact with the Harbour Main Volcanic Series is an unconformity rather than a fault. The contact dips to the northwest, but it is extremely irregular. The Harbour Main rhyolite is overlain irregularly by purple medium-grained micaceous sandstone which strongly resembles the sandy phase associated with the Brigus Formation conglomerate at Duck Point.

On the east side of Duck Point a thick sequence of medium-grained purple conglomerate rests on an uneven surface of the Harbour Main Volcanic Series (Plate 7). Both lateral and vertical variations into coarse red micaceous sandstone are common. Further south the conglomerate passes rapidly into red sandstone of variable thickness. The Harbour Main Volcanic Series is represented here by rhyolite flows and associated fined-grained breccias. At the immediate contact, the Harbour Main Rhyolite is bleached to a creamy colour, is very irregular and is weathered, representing the eroded surface on which the Cambrian rocks were unconformably deposited.

In the complete Cambrian stratigraphy of the Avalon Platform, the Brigus Formation is succeeded by the Chamberlain's Brook Formation, Beckford Head Formation and Gull Cove Formation which are thoroughly described by Fletcher (1972). These rock formations do not occur anywhere in the map area of Fig. 2.

2.2.3.2. The Little Lawn Formation

According to Williamson (1956), the Kelligrews Brook Formation may be regarded as a basal member of the Little Lawn Formation, because of the gradational contact between the two. The Kelligrews Brook Formation is fossilferous (Paradoxides davidis), but it does not occur within the present map area.

The Little Lawn Formation occupies an area south of the main road between Little Lawn and Little St. Lawrence. The age of the formation was determined at Murphy Cove on the west side of Little Lawn Harbour, where the Brigus Formation is in fault contact with grey, purple and black Paradoxides-bearing shale. Williamson (1956) adopted Van Alstine's terminology but pointed out that the fossil assemblage present indicates it to be of Middle Cambrian rather than Ordovician age.

The best preserved fossils were found in thinly bedded shale while some were found in the coarser grained rocks. A number of fossils were recorded, all typical of the Middle Cambrian Paradoxides davidis zone of the Kelligrews Brook Formation.

Most of the Little Lawn Formation consists of fine-grained greywacke and siltstone with lesser amounts of grey and black shale. On the peninsula between St. Lawrence and Little St. Lawrence the formation is composed predominantly of coarser clastic sediments including some conglomerate. Some of the rock fragments in the greywacke are of volcanic origin, and the groundmass of some of these sediments, whether coarse or fine, is suggestive of volcanic ash or reworked volcanic ash. Hence, the rocks should probably be named tuffaceous greywacke and tuffaceous shale. These rocks are best seen in the massive hill of Chapeau Rouge, where they consist of scattered fragments of quartz and plagioclase crystals together with some volcanic fragments and occasionally abundant glass shards, set in a matrix of fine quartz and chloritic material.

Coarser-grained sediments are found east of St. Lawrence while only fine-grained varieties occur to the west. Rapid vertical and lateral variations in grain size are common east of St. Lawrence indicating changing conditions during sedimentation.

The only limestones in the Little Lawn Formation are some thin concretionary limestone horizons in the eastern part of the area. In the vicinity of Mt. Calapoose, thin but persistent bands of martite and magnetite are interbedded with beds of dense black shale. According to Smith (1938), this iron-bearing horizon can be traced across the country northwest of Beaver's Pond for a distance of 5 km.

Variations in strike and dip are common. East of Little Lawn, the strike is northeast and dips southeast. To the east of St. Lawrence, the strike is northeast but dips northwest. Sediments are locally contorted.

Between St. Lawrence and Little St. Lawrence; the Little Lawn Formation is represented by a series of black shales and siltstones which locally grade into fine-grained greywacke with increasing amounts of clastic material. It strikes northwest and dips generally 30^{o} to northeast. These rocks are extremely homogenous in appearance and often so dense as to exhibit subconchoidal fracturing.

Black when fresh, the weathered surface of the shale bleaches to light grey in colour and brown staining occurs where disseminated pyrite is also present. At 2 km from the granite; the shale loses its dense nature and becomes quite fissile. This feature is also found in siltstone in the Little Lawn Harbour and Mine Cove areas.

Because the degree of contact metamorphism may be used as an index as to the proximity of the granite contact, the extensive conversion of sediments to hornfels at Little Lawn Harbour may be taken as evidence that the granite dips gently westward beneath the sedimentary cover. This is confirmed both by geophysics (J.P. Hodych, pers. comm., 1974) and by diamond drilling.

West of Three Stick Pond, the Little Lawn sedimentary rocks are in contact with the rhyolite and basalt of the Harbour Main Volcanic Series. Northeast of Lawn, the contact is traced towards the granite. The nature of this contact is obscure and has no exposure or no topographic expression. Superficial similarities between recrystallised Little Lawn sediments and the fine-grained basalt of the Harbour Main Volcanic Series make the contact difficult to establish without detailed petrographic study. There is an absence of cataclastic features, and thus faulting is unlikely. The contact between the Little Lawn sedimentary rocks and the underlying volcanic rocks is believed to represent an unconformity prior to granite intrusion.

The Little Lawn Formation is composed entirely of sedimentary rocks which contain fragments derived from the underlying volcanic rocks. The fragmentary nature of the greywackes and lack of extensive chemical weathering indicate rapid erosion and deposition.

Wherever the sediments are close to the St. Lawrence granite they have been altered to a dense conchoidally fracturing hornfels in which bedding is obscured. This hornfels is extremely resistant to weathering and forms steep cliffs along the coast and rugged topography further inland. Where the granite batholith dips gently beneath the cover of sediments, the area affected by this thermal metamorphism is extensive.

Although cordierite and andulusite are produced locally, the principal effect of the granite on the sediments was one of recrystallization and induration. Where the sediments contain tuffaceous material chlorite, biotite and hornblende have been produced to a varying degree. Silicification of sediment can be seen along some fractures (Plate 8).

2.2.3.3. Mount Margaret Volcanics

In the Mount Margaret area, the Little Lawn Formation is succeeded by a volcanic series composed exclusively of massive and pillowed basalt named by Van Alstine (1948) the Mount Margaret Volcanics. The basalt typically has a greenish black colour and it is extremely tough. Pillowed structures about 3 to 4 feet in diameter are seen on the north flank of Mount Margaret. The contacts between the Little Lawn Formation and the volcanic rocks are not exposed and are placed where lava flows become numerous in the section. The volcanics apparently conformably overlie and are partially interbedded with the Little Lawn Formation and occupy the central part of the syncline.

To the west of Mount Margaret the volcanic rocks are truncated by the granite. Near the contact with the granite the lava is fine-grained but further away from the margin it becomes coarser and in places amygdaloidal. The amygdules contain quartz and a little epidote or zoisite, though in places specularite and magnetite are present. In thin section, the lava is a basalt containing abundant sericitised andesine phenocrysts and clinopyroxene which is almost entirely replaced by pale green fibrous actinolite and chlorite. Epidote and opaque minerals are also common alteration products. Unlike Harbour Main volcanics, the basalts never show fluxional arrangement of feldspar, no matter how fine grained they become.

A large outcrop of gabbro forms the summit of Mount Margaret, and it appears to form a plug within the basalt, although this is difficult to verify as the contacts are obscure. On the northern slope, there is a slight but abrupt change of gradient coinciding with the change from pillowed basalt to medium-grained gabbro. Towards the summit the gabbro is coarse-grained and the plagioclase has weathered out, giving a knobby surface consisting of elongate partially actinolitized augite crystals. Thin-sections show that the augite is strongly zoned and titaniferous, suggesting that these are alkali basalts in composition (Plate 9).

Since the Mount Margaret Volcanics appear to be stratigraphically above the Little Lawn Formation, they would be at least of Middle Cambrian or possibly Upper Cambrian age. As volcanism was extremely rare on the Avalon Platform in Cambrian time, more precise determination of the age of the volcanics should be useful. McCartney (1955), working further east in Argentia, records the presence of Middle Cambrian pillow lavas. Hence, it is possible that the Mount Margaret Volcanics are Middle Cambrian in age.

2.2.4. Intrusive igneous rocks

2.2.4.1. Metagabbro

Metagabbro is found only north of Loughlin's Pond where it intrudes the Harbour Main Volcanic Series. However, outside the map area, large bodies of the metagabbro occur within the Burin Series in the vicinity of Burin. Xenoliths of basalt belonging to the Harbour Main Volcanic Series were observed in several locations. Towards the west of Loughlin's Pond this gabbro was intruded and extensively veined by the St. Lawrence granite. Van Alstine (1948) assigned the gabbro a pre-Devonian age. Since it nowhere cuts rocks younger than the Burin Series, a Precambrian age for it cannot be ruled out. On the other hand, this metagabbro is petrographically similar to the gabbro forming the core of Mount Margaret and suggests a similar probably Cambrian age.

The metagabbro is generally coarse-grained and greenish black in colour. The weathered surface has a pale green colour and is characterised by a knobby surface due to the presence of large secondary hornblende crystals. Plagioclase, around An_{55}, makes up 50 per cent of the rock. In thin section, the augite is completely converted to hornblende. The texture is commonly hypidiomorphic.

2.2.4.2. Basic dykes

A number of basic dykes have intruded all rocks of the area, including the St. Lawrence granite. They are commonly less than 30 meters thick and are either vertical or have very steep dips (Plate 10).

In hand specimen many of the dykes resemble diabase dykes but Van Alstine (1948) as a result of thin section study classified them as lamprophyres. They are all dark greenish to black in colour varying from fine- to coarse-grained and some are porphyritic with augite and hornblende phenocrysts. Good examples of small basic dykes are seen on the peninsula between St. Lawrence and Little St. Lawrence. Thin sections show these dykes to be composed of a hypidomorphic intergranular aggregation of feldspar, and nearly colourless augite which shows varying stages of alteration to uralite and chlorite. Apatite occurs as accessory needles. The porphyritic dykes contain phenocrysts of augite and hornblende set in a groundmass of hornblende, chlorite and magnetite.

The St. Lawrence granite and its associated dykes are described in Chapter 4.

CHAPTER 3

STRUCTURAL GEOLOGY

3.1. Structural geology of the country rocks

Little work was done on the structural relationships in the Harbour Main Volcanic Series, which strike generally somewhat east of north, with some mafic flows which can be traced along strike for up to 5 km.

Two large northeasterly-trending synclines affect the Little Lawn Formation, one northeast of St. Lawrence and the other east of Little St. Lawrence. In the latter case, the southeastern limb of the syncline is truncated by a fault. The contacts between the Harbour Main Volcanic Series and the overlying formations are commonly marked by thrust faults which strike parallel to the earlier fold axis. Similar thrust faults separate Burin Series rocks from the Precambrian and Cambrian formations. Van Alstine (1948) states that the thrust faults are generally high angle with no dips less than 45°. Evidence for this is given by the straight linear trends and a few actual measurements. The major structures produced by folding and thrust faulting were later transected by normal faults, some of major significance. The effect of gravity faulting was to break up earlier structures into a number of fault blocks or wedges. Repetition of these west of Little Lawn suggests step faulting, although the downthrow is not always in the same direction. Local rotational movements are also suggested (Van Alstine, 1948, p. 15).

The major gravity fault that truncates the early structure northeast of St. Lawrence can be described as causing a rotation in a vertical plane about a point lying east of Mt. Anne. The distribution of different geological units indicates relative downward displacement east of the fault in the north, while to the south the downthrow is on the west. However, the relative displacement of the two major synclines whose axial planes dip northeast would suggest a downthrow to the east. Since the two synclines are part of the same structure, a downthrow to the east would be consistent with the absence of basic lavas from the core of the syncline east of Little St. Lawrence.

The normal faults are considered to be produced in response to uplift and release of pressure following an earlier period of compression which caused the folding and thrusting. The period of uplift during normal faulting was followed by the intrusion of the fluorite-bearing granite. The relationship between the form of intrusion of the granite magma and the earlier underlying structure present in the country rocks is shown clearly from the map (Fig. 2).

The structure of the country rocks may be simply explained with reference to the strain ellipsoid (Ramsay, 1967), using the notations P, Q and R to represent the maximum, intermediate and minimum stress respectively. The fold axes and the thrust faults strike 50^{0}Az (Fig. 3), produced by northwest-southeast compression along P-P. The thrust faults dip north, usually at a high angle, with rocks on the north thrust over those to the south. Any tension fractures produced parallel to P-P would thus strike at 140^{0} Az.

The orientation of Q and R may be interchanged depending on whether the maximum stress release is accommodated vertically or horizontally (Fig. 4). Depending on the confining pressure, two directions of shear will be developed and 40^{0} to the principal stress is a reasonable angle. Those that make an angle of 40^{0} with P-P will strike due north and at 100^{0}Az. The latter strike agrees with the strike of the faults south of Look Out Hill and north of Pinnacles.

If 100^{0}Az is one of the principal shear directions during earlier compression, it would be the direction of greatest release RR, during the later period of tension. Lines of tensional weakness would be established perpendicular to principal shear direction having a direction of 10^{0}Az which is close to the strike of the normal fault east of Mount Margaret. When the normal fault striking at 10^{0}Az is established, it represents tension. The direction perpendicular will be the direction of greatest release which coincides with the principal

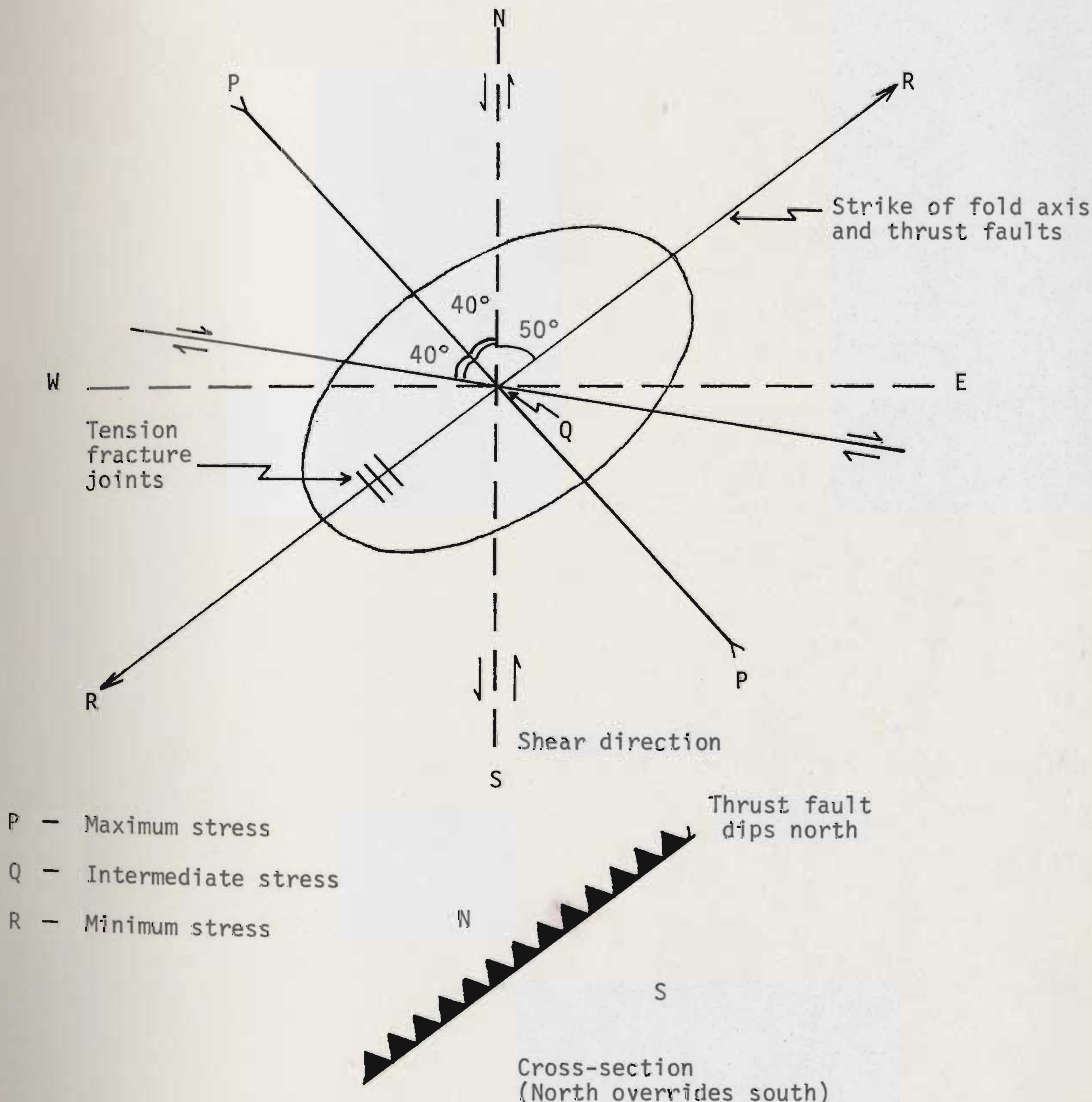


Figure 3: Schematic strain ellipsoid for country rocks around the St. Lawrence pluton based on the orientation of thrust faults.

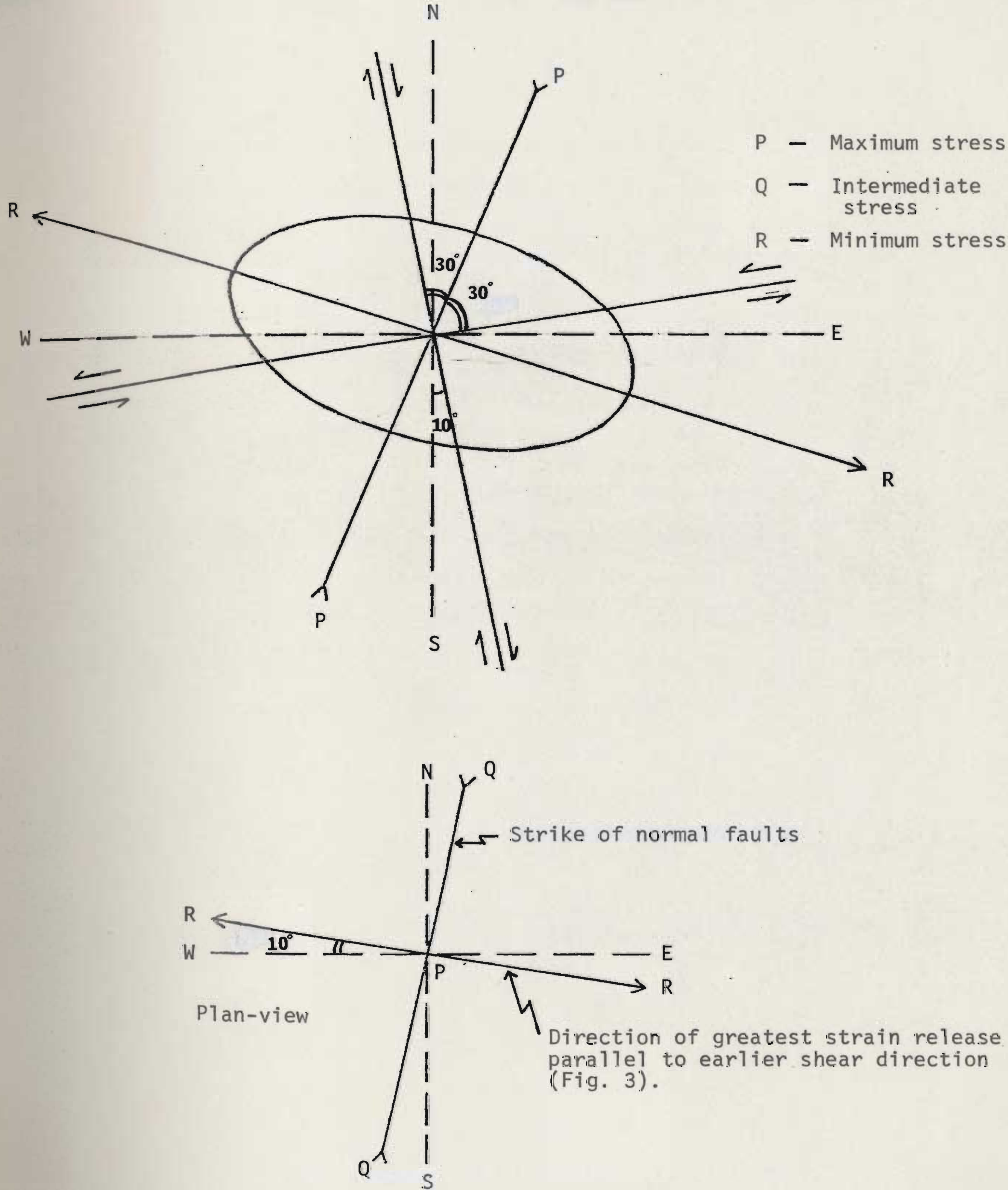


Figure 4: Schematic strain ellipsoid for country rocks around the St. Lawrence pluton based mainly on the orientation of normal faults.

direction of shearing of the earlier period of deformation shown in Fig. 3. Once the fault is established as essentially a normal fault then P must have been vertical and Q must have been in the fault plane paralled to its strike. The downthrow may be either to the east or west depending on the direction of the dip of the fault plane, and the dip of the fault plane will depend upon the magnitude of the confining pressure acting along P-P.

Once the normal fault is established, tension fractures parallel to Q become the direction of weakness. The thrust fault is truncated by the normal fault indicating the latter fault to be younger. Therefore the normal fault dictates the orientation of the later granite intrusives.

CHAPTER 4

ST. LAWRENCE GRANITE

4.1. General

The St. Lawrence granite as presently exposed forms two north-trending lobes of a batholith 30 km by 6 km, their distribution indicating a somewhat irregular top with a number of cupolas. The granite intrudes both Precambrian and Cambrian rocks, which places a lower intrusive limit on its age. Possibly the youngest rocks the granite intrudes are the Mount Margaret Volcanics, which might be as young as Upper Cambrian (Section 2.2.3.3.).

Van Alstine (1948) considered the granite to be Devonian, based to some extent on presumed correlation with known Devonian granites found in the Hermitage Bay and La Poile areas. In the Hermitage Bay area, about 100 km north-west of St. Lawrence, granite cuts conglomerates containing late Devonian plant remains. In the La Poile area, further west along the south coast of Newfoundland, granite cuts slate which also contains early Devonian plant remains, but does not cut Carboniferous rocks. Smith (1957) suggested that the St. Lawrence granite is of Permian age, since 70 km away across Fortune Bay, the Belleoram granite which resembles St. Lawrence granite texturally and mineralogically was considered to be of Permian age. However, the Belleoram granite has been dated isotopically (by potassium-argon) at 400± 20 and 342± 20 million years (Wanless, et al., 1965, 1967) and because it intrudes the Upper Devonian Great Bay de l'Eau Formation, the age is most probably Late Devonian (Williams, 1971). The St. Lawrence granite has been dated isotopically by rubidium-strontium at 330± 10 million years (K. Bell, pers. comm., 1974).

4.2. Field relations

The batholith is elongated in an approximately north-south direction, with contacts exposed at a number of places but best observed along the coast. At Chamber's Cove, St. Lawrence Harbour, and Little St. Lawrence, contacts are sharp and steeply inclined (Plate 11) and the presence of granite veins in the adjacent country rocks (Plate 12) indicates normal intrusive relationships. Inland, it is inferred from sporadic outcrops that the granite intimately interfingers with the country rocks as discrete veins. The presence of large and small stoped blocks of hornfelsed country rocks and the absence of any permeation or injection gneiss rules out any origin involving granitisation in situ.

The granite shows a progressive decrease in grain size towards its contact. In some cases, separate minor, irregular phases of intrusions are found with a general age sequence as follows:

	Younger
porphyritic granite	↑
fine-grained granite	│
medium-grained granite	│
coarse-grained granite	Older

The contacts of these granites are sharp (Plate 13). Miarolitic cavities are seen within a few metres of the contacts. There is little chemical difference between these granites, and they are interpreted as separate phases of the same granitic melt.

Tuffisites are common in the granite, consisting of discrete fragments of the granite in a fine matrix of comminuted rock (Plate 14). The individual fragments, although variable in shape, are rounded at their margin. The size of the fragments ranges from a few mm. to 6 cm. in diameter, but is generally about 3 cm.

West of the granite, there are many small and commonly isolated outcrops of a pink quartz-feldspar porphyry that was named rhyolite porphyry by Van Alstine (1948). The name rhyolite porphyry is used locally by the mining geologists, although they are not true rhyolite in the sense of being extrusive. They are actually a number of distinct north-east-striking dykes. At Grebes Nest on the east side of Little Lawn Harbour, it is possible to trace the dykes for 2 km inland.

In coastal exposures the dykes are seen to dip gently to the north although further inland their attitudes become variable (Plate 15).

It is interesting to note that the dykes are entirely absent to the east of St. Lawrence. They are rarely found in the northern part of the area and are best developed to the west of St. Lawrence near the contact between the St. Lawrence granite and the Little Lawn Formation.

This "rhyolite porphyry" may be distinguished in the field from the earlier true rhyolite porphyry of the Harbour Main Volcanic Series by the higher proportion of quartz phenocrysts, lesser alteration and the proximity to the granite.

The above features indicate that the St. Lawrence granite is a shallow intrusive that has not been deeply eroded, i.e., "epigranite" (Buddington, 1959). The absence of any flow structure, pegmatitic dykes and any evidence of major metasomatic replacement of the country rocks support this interpretation, as does its bulk chemical composition (Section 4.7.7.).

4.3. Lithology

In hand specimen the St. Lawrence granite is a pink to red granitic rock characterised by a scarcity of ferromagnesian minerals. The texture varies from medium-grained hypidiomorphic to aphanitic depending upon nearness to the contacts. The mafic minerals and plagioclase, when present, tend to be euhedral, while most of the alkali feldspar is subhedral and quartz occupies irregular interstices. The granite consists essentially of red alkali feldspar and glassy quartz. Miarolitic cavities are commonly lined with quartz and, in some cases, fluorite crystals.

Weathering of the granite causes bleaching of the feldspar due to alteration to sericite, and removal of some fine hematite in the feldspar. Local mineralogical variations are found close to the contacts where assimilation of the country rocks produces a more basic phase of the granite.

The granitic dykes cutting the country rocks are pinker in colour due to finer grain size and more extensive oxidation of iron in the alkali feldspar. Increase of alteration towards the fluorite veins is shown by the darker red colour of the granite with especially striking reddish brown orthoclase crystals. The xenoliths of the country rock show only thermal metamorphism with no marked assimilation.

Calcite is present in vugs between fluorite and granite, in veins cutting fluorite and as dog-tooth spar crystals coating cubes of fluorite. Intergrowths of fluorite with calcite suggest that the calcite deposition occurred sometime during fluorite mineralisation but continued after fluorite deposition had ceased.

The rhyolite porphyry is typically a pink porphyritic rock characterised by phenocrysts of vitreous quartz and pink to buff-coloured feldspar, varying from 2 to 10 mm. in length, set in a dense aphanitic groundmass. The rock has a conchoidal fracture indicating that it solidified rapidly.

4.4. Petrography

Petrographic studies made on 50 representative thin-sections of the St. Lawrence granite show that the granite is composed essentially of quartz, orthoclase and albite with minor amounts of riebeckite, aegirine, biotite, fluorite, magnetite and hematite.

The granite contains between 20 to 40 per cent of free quartz, generally clustered between the larger feldspars but in some cases forming phenocrysts about 2 mm in length. In some cases quartz is micrographically intergrown with orthoclase giving a granophyric texture (Plate 16), which is seen mostly in the marginal phase of the granite. The origin of this granophyric texture is discussed in section 4.7.7. Marginal phases of the granite also display deeply embayed quartz phenocrysts.

Alkali feldspar is the most abundant mineral in the St. Lawrence granite, making up 30 to 60 per cent of the thin-sections studied. The feldspar is generally turbid and contains finely disseminated hematite. Orthoclase and microcline perthites are common potassium feldspars, the former being more common (Plate 17). The perthitic plagioclase is generally albite with a range of composition between An_5 and An_{10}. The proportion of plagioclase lamellae ranges from 20 to 50 per cent but is generally about 30 per cent. Deuteric albitisation is a common feature of the perthites (Plate 18). Modal plagioclase (albite) content of the St. Lawrence granite ranges from 0 to 20 per cent, most of it exsolved from the alkali feldspars.

Riebeckite, when present, varies in grain size from 1 mm. to 3 mm., is generally associated with aegirine and locally becomes the more abundant of the two. The riebeckite appears to have crystallised after aegirine as shown by the riebeckite growing along the cleavages of the aegirine crystals (Plate 19). Some thin-sections contain up to 5 per cent riebeckite. Aegirine, where present, is always associated with riebeckite.

Biotite, where present, is commonly altered to chlorite. Some thin-sections contain up to 10 per cent biotite, but in most thin-sections it is absent.

Hornblende is present only in the specimens of contact rocks from the east lobe of the batholith around the Lawn Lookout. In these areas the granite locally approaches granodiorite, consisting of a small amount of quartz and a higher proportion of plagioclase to orthoclase, combined with an increase in hornblende to about 10 per cent. Plagioclase changes from albite to medium obligoclase. Sphene is an important accessory.

Fluorite crystals are seen in some sections and they are commonly associated with biotite (Plate 20) and also as an accessory mineral (Plate 21). Hematite and magnetite are common accessory minerals. Zircon and apatite are rarely seen.

The "rhyolite porphyry" consists essentially of the same minerals as the St. Lawrence granite, the only difference being in the texture. Feldspar phenocrysts are commonly perthitic orthoclase and sometimes sanidine, while albite is relatively rare. Quartz is commonly euhedral, but shows embayed and corroded boundaries indicating some resorption (Plate 22). Ferromagnesian minerals are never present as phenocrysts and are only rarely found in the groundmass. Chlorite is the only recognisable mafic mineral and it is secondary after biotite. Magnetite and hematite are disseminated in the groundmass of quartz and feldspar.

It is interesting to compare the modal analysis (Fig. 5a and Appendix II) with the normative analysis (Fig. 5b and Appendix II) of the granite. It is shown that the modal plots lie very close to the quartz and orthoclase sideline, whereas the normative plots lie around the centre of the triangular diagram. This reflects the amount of albite in solid solution in the alkali feldspar. Most of the alkali feldspar is perthitic and the writer grouped all the perthites with alkali feldspar for the purposes of modal analysis.

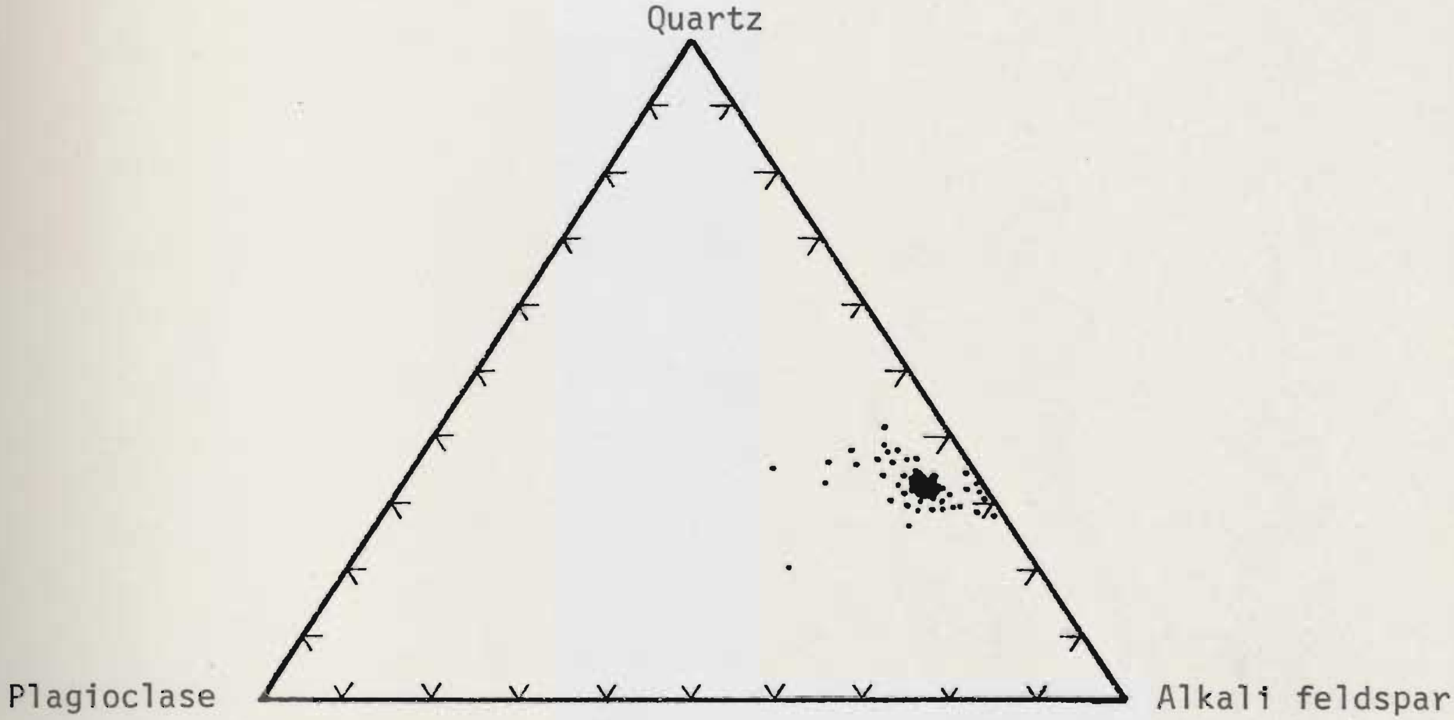


Figure 5a. Modal plots (vol. %) of quartz-plagioclase-alkali feldspar of the St. Lawrence granite.

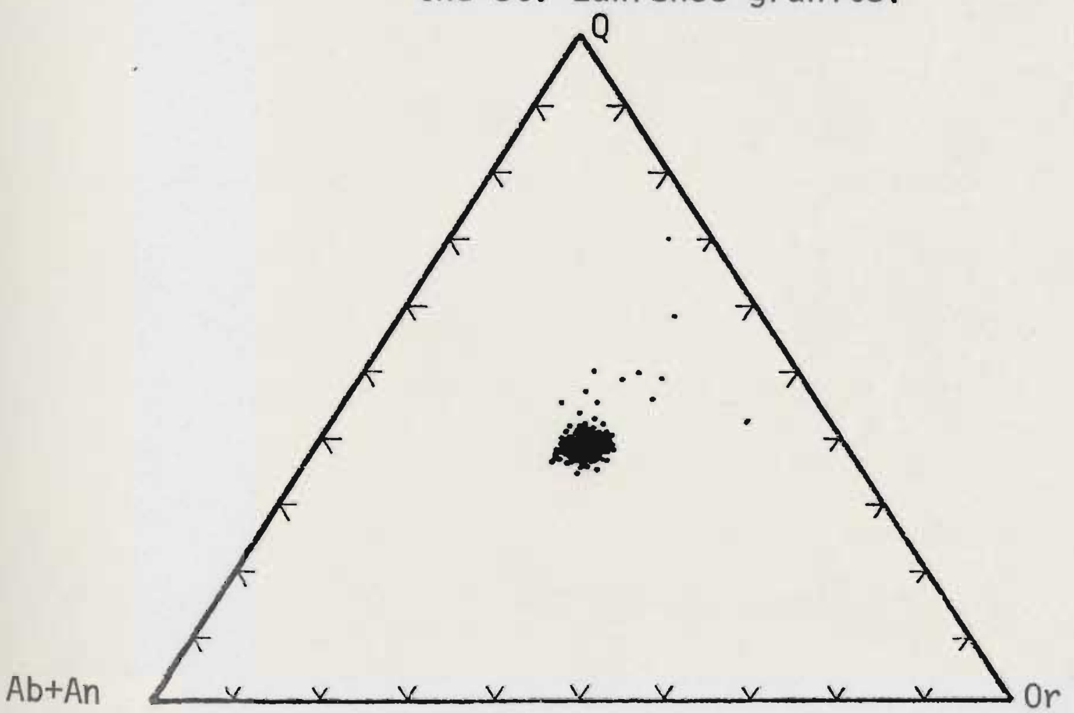


Figure 5b. Normative plots (wt. %) of Q-Ab-Or of the St. Lawrence granite.

4.5. Structures of the granite

In the St. Lawrence granite two prominent sets of nearly vertical joints are seen, along with a third set which is sub-horizontal. Orientation of the joints in the country rocks in the vicinity of the granite is similar to those within the granite. Vertical joints strike around 10°Az and 100°Az. The sub-horizontal joints dip very gently and have variable strikes, producing sheeting structures developed very late and after the fluorite veins through which they pass uninterrupted. According to Billings (1972) such sheeting structures are produced as a result of tension perpendicular to the roof of the batholith during cooling and later accentuated during removal by erosion of the superincumbent load of sediments.

Slickensided surfaces are generally coated with thin shiny films of red hematite and purple fluorite (Plate 23). Variation in orientation of slickensides on joint surfaces and fault planes show evidence of repeated mechanical readjustment presumably in response to the changing physical conditions during and after consolidation of the magma. Although the distance between adjacent parallel surfaces may be only as little as a meter, the slickensides may be vertical on one surface and horizontal on the adjacent one. Nevertheless, the majority of the slickensides indicate horizontal or near horizontal movement.

The normal faults, being the youngest structural feature in the country rocks (see section 3.1.), provided a zone of weakness for intrusion of the granite. This is illustrated, for example, by the parallelism of the granite from north of St. Lawrence Harbour to Berry Hills with the major normal fault east of Mt. Anne (Fig. 2). The most striking example of this control is provided by the long and very narrow outcrop of granite near Shearstick Brook, the south end of which passes into a major normal fault which strikes towards Little St. Lawrence (Figs. 2 and 6).

The normal faults thus dictate the shape of the batholith, with its elongation in a northerly direction. During the cooling of the granite, the elongated shape of the pluton would correlate with the orientation of tension and shear fractures of the granite in a manner analogous to that of a strain ellipsoid (Ramsay, 1967, pp. 158), possibly resulting in reorientation of the earlier principal stress direction (see section 3.1.).

Elongation of the granite in a direction 10°Az would imply that not only is it the region of greatest release (R) but perpendicular to it is the direction of greatest compression (P)(Fig. 6). Tension fractures in the granite occur at right angles to the direction of elongation at about 100°Az. Symmetrically on either side of the tension fractures, there

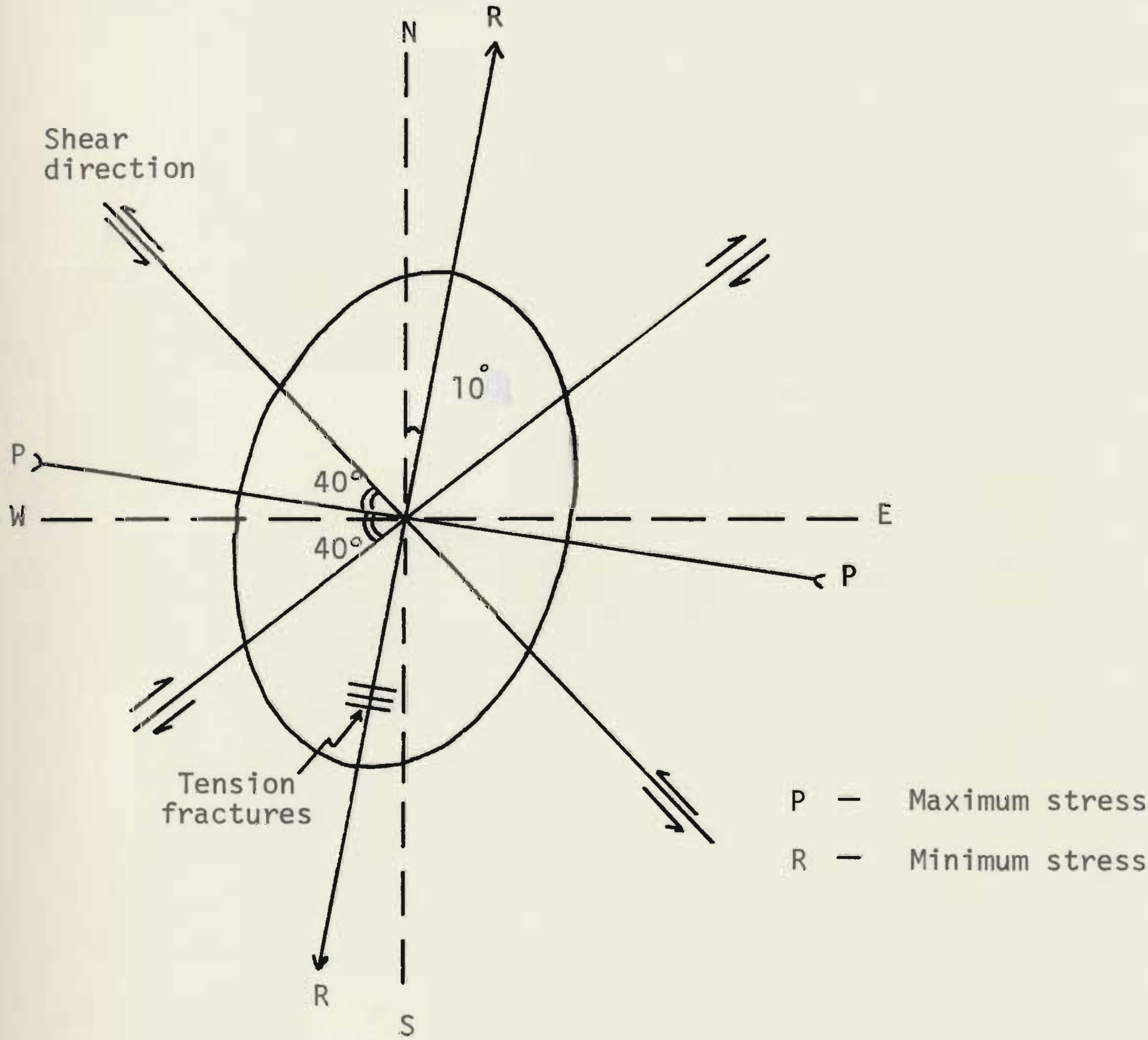


Figure 6: Schematic strain ellipsoid for the St. Lawrence granite based mainly on the elongated shape of the pluton.

would develop two directions of minimum stress and maximum shear, along which predominantly horizontal movements could take place. The angle between the tension fractures and the maximum shear would depend on the confining pressure. Since the St. Lawrence granite has features of a shallow intrusion (see section 4.7.7.), low confining pressure would be operative. Therefore, the two directions of shear will make an angle of about 40^{o} with the direction of tension fractures, i.e. 60^{o}Az and 140^{o}Az.

The orientation of the fluorite veins in the St. Lawrence granite was controlled by the presence of these tension features. For example, the Lord and Lady Gulch and the Canal veins have a mean strike at about 100^{o}Az, coincident with the strike of the expected tension fractures. Similarly, the Tarefare, the Director and the Blue Beach veins have a mean strike at about 140^{o}Az and the Doctor's Pond and the Black Duck veins are at 60^{o}Az showing the two directions to be coincident with the two directions of maximum shearing. It is interesting to note in the field that Tarefare, Director and Blue Beach veins show fault brecciation and slickensides which suggest a larger horizontal movement compared to Lord and Lady Gulch and Canal veins which show little such evidence of relative movement. Slight variation in orientation of the fluorite veins may be due to inhomogeneity of the granite or variation in stress orientation.

4.6. Classification of the granite

The St. Lawrence granite composed essentially of quartz and K-feldspar, with minor amounts of mafic-minerals can be readily classified as an alaskite granite (Moorhouse, 1957, p. 273). The pluton likewise is clearly classified as granite on various chemical bases, e.g. Streckeisen's (1967) modal classification (Fig. 7a) or the normative classification of Strong, et al.(1973a) (Fig. 7b). There are several quartz-rich exceptions to this classification (Fig. 7b) which are discussed in section 4.7.7.

Tauson and Kozlov (1972), in discussing chemical features useful in evaluating the economic potential of granitoid rocks, describe five geochemically distinct types, namely "plagiogranites", "ultrametamorphic granites", "palingenic granites", "plumasitic leucogranites" and "agpaitic leucogranites". The plagiogranites are characterised by very low contents of potassium, lithium, rubidium, beryllium, tantalum and lead. The ultra-metamorphic granites have a low content of volatiles, lithium, beryllium and tantalum, a high barium content and a predominance of potassium over sodium. Palingenic granites have trace element contents close to that of the 'average granite' of Vinogradov (1962). Plumastic leucogranites are characterised by a predominance of potassium over sodium, are saturated with water and fluorine, and have high lithium, rubidium, beryllium, tin, tungsten, niobium, tantalum and rare-earth contents. Agpaitic leucogranites are

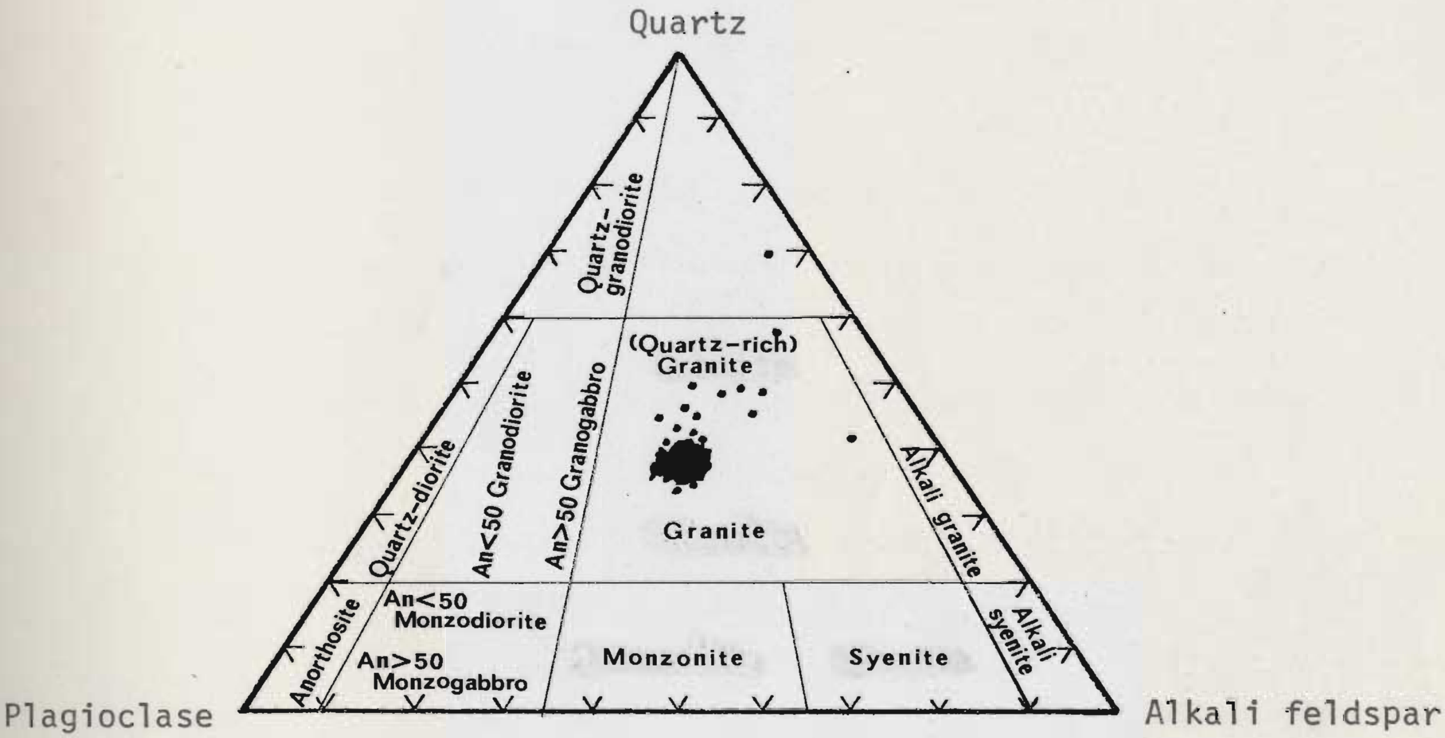


Figure 7a: Classification of granitic rocks (Streckeisen, 1967).

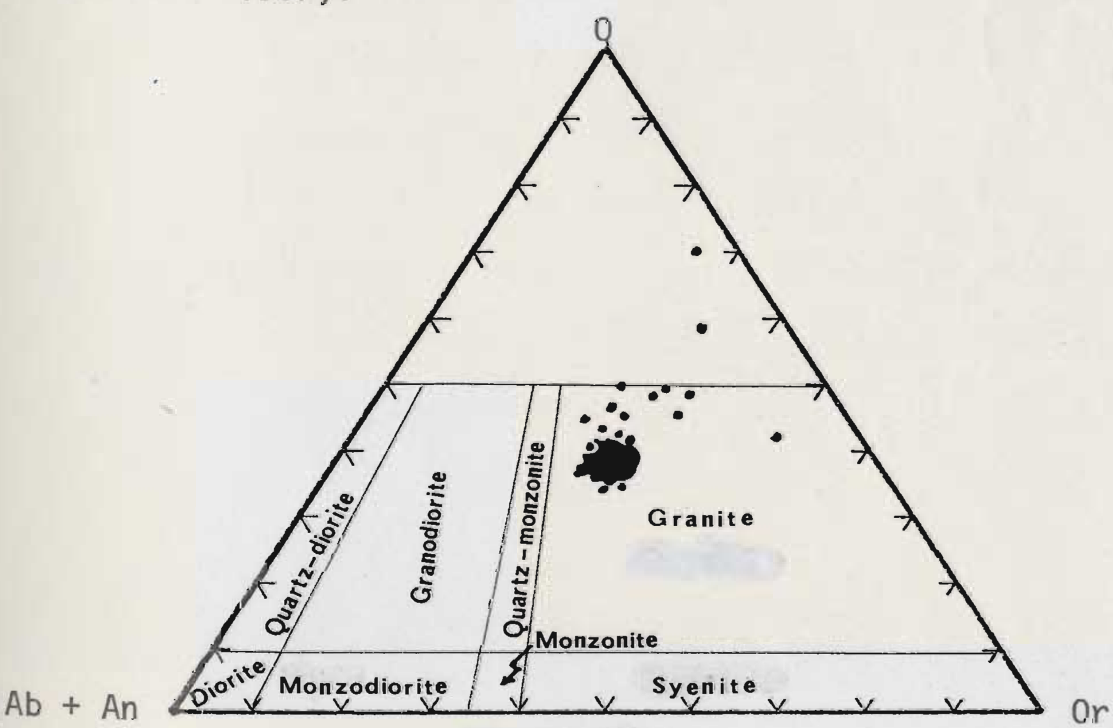


Figure 7b: Classification of granitic rocks (Strong, *et al.*, 1973a).

distinguished by being undersaturated in water and contain alkali-rich melanocratic minerals such as aegirine, riebeckite-arfvedsonite and alkali titanium- and zirconium-silicates, and have a high content of zirconium, hafnium, rare earths, yttrium, tin, niobium and tantalum and a low content of strontium and barium. The last two types are regarded by Tauson and Kozlov as having the greatest economic potential in terms of non-metallic minerals.

The St. Lawrence granite seems to fall between the plumasitic leucogranites and the agpaitic leucogranites. It has the characteristic of plumasitic leucogranite in having predominance of potassium over sodium, being saturated with volatiles, e.g. F (average 1308 ppm.), and having a high rubidium (average 295 ppm.) content. Similarly, it also has the characteristic of agpaitic leucogranites in having high zirconium (average 516 ppm.) and low strontium (average below 10 ppm.) and barium (average 70 ppm.) values. It also contains minerals such as riebeckite and aegirine, and likewise conforms to their suggested pattern of economic potential.

4.7. Chemical variation

4.7.1. Introduction

The distributions of elements in a pluton is governed by the physiochemical processes, both magmatic and post-crystallisation, to which the pluton has been subjected. The distributions may also be indirectly related to the size of the pluton and position within it. This section attempts to explain the causes of chemical variation within the St. Lawrence pluton.

Two hundred and fifty rock samples were collected in the map area and 140 granitic rocks were analysed for major elements and 220 for trace elements. Na_2O and MnO were analysed by atomic absorption spectrometry, fluorine by fluorimetry and the remaining elements were analysed using a Phillips 1220-C computerised spectrometer. The analytical precision and accuracy and the results are shown in Appendix I. The sample location map is presented in Fig. 8.

4.7.2. Variation diagrams.

The various elements are plotted against silica in the variation diagrams shown in Figs. 9a and 9b. Silica is used as an independent variable because of its wide variance and because magmatic differentiation generally gives rocks of steadily increasing silica content. Because of closure or constant sum effects, (Krauskopf, 1967) the increase in silica content from 62 to 82 per cent will be reflected in a total decrease from 38 to 18 per cent of all the other oxides, regardless of differentiation or other effects.

The variation diagrams for the major elements show that CaO, TiO_2, Fe_2O_3 (total), MgO, Na_2O and Al_2O_3 have a negative correlation with silica. K_2O is the only oxide showing a positive correlation with silica.

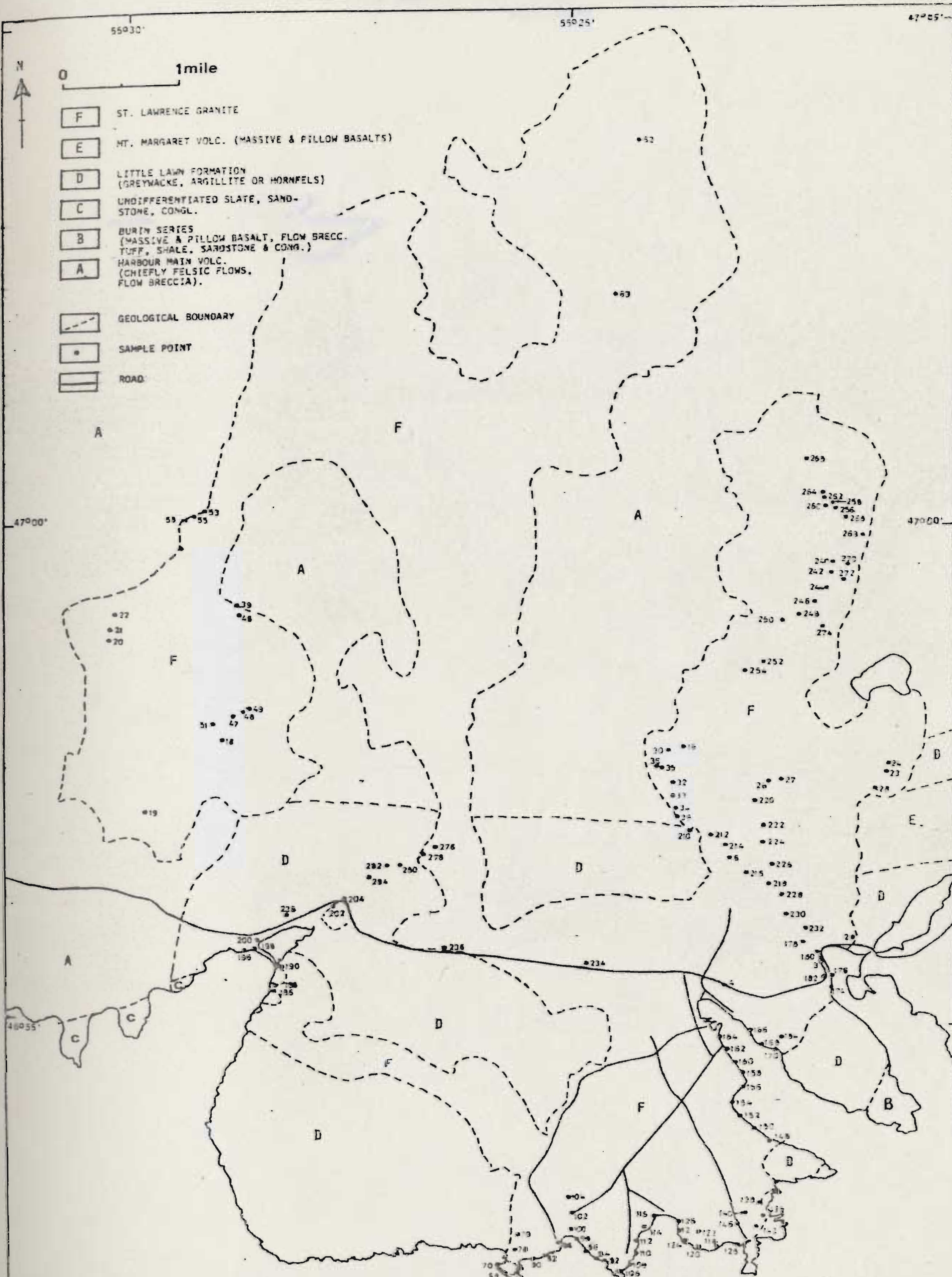


Figure 8: Sample location map.

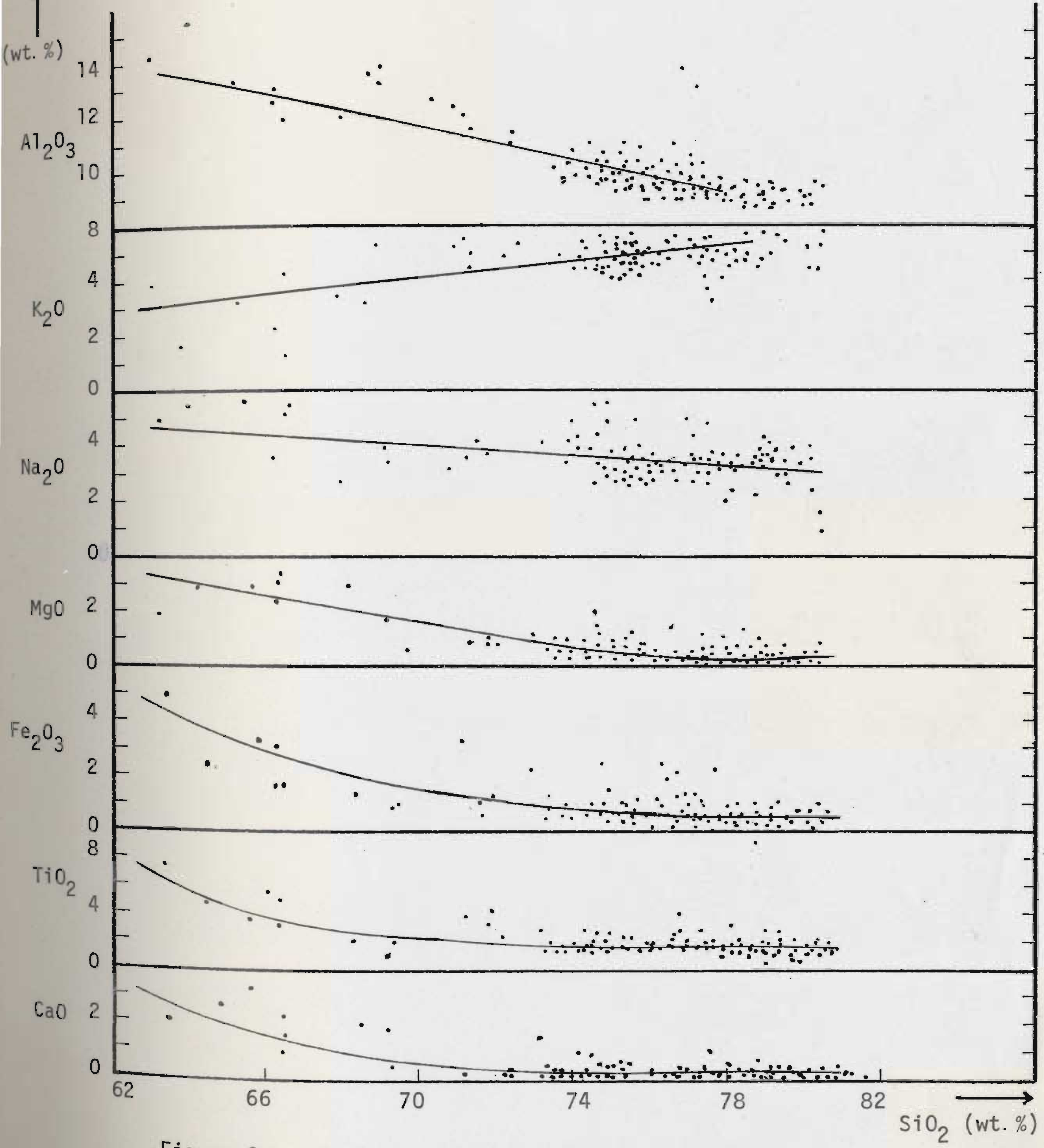


Figure 9a. Variation diagram for major elements (Line is visually estimated best fit).

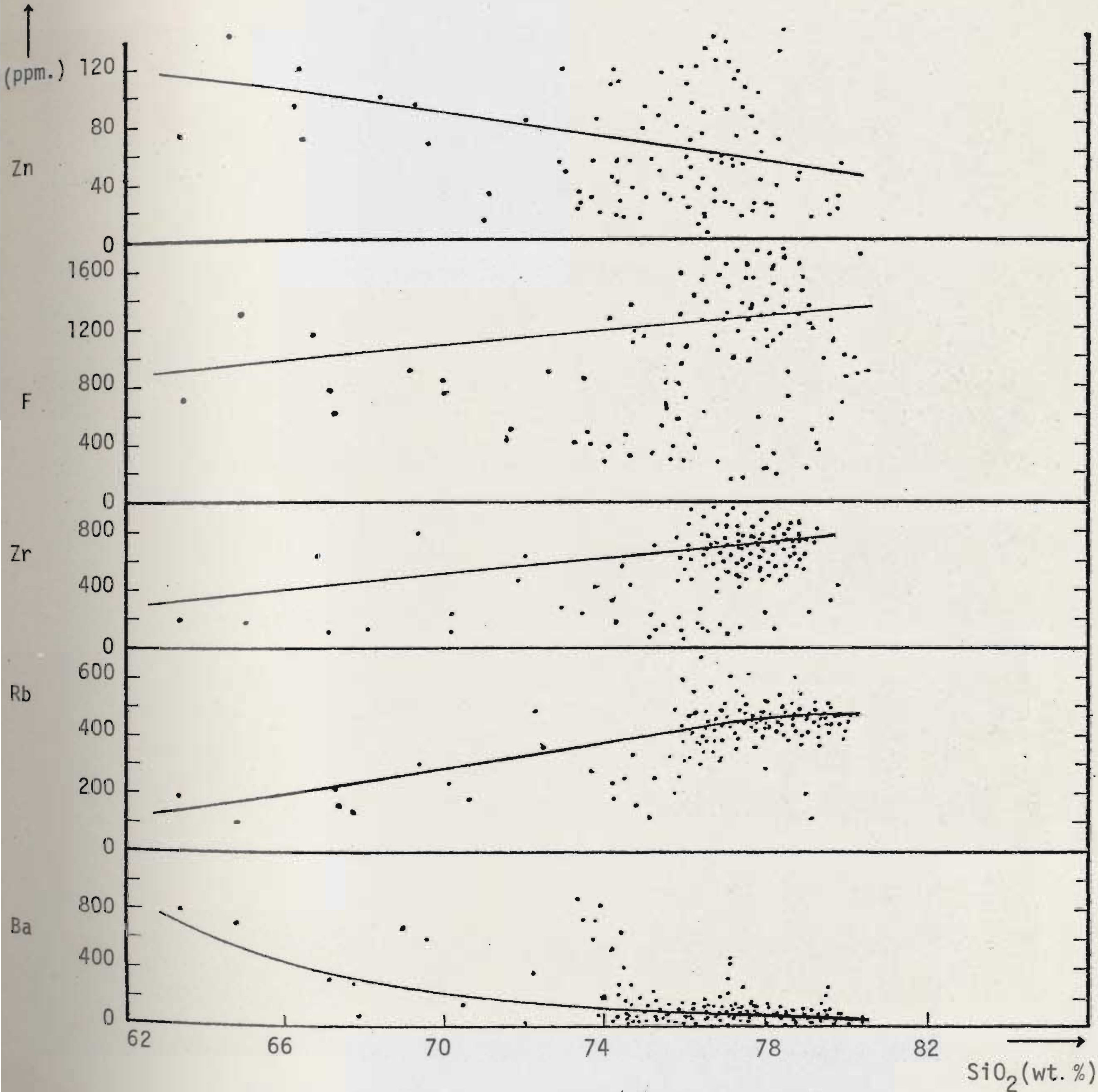


Figure 9b: Variation diagram for trace elements (Line is visually estimated best fit).

CaO, TiO_2, Fe_2O_3 (total) and MgO decrease to much less than half their initial values as would be expected from differentiation, since these oxides are concentrated in low silica minerals. The apparent decrease in Al_2O_3 is a result of the method of plotting. Similarly, Na_2O which has a small negative correlation with silica, is in fact increasing in total content with increasing silica. The actual increase of K_2O and Na_2O across the variation diagram reflects a strong concentration of alkali feldspar in the later stages of differentiation.

No variation diagrams were drawn for P_2O_5 and MnO_2 because their concentrations are generally too low to be detected by the analytical methods (i.e. less than 10 ppm. and 50 ppm. respectively).

The trace element distributions are erratic, with only two trace elements showing any significant trend. Barium has a negative correlation and rubidium has a positive correlation with SiO_2. For the rest of the trace elements the distributions are erratic where the silica content is greater than 71 per cent.

The negative correlation of barium with silica is consistent with the general trend of a differentiating magma (Nockolds and Allen, 1953; Taylor, 1965). Similarly, rubidium (ionic radius = 1.47A°) is very similar in size and chemical character to potassium (ionic radius = 1.33A°), and under extreme fractionation, rubidium isomorphously substitutes for potassium and becomes slightly concentrated, entering the K-positions in micas in preference to those of feldspar.

Tauson and Kozlov (1972) suggested that rubidium shows a stronger relationship than barium with fluorine, and hence rubidium migrates with fluorine. As a result, during differentiation of a volatile-rich magma, barium decreases and rubidium increases in concentration. This agrees with the observation of an increase in rubidium content and a decrease in barium content in the St. Lawrence granite with increasing fluorine and silica.

Strontium, if present in the granite, is of too low concentration to be detected by the analytical method used (<10 ppm). In plagioclase, calcium may be replaced by strontium up to 0.3 to 0.4 per cent. Ca - rich plagioclase contains more strontium than the sodic variety (e.g. An_{70-93} contains 0.1 to 0.13 per cent of SrO and An_{21} contains merely 0.014 per cent; Sen, et al., 1958), and the Sr/Ca ratio tends to increase during fractionation (Wager & Mitchell, 1951; Taylor, 1965). This is consistent with the low Sr content of St. Lawrence granite, where the calcium content (average 0.36 per cent) is very low and plagioclase compositions are less than An_{10}, hence, the low value of strontium.

Zirconium, fluorine and zinc are discussed in the economic geochemistry (section 4.7.3.).

4.7.3. Economic geochemistry

4.7.3.1. Introduction

The variation diagrams of zirconium, fluorine and zinc with silica show very erratic distributions as shown in Fig. 9b. There are no clear general trends for zirconium and fluorine mainly because they are volatile elements and as shown in Chapter 5, have a complex population distribution.

4.7.3.2. Zirconium

Zirconium substitutes to varying degrees for titanium and iron in apatite and sphene, (Nockolds and Mitchell, 1948) and forms a separate mineral, zircon ($ZrSiO_4$).

Generally, the distribution of zirconium is in part reflected by the presence of zircon. In the St. Lawrence granite, zircon is associated to some extent with hornblende and biotite only as an accessory mineral, although high zirconium values (average 516 ppm.) up to 2700 ppm. are encountered in the granite. The relative lack of zircon, despite high zirconium contents might be explained by the solubility of zirconium in an alkaline magma. The increase in alkalinity causes a rise in the solubility of zirconium and prevents any crystallisation of zircon to any marked extent (Sieder, 1965; Bowden, 1966).

Since the high zirconium content in St. Lawrence granite does not appear to form zircon crystals, it must be incorporated in the lattice of iron-rich minerals, e.g. hornblende, biotite, riebeckite and aegirine. It is noted that zircon is associated with hornblende and biotite, and not with riebeckite and aegirine. This is in accordance with the fact that riebeckite and aegirine form in a strongly alkaline to peralkaline magma which would prevent the crystallisation of zircon and hence the zirconium may be incorporated in the lattice of riebeckite and aegirine. Degenhardt (1957) found that aegirine may contain up to 0.5 per cent zirconium. Gerasimovskii, et al.,(1962) have commented that zirconium could form a solid solution series with iron in aegirine. Butler and Thompson (1967) have noted that alkali amphiboles and pyroxenes are conspicuous carriers of zirconium.

Thus, under alkaline conditions zirconium will not crystallise wholly as zircon but will be mainly incorporated in the lattice of alkaline mafic minerals. The presence of aegirine and riebeckite, and the near absence of zircon in the St. Lawrence granite suggests that the high zirconium values are mainly derived from the aegirine and riebeckite although accessory apatite may contribute slightly to the high zirconium values. Volatile-rich residual phases should be rich in zirconium (Goldschmidt, 1954; Siedner, 1965).

4.7.3.3. Fluorine

Fluorine shows a general positive correlation with silica (Fig. 9b), but the distribution becomes erratic when the silica content is greater than 71 per cent. In general, fluorine accumulates in the residual magmas during magmatic crystallisation and differentiation of the magma (Tauson, 1962). However, this trend varies appreciably and may be affected by the escape of the volatile fluorine during crystallisation of a magma. This may have caused the erratic behaviour of fluorine with increase in silica in the St. Lawrence granite.

The main factor affecting fluorine concentration in residual magmas during crystallisation and differentiation is that the main rock-forming minerals are not able to accept appreciable amounts of fluorine in their lattice. Only the accessory fluorapatite has fluorine as a main constituent. During crystallisation, fluorine could enter minerals in structural positions of OH^-. However, the amount of this fluorine may be limited, so that the residual magma is further enriched in fluorine.

Secondly, HF is more soluble than water in silicate melts, and lowers the melting temperature more, and thus will be accumulated to a higher degree in the residual melts (Wyllie and Tuttle, 1961). With increasing alkalinity, the separation of fluorine into gaseous phases decreases (Kogarko, et al., 1968) thereby causing an enrichment in fluorine in gases.

Since the St. Lawrence granite is very low in alumina (average 10.9 per cent) but rich in silica (average 76.8 per cent), fluorine may act as a depolymeriser by forming SiF bonds. SiF_4 is the most stable fluorine compound (Heat of formation 370 K cal/mole). Increase in SiO_2 of the melt is accompanied by the increase in production of SiF_4 (Kagarko, et al., 1968). Because of its great mobility, SiF_4 escapes from the magma and decreases the amount of fluorine in the siliceous melt. Thus SiF_4 complexes might play an important role in the removal of fluorine from magma.

As a rule, independant fluorine minerals do not form during the crystallisation of magma which is too poor in calcium, to contribute to the formation of fluorite (Solov'yer, et al., 1967). In general fluorine is dispersed among the inosilicates and phyllosilicate, and enters into apatite.

In the St. Lawrence granite, groundmass fluorite crystals are commonly associated with chloritised biotite and rarely with riebeckite and aegirine. During the post-magmatic stage, fluorine together with other volatiles may migrate through faults and other fractures towards the boundaries of the intrusives. The migration of fluorine is commonly accompanied by the formation of greisens and by low temperature hydrothermal alteration of the country rocks.

The St. Lawrence granite was subjected to violent and rapid escape of volatiles as shown by the presence of tuffisite, presumably preventing the formation of greisen. Nevertheless, the country rocks are altered, and in certain areas, silicification bands which contain purple fluorite are recognised in the hornfels. The formation of fluorite within the hornfels may be explained by the escape of SiF_4 reacting with calcium released by the breakdown of minerals such as plagioclase and amphiboles. The product would be fluorite, with the released silica forming the silicification bands in the hornfels.

Trace element analysis of the hornfels shows leaching of Cr, Ni, La and Ba from the dark hornfels towards the silicified hornfels (Table 2; Fig. 10).

The scarcity of hydrous minerals in the St. Lawrence granite would allow the fluorine to accumulate in magma rather than being incorporated in crystalline phases during crystallisation. Since the magma is highly volatile, the escape could be erratic and may fill pockets in the granite with volatiles. This can be seen in the field where patches of darker brown rocks are in the midst of the lighter coloured granite (Plate 24).

4.7.3.4. Zinc

From Fig. 9b, zinc seems to decrease with increase

TABLE 2

Selected Trace Elements in Hornfels of St. Lawrence Granite

Element	Cn-72 20-0'	CN-72 20-194'	V-5 Black	V-5 Green	V-5 White	Average Shale *
Nb	11	12	21	13	21	-
Zr	161	151	223	142	248	160
Sr	119	139	133	302	495	300
Rb	116	160	173	87	127	140
Zn	92	108	116	84	54	95
Cu	n.d.	n.d.	307	n.d.	n.d.	
Ni	72	67	58	46	28	68
Cr	128	116	82	64	48	90
La	86	84	n.d.	28	19	
Ba	778	1084	641	101	154	580

V-5 is from the quarry on the western margin and represents the progressive silicification from black to green to white in a single hand specimen.

* After Turekian and Wedepohl, Bull. GSA. v. 72, pp. 175-192, 1961.

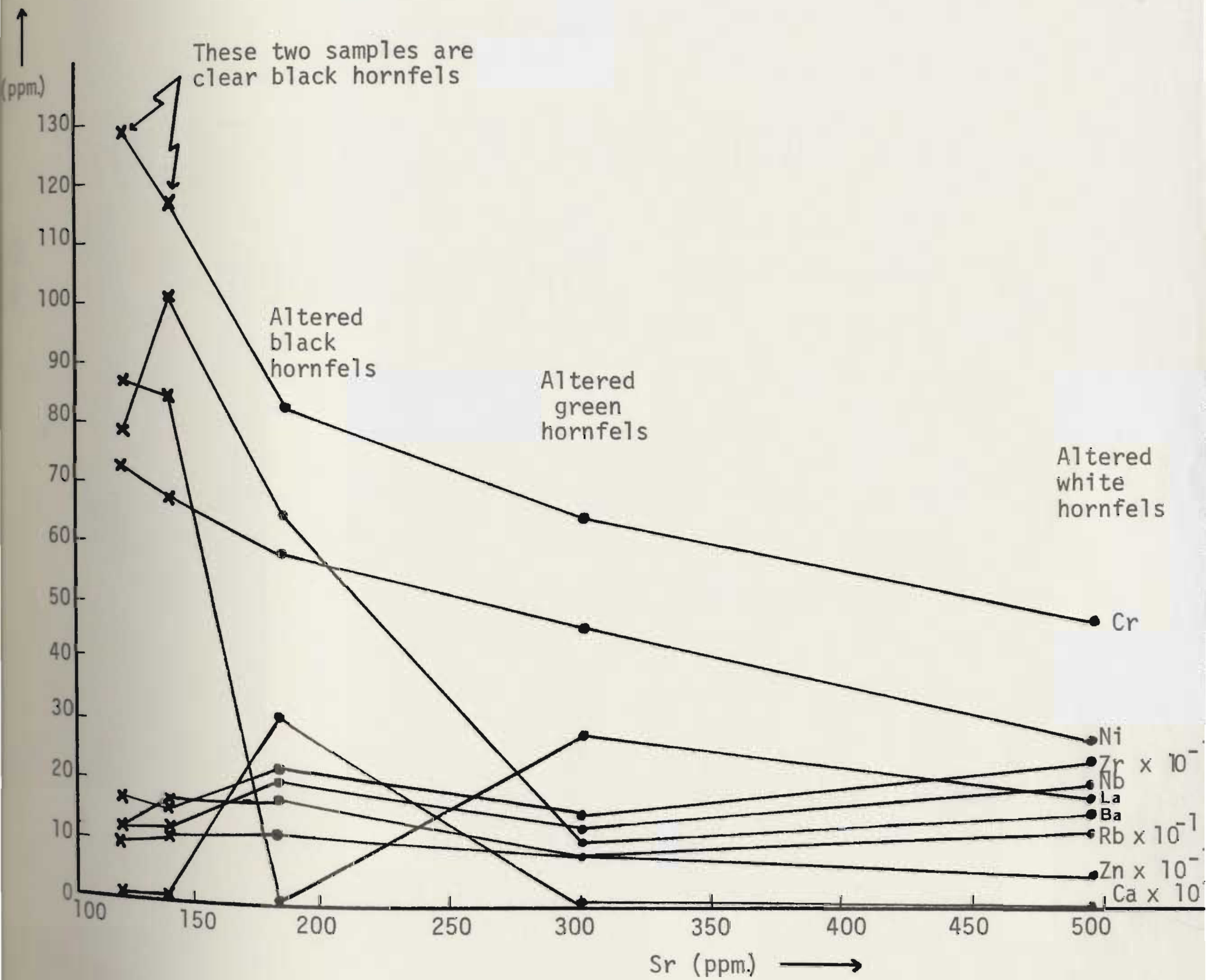


Figure 10: Variably silicified hornfels of the St. Lawrence granite (see also Plate 8).

in silica up to about 71 per cent whereby the zinc values become erratic. Zinc will enter late Fe^{2+} positions and the Zn^{2+}/Fe^{2+} ratio will increase during fractionation in silicate melts (Taylor, 1965). Since the Fe^{2+} values were not determined in the analysis of St. Lawrence granite, the ratio Zn^{2+}/Fe^{2+} cannot be compared.

However, in the field sphalerite occurs in veins at the contact of granite with its country rocks, while there is no separate sulphide phase in the granite. Hence, the high zinc values could be from the more basic rocks at the contact.

Cu, Ni, and Cr contents are below detection.

4.7.4. Alkalinity trend

Because of the alkaline nature of the St. Lawrence granite, it is interesting to examine it in terms of Wright's (1969) alkalinity index. Fig. 11a shows that the St. Lawrence granite has an alkaline to peralkaline affinity according to Wright's terminology, with most samples in the alkaline field. Using the agpaitic index (Bailey and MacDonald, 1969), i.e. classifying peralkaline rocks as those with an agpaitic index greater than one, the St. Lawrence granite is dominantly peralkaline. This suggests that the alkaline-peralkaline boundary in Wright's diagram should be shifted slightly to the left as shown by the dashed line in Fig. 11a.

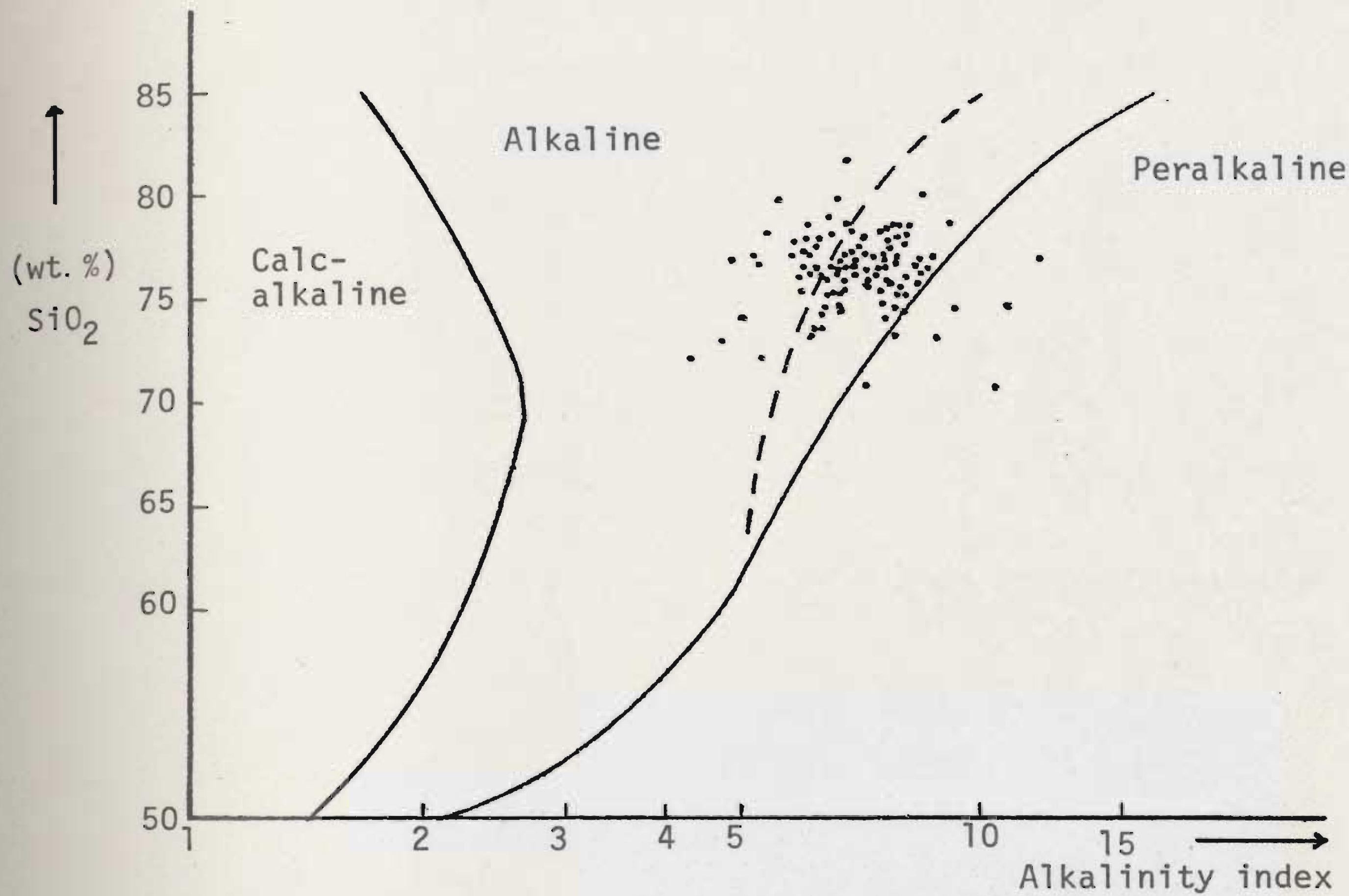


Figure 11a. Alkalinity index of Wright (1969) vs SiO_2

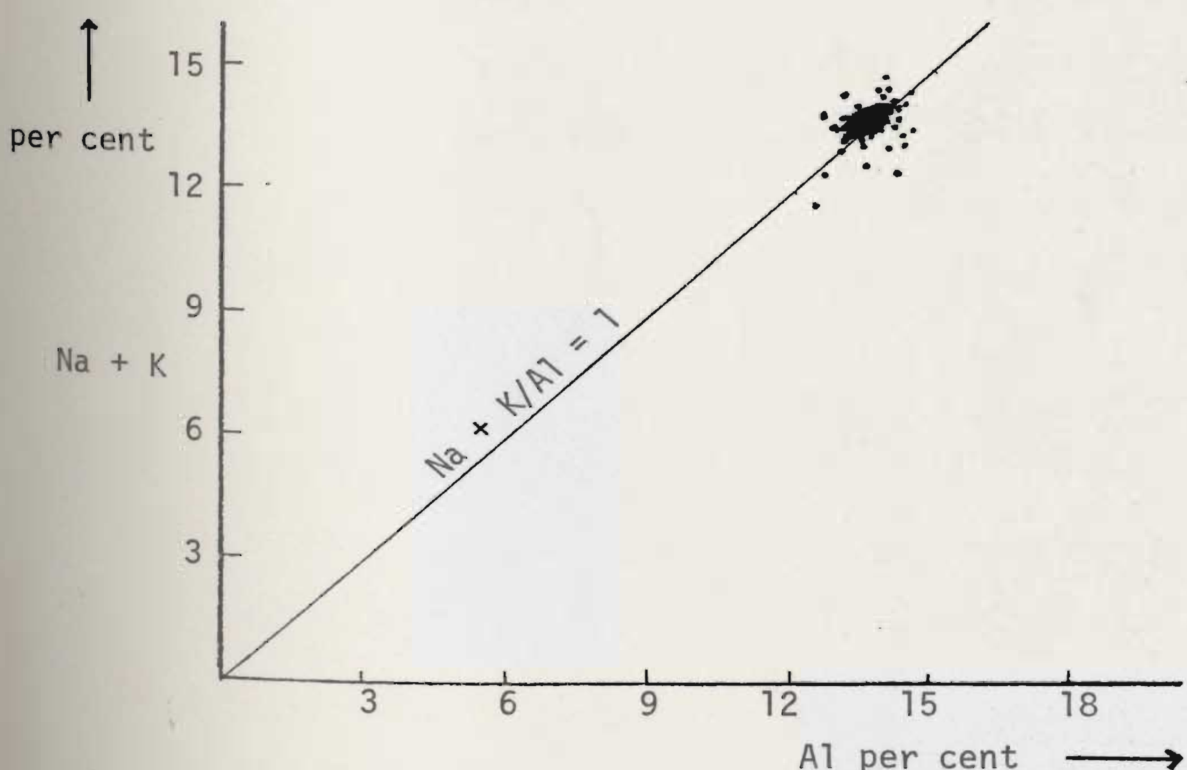


Figure 11b. Cation (%) Na + K vs Cation (%) Al.

Fig. 11b shows a plot of the cation per cent of Na + K against Al, with the majority of points at (Na + K)/Al ratios between 0.9 to 1.1. Any point that lies above the line (i.e. with (Na + K)/Al greater than one) is considered (according to the Bailey and MacDonald, 1969, definition) as peralkaline. There is no distinctive separate grouping of peralkaline or alkaline granite, and likewise in the field there is no apparent localisation of peralkaline or alkaline granite phases.

This lack of separation suggests that our artifical boundary between peralkaline and alkaline granites has no natural basis.

The St. Lawrence granite is characterised chemically by containing insufficient alumina (average 10.9 per cent) to accommodate the alkalis in feldspar, resulting in the formation of the normative mineral acmite. Mineralogically, it contains relatively sodic plagioclase (average An_{10}) and silica-under-saturated mafic minerals such as riebeckite and aegirine. These chemical and mineralogical features further classify the St. Lawrence granite as peralkaline.

4.7.5. K/Rb ratios

Potassium-rubidium ratios of the St. Lawrence granite are shown in Fig. 12. These ratios are compared to the generalised

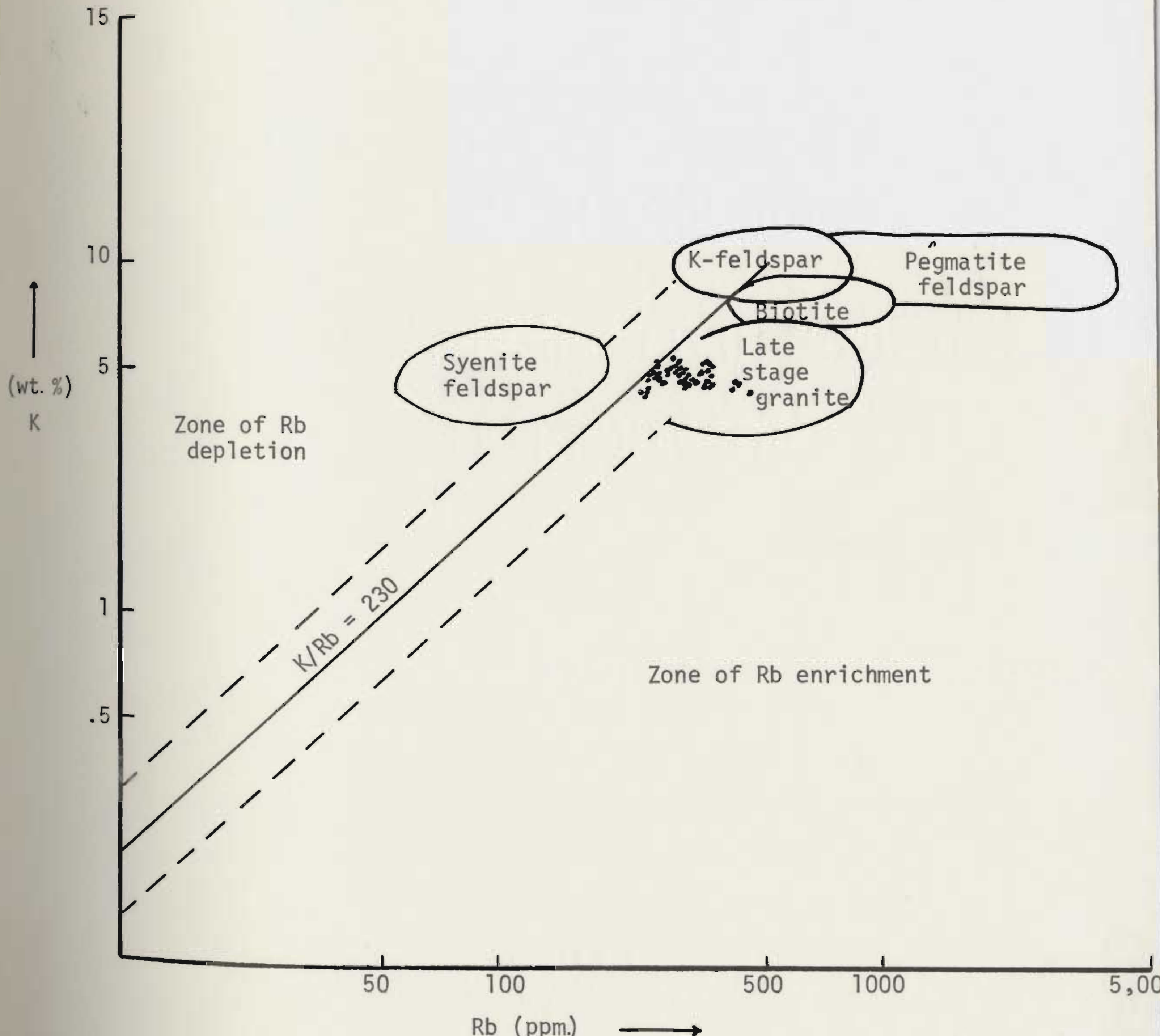


Figure 12: K/Rb ratio (Fields of different rock types after Taylor, 1965).

geochemical relationships of potassium-rubidium in common crustal rocks (from Taylor, 1965). The St. Lawrence granite, having an average K/Rb ratio of about 150, plots in the field given for late-stage granite. This is in accordance with an interpretation that the St. Lawrence granite is a late-stage granite.

An interesting observation is that the K/Rb ratios decrease corresponding to the sequence of intrusion. From field evidence, 4 generations of the granite are observed (section 4.2.). The age relationships and the corresponding K/Rb ratio of these granites are tabulated below:

		K/Rb
Younger ↑	Porphyritic fine-grained granite	129
	Fine-grained granite	131
	Medium-grained granite	137
Older	Coarse-grained granite	148

4.7.6. Differentiation Index

In this section, the writer attempts to compare the various granite plutons of the Burin Peninsula, as well as the Belleoram granite, to the St. Lawrence peralkaline granite to investigate whether there is any apparent genetic relationship amongst the granite plutons. The locations of the various plutons are shown in Fig. 13. This comparison is carried out by

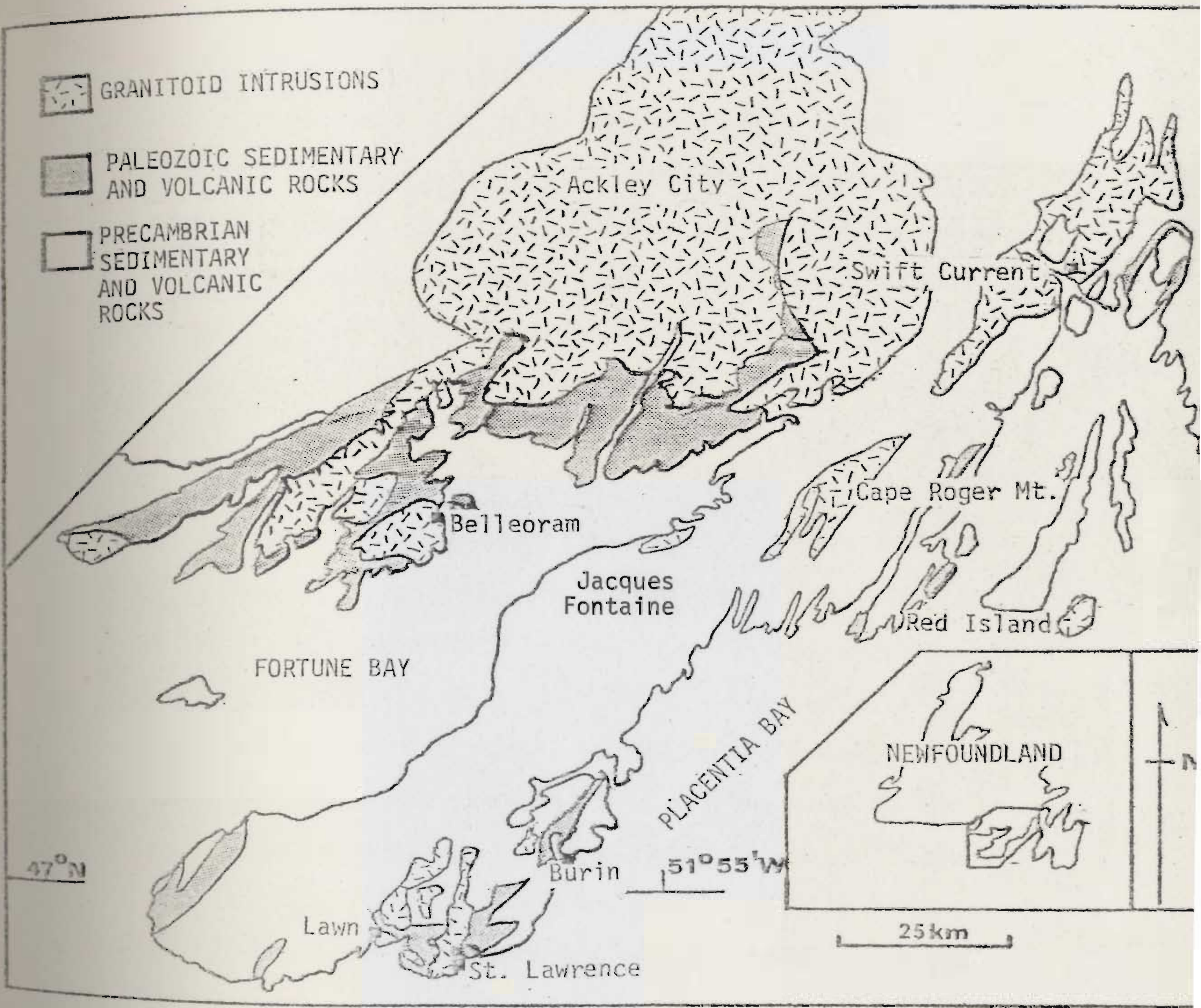


Figure 13: Location map of the various granitic pluton of southeast Newfoundland discussed in the text.

plotting the major oxide percentages against the Thornton and Tuttle (1960) differentiation index (normative Q + Ab + Or + Ne + Lc + Kp). The data for the other plutons was obtained from Strong, et al., (1973b).

The silica - D. I. diagram (Fig. 14) shows that the majority of the plutons of south-east Newfoundland are over-saturated in silica. Some granodioritic rocks of the Belleoram granite extend to the saturated range of the Thornton and Tuttle diagram. The heavy dashed line shows the general trend of silica content in igneous rocks (after Thornton & Tuttle, 1960).

One can see that the trends of Swift Current and Cape Roger Mountain granites are similar. Field evidence shows that the Swift Current and Cape Roger Mountain granites have similar geological settings, are both foliated, lie along the same strike, and are chemically and texturally very similar (O'Driscoll, 1973; Strong, et al., 1973b). Hence, the Swift Current and Cape Roger Mountain granites may be genetically related. The only other granite that lies very close to the field of Swift Current and Cape Roger Mountain granite is the Jacques Fontaine granite. The close proximity of the Jacques Fontaine granite and the similarity in the chemical trend may likewise indicate that Jacques Fontaine granite is also genetically related to them, as suggested by Bradley (1962).

The St. Lawrence granite which, like Cape Roger

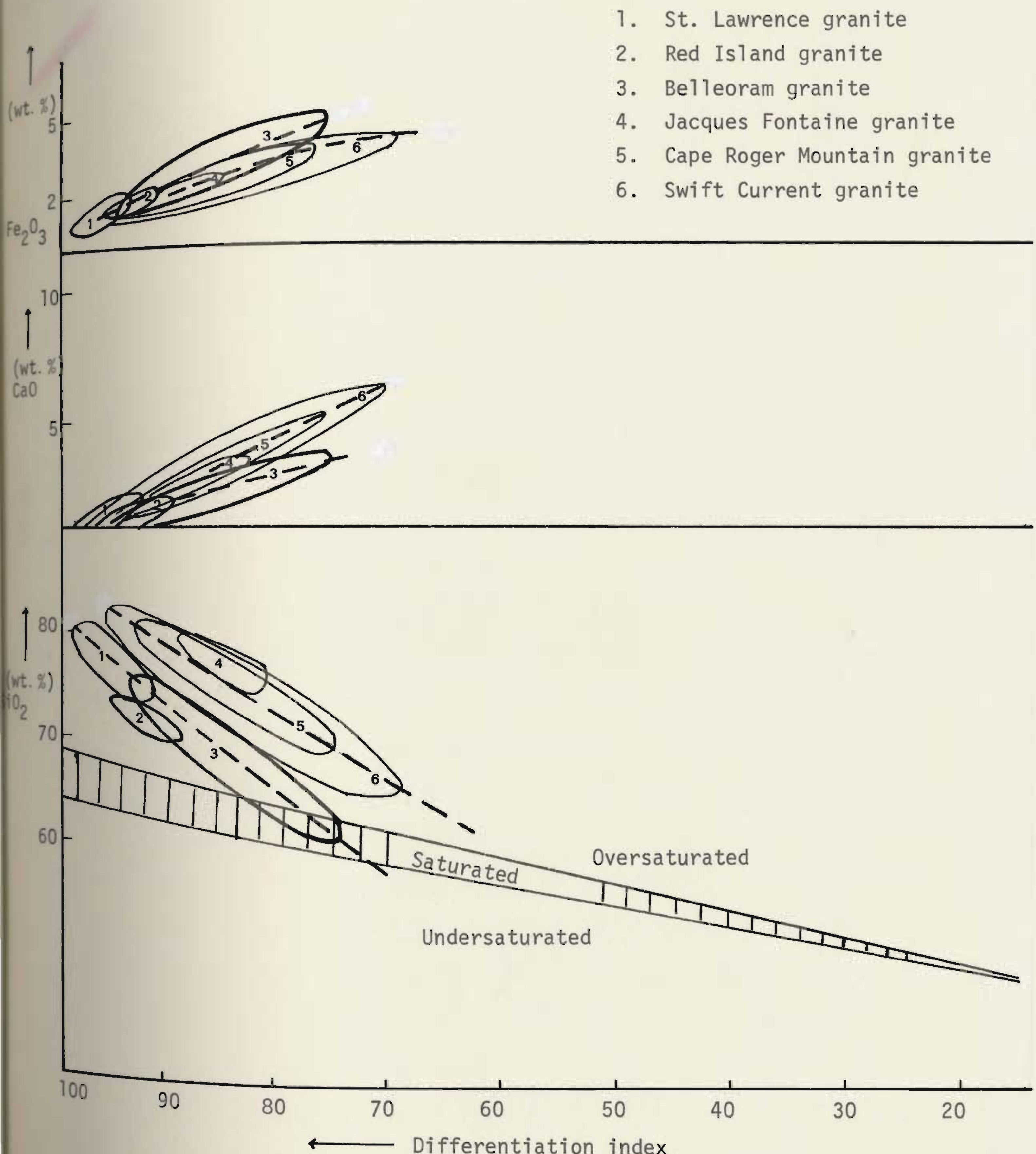


Figure 14: Outline of fields enclosing points for SiO_2, Fe_2O_3 and CaO plotted against the differentiation index of Thornton and Tuttle (1960).

Mountain and Swift Current granites, lies along strike and in Zone H of the Canadian Appalachian Structural Province (Williams, et al., 1972) could be suggested to be genetically related to them. However, it is distinctly offset from the trend of these plutons in the silica - D.I. diagram of Fig. 14, and thus appears not to be genetically related to them.

However, the St. Lawrence and the Belleoram granites lie on a continuous trend which may suggest that St. Lawrence granite is a late differentiate of magma similar to the Belleoram granite. Field evidence shows that the Belleoram granite is a high-level and unfoliated granite. This is similar to St. Lawrence granite except that mineralogically St. Lawrence granite is more differentiated. The Red Island granite has its trend lying close to the Belleoram granite and it appears that there is a fractionation trend from Belleoram granite -- Red Island granite -- St. Lawrence granite.

The distribution trends of Fe_2O_3 and CaO, all showing a definite decrease with increasing D. I., are also shown in Fig. 14. As for SiO_2, the trends of these elements for Swift Current, Cape Roger Mountain and Jacques Fontaine granites are shown to be different from the trends of the St. Lawrence, Red Island and Belleoram granites.

4.7.7. Petrogenesis

Fig. 15 shows a plot of normative Q:Ab:Or of St. Lawrence granite. Superimposed on these plots are the positions of the ternary minina and eutectics ($M_{0.5-3}$) at various water pressures. $M_{0.5}$ is the ternary minimum at 0.5 kb P_{H_2O}, M_1 at 1 kb P_{H_2O}, etc. Eighty per cent of the points plot in a field centred on the ternary cotectic at 0.5 kb, and 70 per cent plot on the orthoclase side of the minimum at this pressure. The maximum P_{H_2O} allowed by the wider scatter of points is less than 3 kb. Those points which plot towards the quartz-orthoclase sideline are found in thin sections to consist essentially of quartz and orthoclase phenocrysts, and the relative proportions of modal quartz and orthoclase are directly reflected in the relative normative proportions in Fig. 15, indicating the effects of phenocryst accumulation in a melt of the main granite composition.

The presence of granophyric texture in some rocks (see section 4.4.) can be explained with reference to Fig. 15. The build up of water pressure, say to 3 kb, will cause any liquid of the St. Lawrence granite compositions to crystallise quartz alone, and the sudden release of water pressure will cause the cotectic to move towards the quartz apex. Hence, the liquid

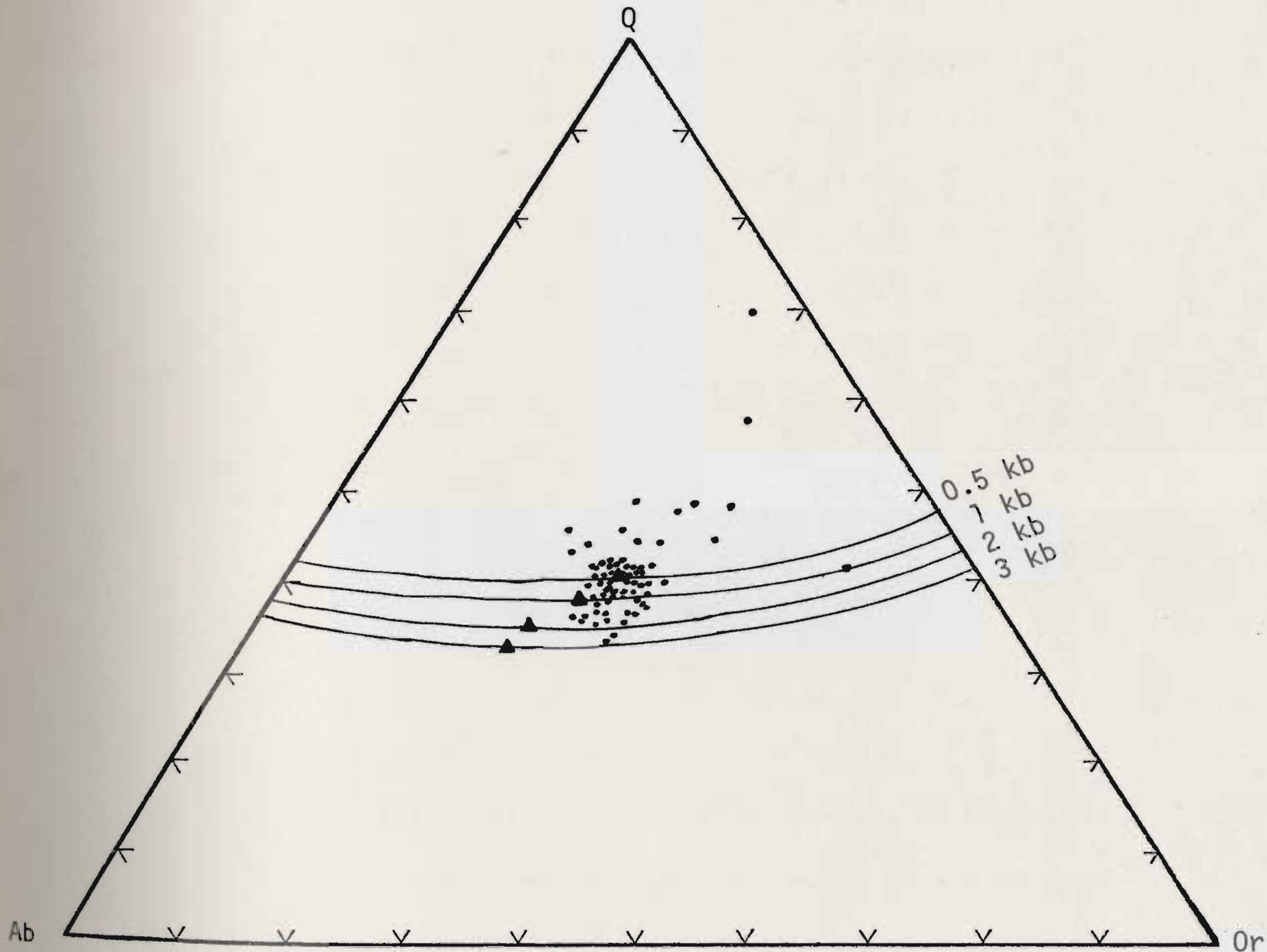


Figure 15: Q-Ab-Or (wt. %) system showing data for the St. Lawrence granite and the effect of water vapour pressure on position of cotectic and ternary minimum (triangles) (after Tuttle and Bowen, 1958).

that was crystallising quartz would then crystallise feldspar. Depending on which side the liquid compositions are with reference to the ternary minimum, the feldspars could be sodic or potassic. In the St. Lawrence granite, most points fall on the potassic side of the minimum. Hence, with the build up and release of water pressure, the crystallisation sequence could alternate between quartz and K-feldspar, or both simultaneously, and sudden pressure release could cause quenching in a granophyric intergrowth. There is abundant field evidence of sudden explosive release of pressure, indicated by the presence of tuffisite (gas breccia) supporting the above explanation (Reynolds, 1954; Hughes, 1971). It is also supported by the fact that the granophyres are most common around the rapidly cooled edges of the pluton.

Since eighty per cent of the points plot in a small field centred on the ternary minimum at 0.5 kb (see Fig. 15), the temperature of crystallisation of the granite is around 780°C which is the thermal valley temperature of this pressure as shown in Fig. 16. The perthite indicates that the granite cooled too fast for complete unmixing, but too slow for homogeneous quenching in the absence of water vapour.

The St. Lawrence granite is thus considered to be relatively a dry, hot melt because of its low P_{H_2O} minimum composition, i.e. a hypersolvus granite. Tuffisites suggest

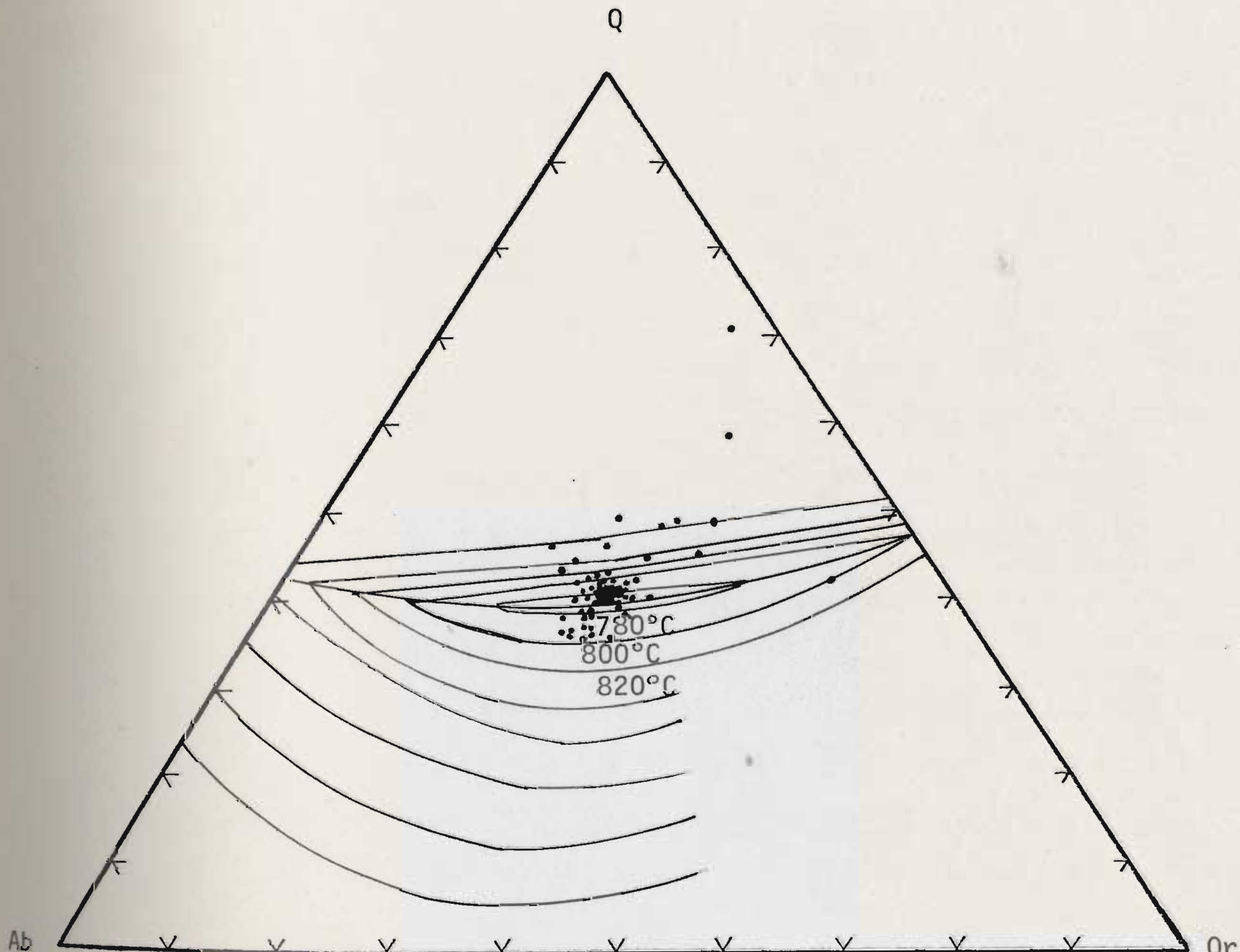


Figure 16: Isobaric equilibrium diagram for the system $NaAlSi_3O_8$ - $KAlSi_3O_8$ - H_2O at 0.5 kb. (after Tuttle and Bowen, 1958).

a shallow depth of emplacement of the granite. If the granite contained excess water, marked metamorphism of the country rocks with considerable metasomatic granitisation might be seen (Tuttle & Bowen, 1958, p. 93). Field evidence shows that the metamorphism of the country rocks by the granite produced only local thermal, but minimal metasomatic effects, which thus indicates a relatively anhydrous melt. The relative lack of hydrous minerals such as biotite and hornblende and the complete absence of pegmatites or aplites enhances the interpretation that the melt is relatively dry.

Peralkaline granites are a very characteristic and apparently unique to stable continental environments, associated with rifting or "thermal plumes" (Greenwood 1951; Jacobson, et al., 1958; Wright, 1969; and MacDonald, et al., 1970). Most of these are composite ring-dykes in which the peralkaline granites are associated with alkaline granites that are not peralkaline. Similarly, the St. Lawrence pluton contains peralkaline granite associated with strongly alkaline but not peralkaline granite.

There appear to be five theoretically possible solutions to the origin of peralkaline granites:

1. Small amounts of peralkaline magma are common in alkali olivine basalt provinces and in some places may be strongly developed (Bailey and Schairer, 1966). Even within separate flows and intrusions of alkali basalt, there is evidence of peralkalinity

in the residual liquid, indicated by the presence of acmite or acmitic rims of pyroxene and acmite-bearing pegmatoids. Normative acmite appears in some analyses of the rocks in alkali basalt provinces (Chayes, 1963). These indications of peralkalinity suggest that many alkaline and peralkaline rocks are differentiation products of alkali olivine basalt (Turner and Verhoogen, 1960).

In the St. Lawrence area, the Mount Margaret Volcanics (section 2.2.3.3.) are alkali basalts. On field evidence, the granite intrudes the basalt, but this is not an uncommon relationship in genetically related suites, and the granite might thus have formed by fractionation from the basalt. However, there is a disparity in that the basalt occupies about 2 square km. of the map area whereas the area of the granite is about 80 square km. of granite. If substantial basalt underlay the granite, it would produce a positive gravity anomaly. Instead, the area has a negative anomaly (J. P. Hodych, pers. comm., 1973) suggesting a lack of basic material associated with the granite (Fig. 17). The disparity in the volume relations suggests that derivation as residual liquid from basalt magma was not involved in the formation of St. Lawrence granite.

2. Bowden (1970) suggested that the peralkaline granites of Nigeria were produced by progressive melting of bauchite, a fayalite-quartz monzonite, by a linear zone of heat flow from the mantle during the disruption of Gondwanaland, as suggested by the remarkable alignment of the Nigerian younger

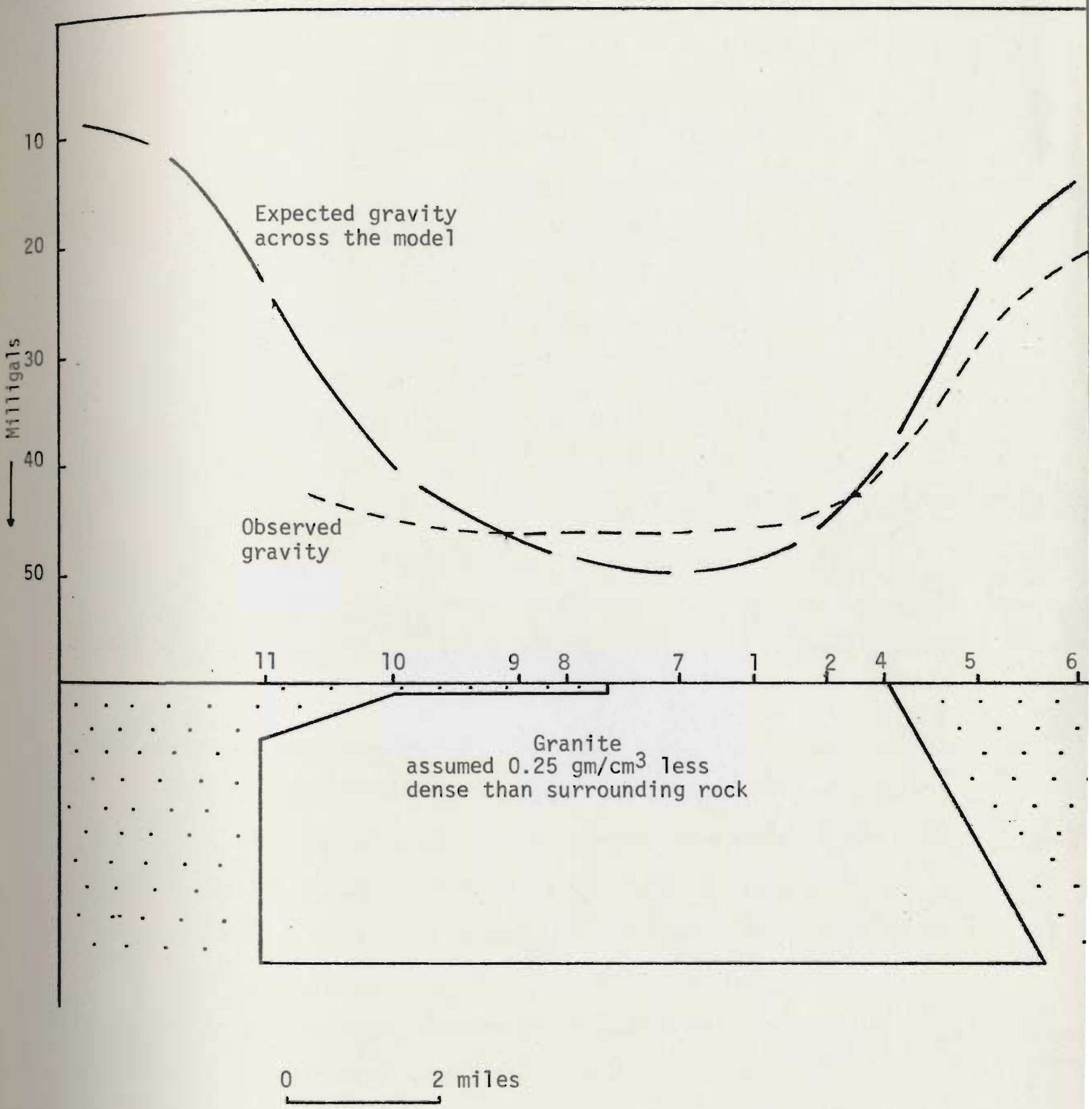


Figure 17: Gravity model of the St. Lawrence granite (after J. P. Hodych, pers. comm., 1973) based on a single traverse along the main highway from the eastern to the western margin.

granites and the structurally similar but dominantly per-alkaline granites to the north, through the Zinder district of the Niger Republic to the I'Air plateau. Black (1969) has also postulated that the development of the Mesozoic Nigeria-Niger Younger Granite province and the disruption of Gondwanaland may be related to the same cause, i.e. that the linear distribution of the ring-complexes reflects the former location of a zone of high heat flow in the mantle, thus supporting Bowden's interpretation.

Eborall and Wright (1974) criticised this hypothesis because it is not supported by geological arguments. They pointed out that there are very few bauchites near Jos plateau and none within the Younger Granite Province itself (Wright, 1970) and suggested that there is an absence of any extensive layer of bauchite beneath the Jos plateau region or a bauchite body beneath each of the Younger Granite intrusions (Oyawaye, 1962). In conclusion, they emphasise that the similarity between bauchite and fayalite-bearing Younger Granites, notably the greenish charnockitic aspect and the presence of hastingsite and fayalite, is due principally to the high content of iron relative to other elements in both rocks. This does not imply that one is derived from the other but that processes of iron enrichment have been important in the magmatic history of both.

In the St. Lawrence area there is no evidence of the presence of bauchite or any other similar metamorphic rocks.

3. Melting of crustal rocks could be responsible for the generation of high level granites, the majority of which are aluminous but some are peralkaline.

Brown's (1963) experimental studies of Precambrian and Tertiary rocks from Skye first gave convincing evidence that the Tertiary rocks could be produced by the fusion of Lewisian basement rocks, although he conceded that subsidiary amounts could have been derived from higher levels in Torridonian arkoses. The evidence of Moorbath and Bell (1965) that the granites have very high $^{87}Sr/^{86}Sr$ ratios (0.712 to 0.721) compared with the Skye basic rocks and their differentiates (0.706), adds strong support to the above hypothesis. Thompson (1969), from petrological and chemical studies, postulated that the Glamaig Epigranite is essentially a partial melt from relatively sodic acid Lewisian gneiss, and the Southern Porphyritic Epigranite is thought to be a large partial melt-fraction from predominantly Torridonian arkose source rocks. In the St. Lawrence area, no arkose formation or gneissic terrain is recorded although there is indirect evidence that it underlies the Avalon Platform (Strong, et al., 1973c). The high $^{87}Sr/^{86}Sr$ ratio of 0.720 $\pm$ 0.005 in the St. Lawrence granite (K. Bell, pers. comm., 1974) may allow a similar interpretation of its origin.

4. Bailey and Schairer (1966) suggested that limited fractional melting at the base of the continental crust would be capable

of producing a peralkaline granite parent magma, subsequently modified to varying degrees by reacting with less alkaline continental crust. Eborall and Wright (1974) agree with the above suggestion and emphasise that the appropriate magmas are probably generated in the deep crust or upper mantle, due to a slightly increased geothermal gradient such as characterises all non-orogenic magmatic provinces.

Luth, et al., (1964), have shown experimentally that under the pressure that obtains at deep crustal to upper mantle levels, granites would be strongly alkaline to peralkaline and sodic in nature.

The St. Lawrence granite is intruded in a zone of weakness along N-S normal faults (see section 4.5.). Although it is not known how deep these faults may have penetrated, they may have acted as channelways for the intruding magma. Although the peralkaline magma might be contaminated by sialic rocks which could destroy the peralkaline nature of the magma by supplying alumina, it could have survived intrusion through continental crust if it rose through a conduit already lined with co-magmatic material. The presence of peralkaline granite closely associated with strongly alkaline granite in the St. Lawrence area may indicate that a peralkaline parent magma had been contaminated with the sialic rocks while intruding through the continental crust, although it cannot be said that the alkaline granite is concentrated around the margins of the plutons.

5. Fractionation of a rather uniform and relatively calcalkaline acid parent would produce alkaline to peralkaline granites (Jacobson, et al., 1958).

The granites in the Burin Peninsula, e.g. Swift Current and Cape Roger Mountain granites, and the Belleoram granite are calcalkaline to alkaline in composition (Strong, et al., 1973b). From section 4.7.6., the Swift Current and Cape Roger Mountain granites were not considered to be genetically related to the St. Lawrence granite and thus will not be discussed further. The Belleoram and Red Island granites on the other hand are of a composition that could be genetically related to the St. Lawrence granite.

A normative plot of Q:Ab+An:Or of Belleoram granite shows that the points plotted for the Belleoram granite trend into the St. Lawrence granite normative field (Fig. 18). This is in accordance with the interpretation that St. Lawrence granite might have been fractionated from a more calcic magma analogous to the Belleoram granite.

Bailey and Schairer (1964) suggested that the separation of alkali feldspar from a slightly alumina-deficient liquid would fractionate alumina and eventually potash, leading to strongly peralkaline and sodic residual liquid (i.e. the "orthoclase effect"). However, the "orthoclase effect" was based on the assumption that the alkali ratio of the crystals is related in a simple fashion to the alkali ratio of the liquid. Thompson and MacKenzie (1967) showed that this is not the case, and there is thus no reason to expect peralkaline granites to be strongly sodic.

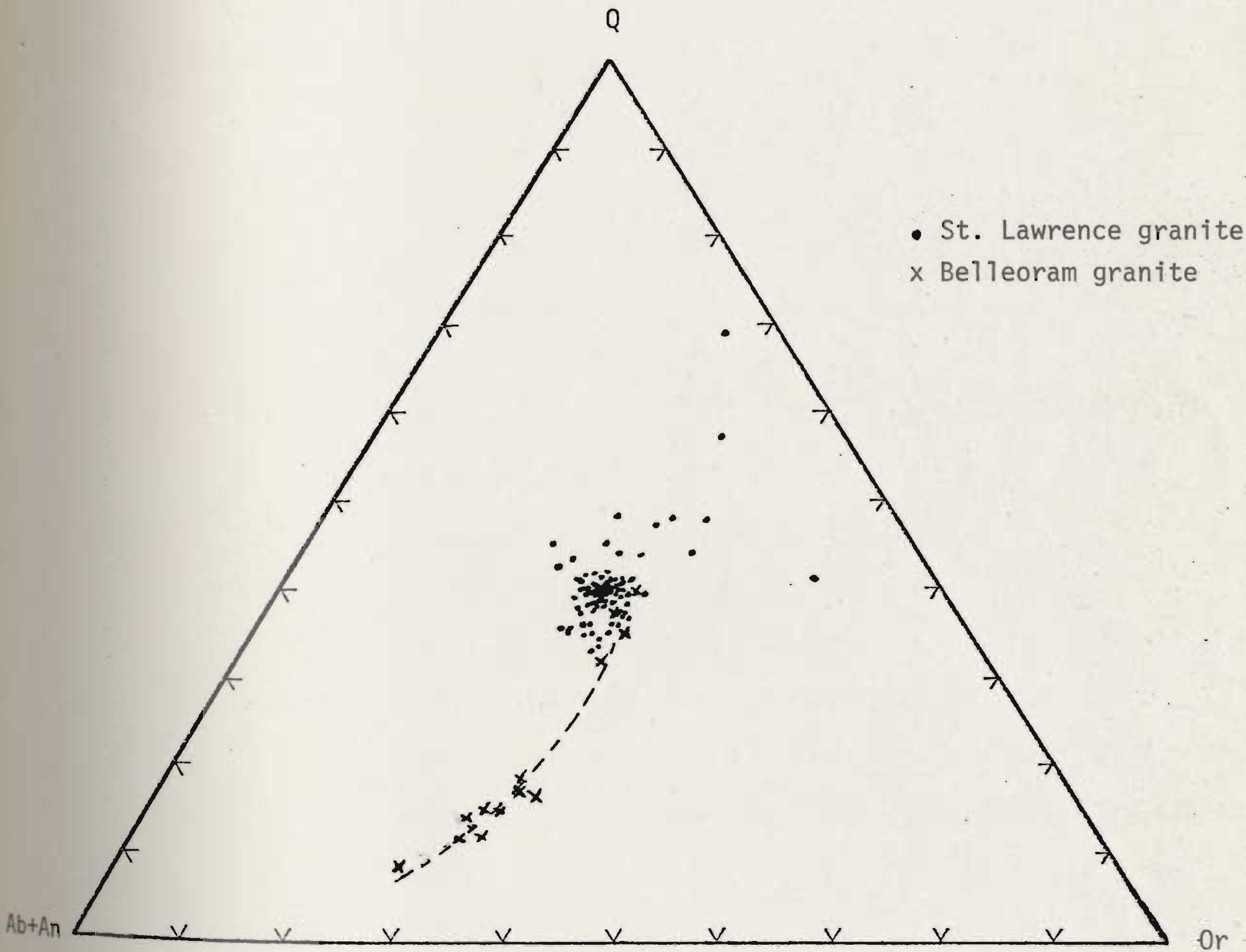


Figure 18: Normative plots (wt. %) of the Belleoram granite in the Q-Ab+An-Or system (after Strong, et al., 1973c).

Although the St. Lawrence granite is not particularly sodic, extreme fractionation of magma such as the Belleoram granite may produce a peralkaline residual liquid that can be intruded at higher levels to form the St. Lawrence peralkaline granite.

4.7.8. Comparison with other granites

Because of their gross chemical similarities and similar associated mineral deposits, it is interesting to compare the St. Lawrence granite to those of the South-West England granites and the Younger Granites of Northern Nigeria.

The normative plots of Q:Ab+An:Or for riebeckite granite of the Younger Granites of Northern Nigeria (Jacobson, et al., 1958) and the porphyritic biotite granites of South-West England (Exley and Stone, 1964) are shown in Fig. 19. Points 1 and 2, which are riebeckite-aegirine-bearing granites of Kudaru and Liruei respectively, fit precisely in the centre of the St. Lawrence granite field. Points 5, 6, 7, are biotite-riebeckite bearing granites and fall towards the plagioclase corner outside the St. Lawrence field. Points 3 and 4 are albite-riebeckite bearing granites and they plot well outside the St. Lawrence field close to the quartz-orthoclase cotectic at water pressure around 10 kb. Mineralogically, the riebeckite-aegirine-bearing granites of the Younger Granites of Northern Nigeria are very similar to that of St. Lawrence granite. These similarities are emphasized by Table 3, where the only significant difference is the lower Na_2O of St. Lawrence granite.

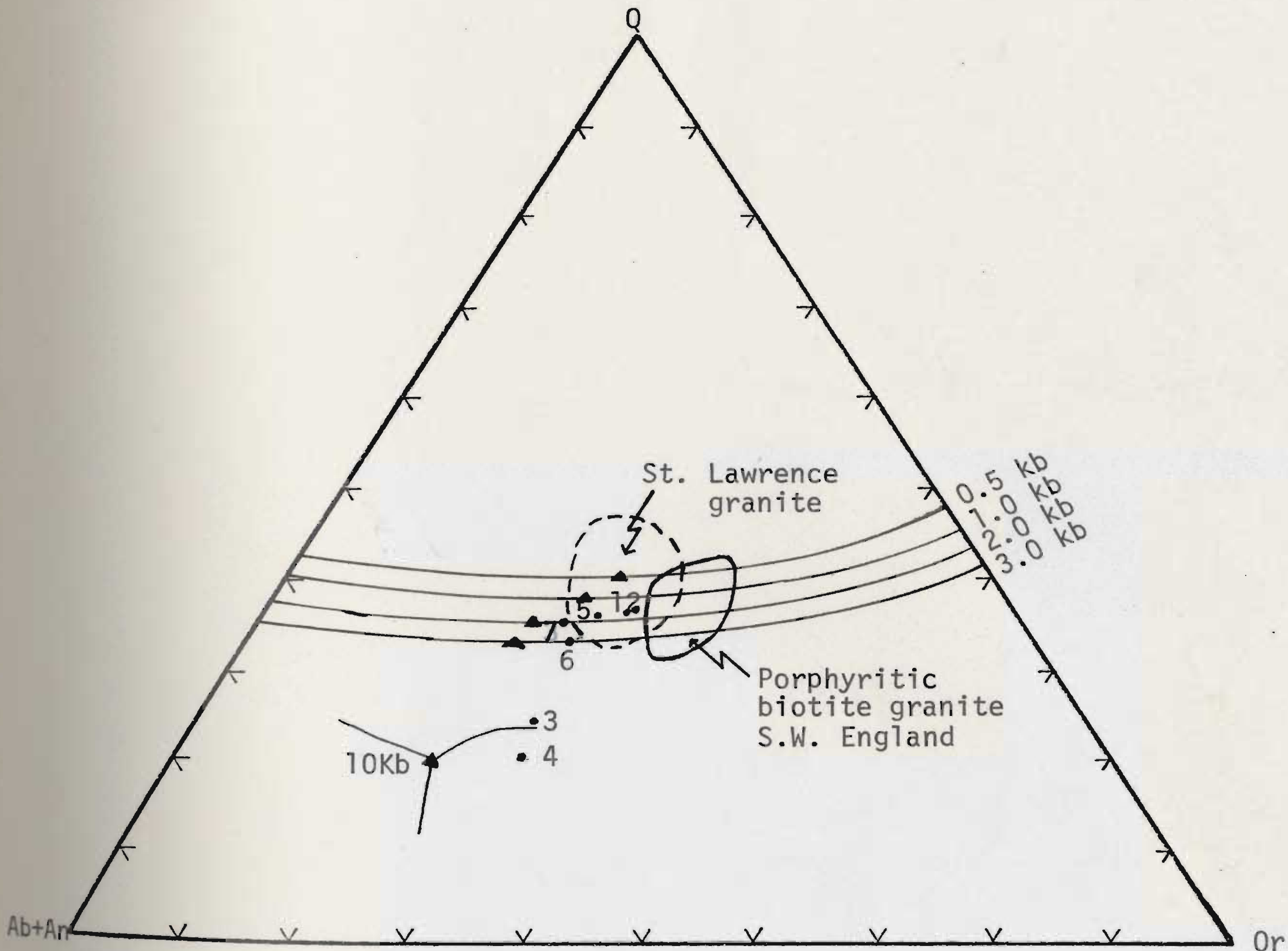


Figure 19: Normative plots (wt %) of Q-Ab+An-Or system of the Younger Granite of Nigeria and the St. Austel granite of S. W. England. (Numbers explained in text.)

TABLE 3

CHEMICAL ANALYSIS OF VARIOUS GRANITES

	1	2	3	4
SiO_2	76.46	76.25	75.26	72.2
TiO_2	.14	.11	.26	----
Al_2O_3	10.70	10.23	10.48	15.1
Fe_2O_3	1.70	1.23	2.42	.25
FeO	----	.76	1.32	----
MnO	.00	----	----	.004
MgO	.02	.18	.35	.08
CaO	.35	.37	.57	1.7
Na_2O	3.61	4.68	4.04	3.92
K_2O	4.74	4.65	4.66	4.58
P_2O_5	.00	.01	.08	----
F	.13	.29	.09	1.36

1. St. Lawrence peralkaline granite
2. Riebeckite aegirine granite, Kudaru, Nigeria
3. Riebeckite aegirine granite, Liruei, Nigeria
4. Porphyritic biotite granite, St. Austel, S-W. England

The fluorite granite (Mean of 3 analyses), St. Austell (from Exley, 1956) of South-West England is compared to the St. Lawrence granite in Table 3, showing that the St. Lawrence peralkaline granite has a higher silica content, and the high Al_2O_3 content of the St. Austell granite classifies it as peraluminous and not peralkaline.

Although the normative plots of the porphyritic biotite granite of St. Austell fall near the field of St. Lawrence granite, they are strikingly different in their mineralogy and alkalinity.

4.7.9. Other Newfoundland peralkaline granite

There are two other granitoid plutons in Newfoundland that are riebeckite-bearing, namely the La Scie granite and the Traytown granite. The La Scie granite, located on the Burlington Peninsula, has not been chemically analysed, and thus will not be discussed further. On the other hand, the Traytown granite is in the same geological setting, i.e. Zone H (Williams, et al., 1972) as St. Lawrence. The average chemical analyses of it is shown in Table 4 (from Strong, et al., 1973b). Most of the major elements of Traytown and St. Lawrence granites are similar, except that the Traytown granite has higher Al_2O_3 (average 12.06 per cent) and Na_2O (average 4.29 per cent) contents. The trace elements of these two granites, on the other hand, are completely different.

TABLE 4

CHEMICAL ANALYSIS OF ST. LAWRENCE AND TRAYTOWN PERALKALINE GRANITES

	1	2
SiO_2	76.46 %	76.10 %
TiO_2	.14	.20
Al_2O_3	10.70	12.06
Fe_2O_3	1.70	.94
FeO	----	.64
MnO	.00	.03
MgO	.02	.07
CaO	.35	.40
Na_2O	3.61	4.29
K_2O	4.74	4.72
P_2O_5	.00	.20
Zr	516 ppm.	289 ppm.
Sr	0	21
Rb	295	99
Zn	50	70
Cu	0	5
Ba	70	790
F	1308	-

1. St. Lawrence peralkaline granite
2. Traytown peralkaline granite

The Traytown granite have a very high Ba (average 790 ppm.) content and is low in Zr (average 289 ppm.) and Rb (average 99 ppm.). Although the Traytown granite is riebeckite bearing, the distinct difference in the trace element concentrations require some caution in interpreting them as genetically related (cf. Strong, et al., 1973b).

CHAPTER 5

STATISTICAL TREATMENT OF GEOCHEMICAL DATA

5.1. Introduction

An important phase of geochemical interpretation is to condense a large set of analytical data, which is cumbersome and difficult to interpret by normal manipulation, into an intelligible and useful form by the use of descriptive statistics. This is most readily done by graphical means, where investigation of the frequency distribution, e.g. histograms or cumulative curves, of a given set of data simplifies comparisons.

Ahrens (1954) suggested that the distribution of the concentrations of some elements in particular rock suites is log-normal, invariably showing a positive skewness when the dispersion of values is large. When the concentration of the elements is changed to log concentration, the distribution follows a normal or Gaussian distribution. These features are well illustrated by the St. Lawrence granite data.

5.2. Methods of plotting frequency distribution curves, histograms and cumulative frequency distribution curves

A correct grouping of the values is essential in plotting of histograms. Too few classes will result in shading out the important features of the curves and too many classes will result in the loss of significant details amidst a cloud of erratic minor details. Miesh (1967) noted that the logarithmic interval must be adapted to variation amplitude of the values and to the precision of the analytical methods. Generally, the number of classes desired is governed by three factors, namely, i) the total number of values, ii) the range of distribution of the values, and iii) the interval to be selected. Lepeltier (1969) recommends working with 50 to 25 intervals.

The cumulative frequency distribution curves can be plotted to check if the concentrations fit a log-normal distribution which will give a straight line. In this simple case, the background value could be arbitrarily taken as the line intersecting with the 50 per cent ordinate. In a log-normal distribution, the background thus calculated corresponds to the mode and the median values, and is the geometric mean of the results. This geometric mean is more significant than the arithmetic mean as it is less subject to change with the addition of new data and is less affected by high values.

When the probability log plot shows a break in slope of the straight line, it indicates that more than one distribution occurs within the set of data (Tennant and White, 1959).

Lepeltier (1969) recommends accumulating the frequency percentage from the highest to the lowest values because he considers there is a lack of precision in the low values and high values are more important for the determination.

of the threshold level. The writer agrees with Lepeltier and plotted the data by accumulating the frequency percentage from the highest to the lowest values.

5.3. Interpretation of the results

5.3.1. Major elements

It can be seen from the histograms and the frequency curves for SiO_2, Fe_2O_3, Al_2O_3, Na_2O and K_2O values (Fig. 20) that their distributions closely approximate to that of the normal distribution curves which indicates a normal distribution of these elements.

CaO shows the frequency distribution curves on the arithmetic concentration interval to be slightly negatively skewed (Fig. 21). When the values are plotted on log-concentration interval, the curve gives an approximately bell-shaped distribution. On the probability-log plot, the curve closely approximates a straight line, showing that the distribution is essentially a log-normal distribution. The negative skewness is due to an excess of low values. Provided that the proportion of low values is not too high (20 per cent or less) they do not interfere in the interpretation of log-normal distribution (Lepeltier, 1969).

In Figs. 22 and 23 the frequency distributions of MnO and MgO are extremely negatively skewed, showing an excess of very low values. These features are duplicated in the

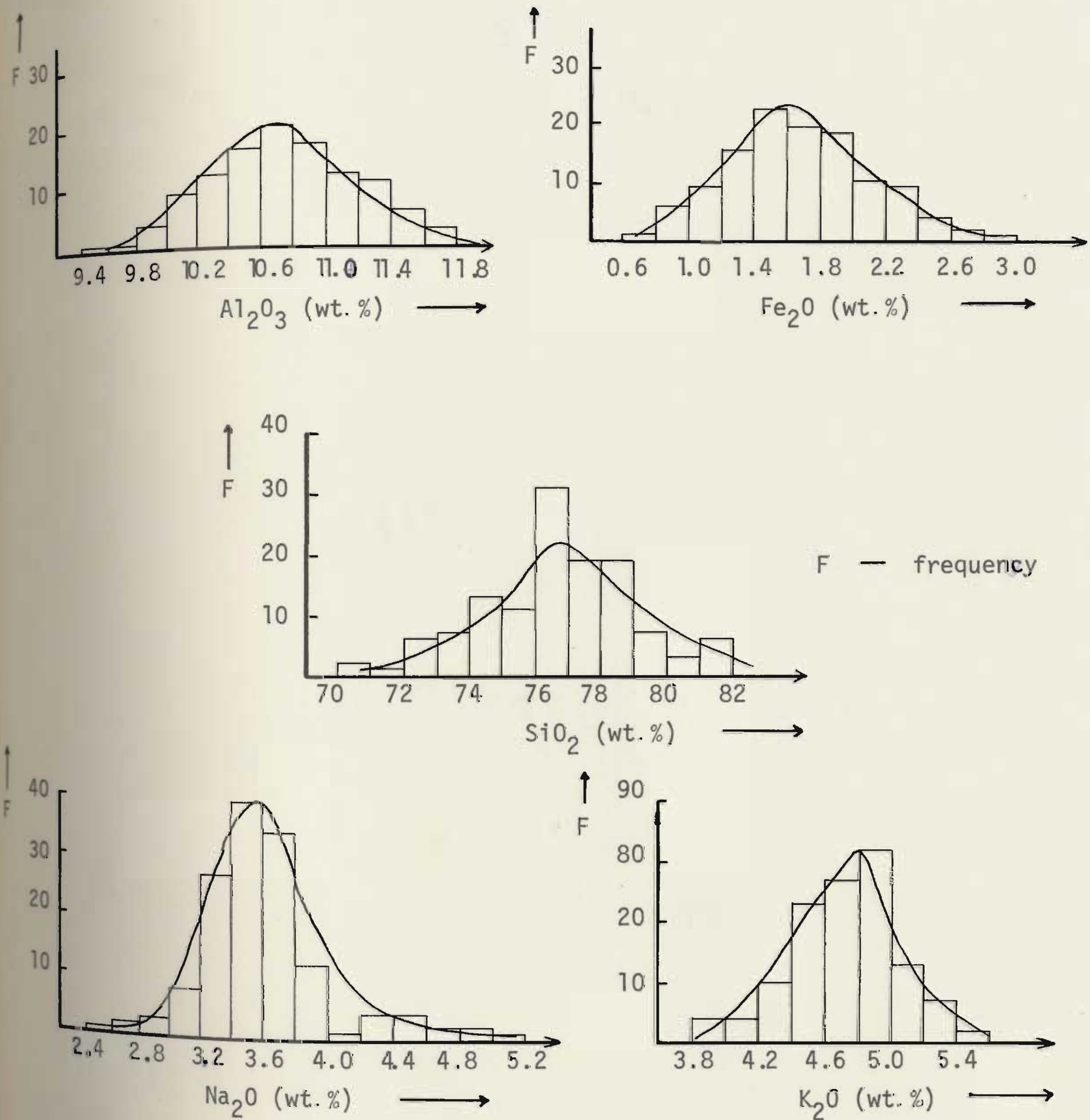


Figure 20: Histograms and frequency curves for SiO_2, Fe_2O_3, Al_2O_3, Na_2O and K_2O.

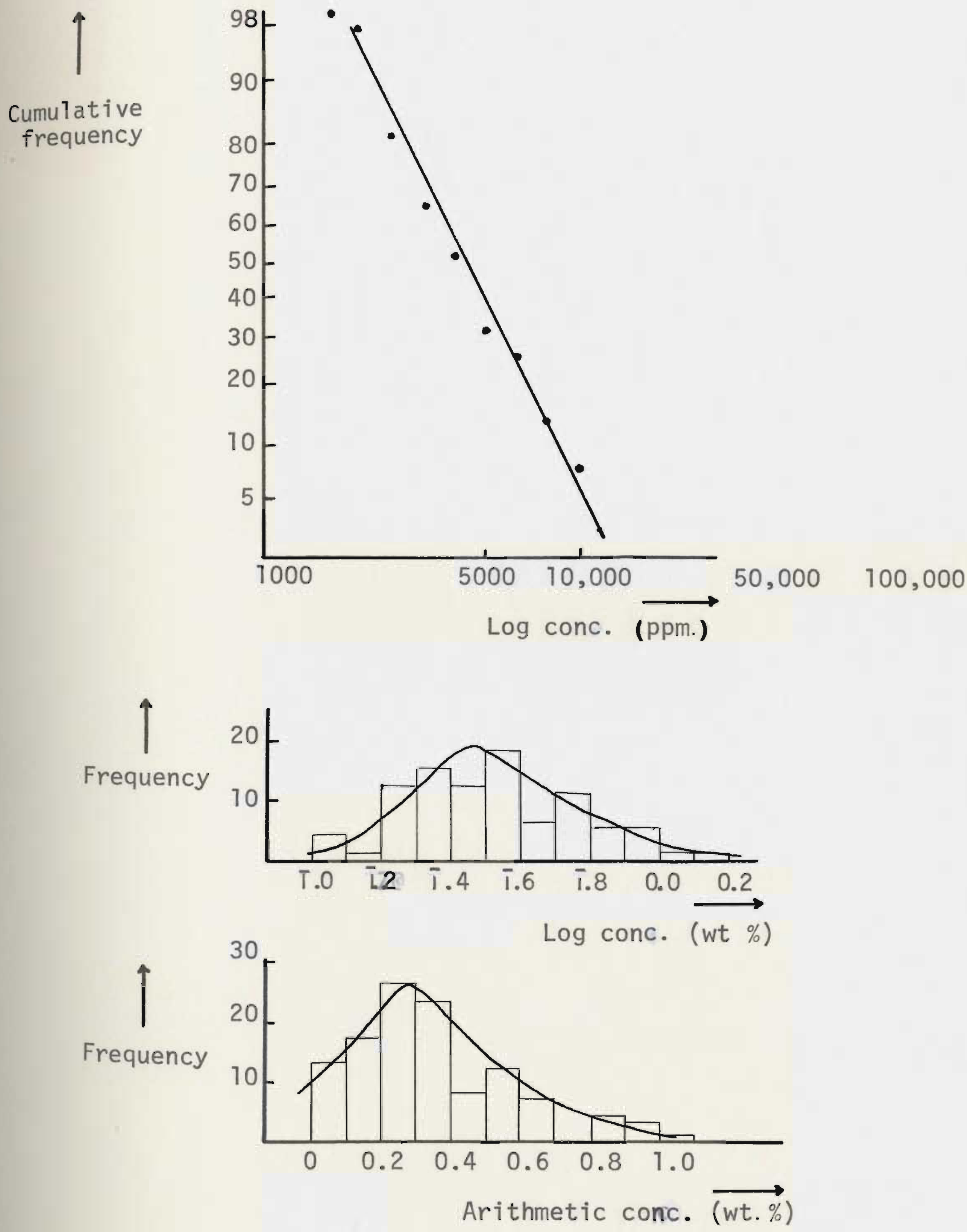


Figure 21: Histograms, frequency curves and cumulative frequency distribution curve for CaO.

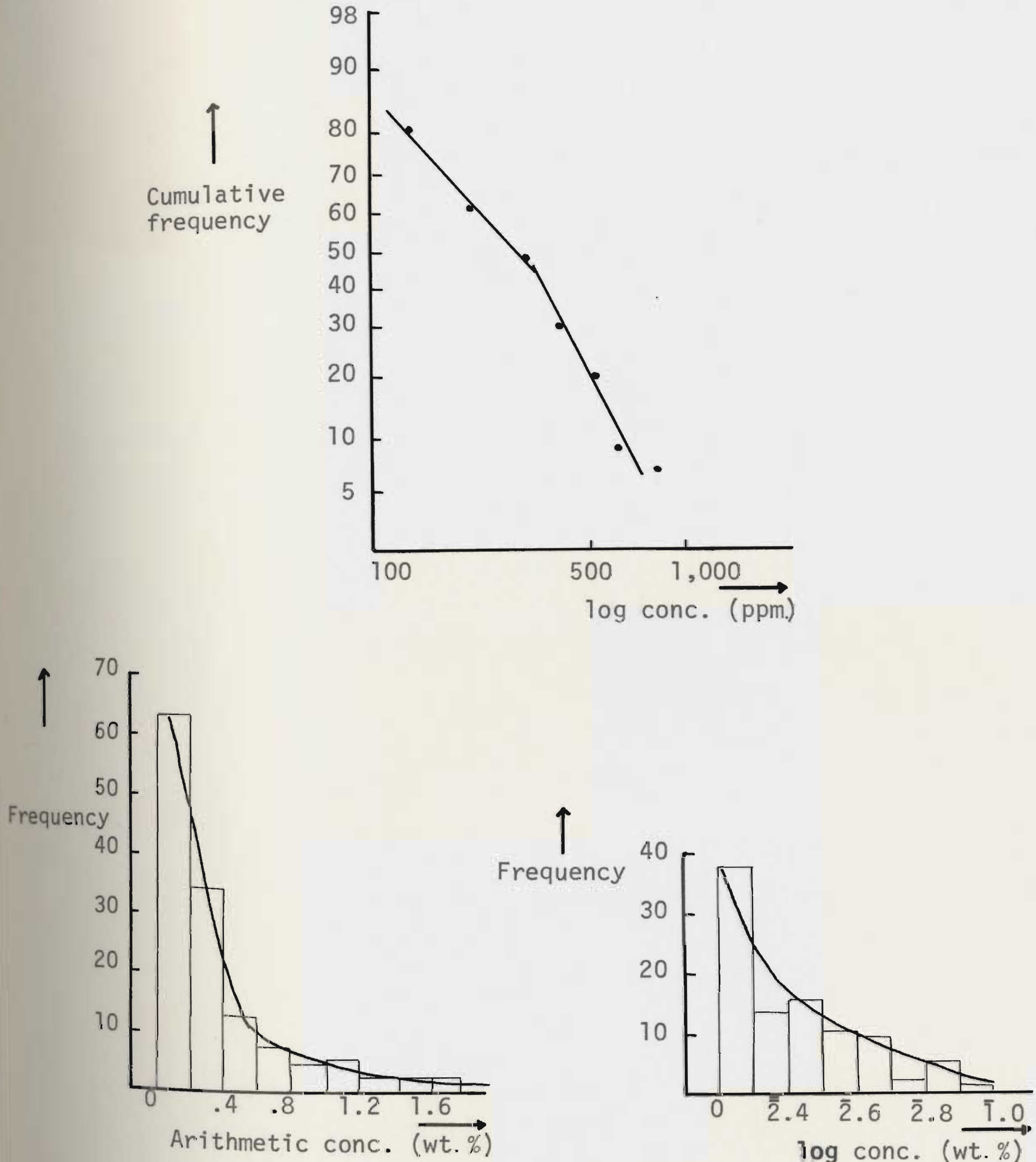


Figure 22: Histograms, frequency curves and cumulative frequency distribution curve for MnO.

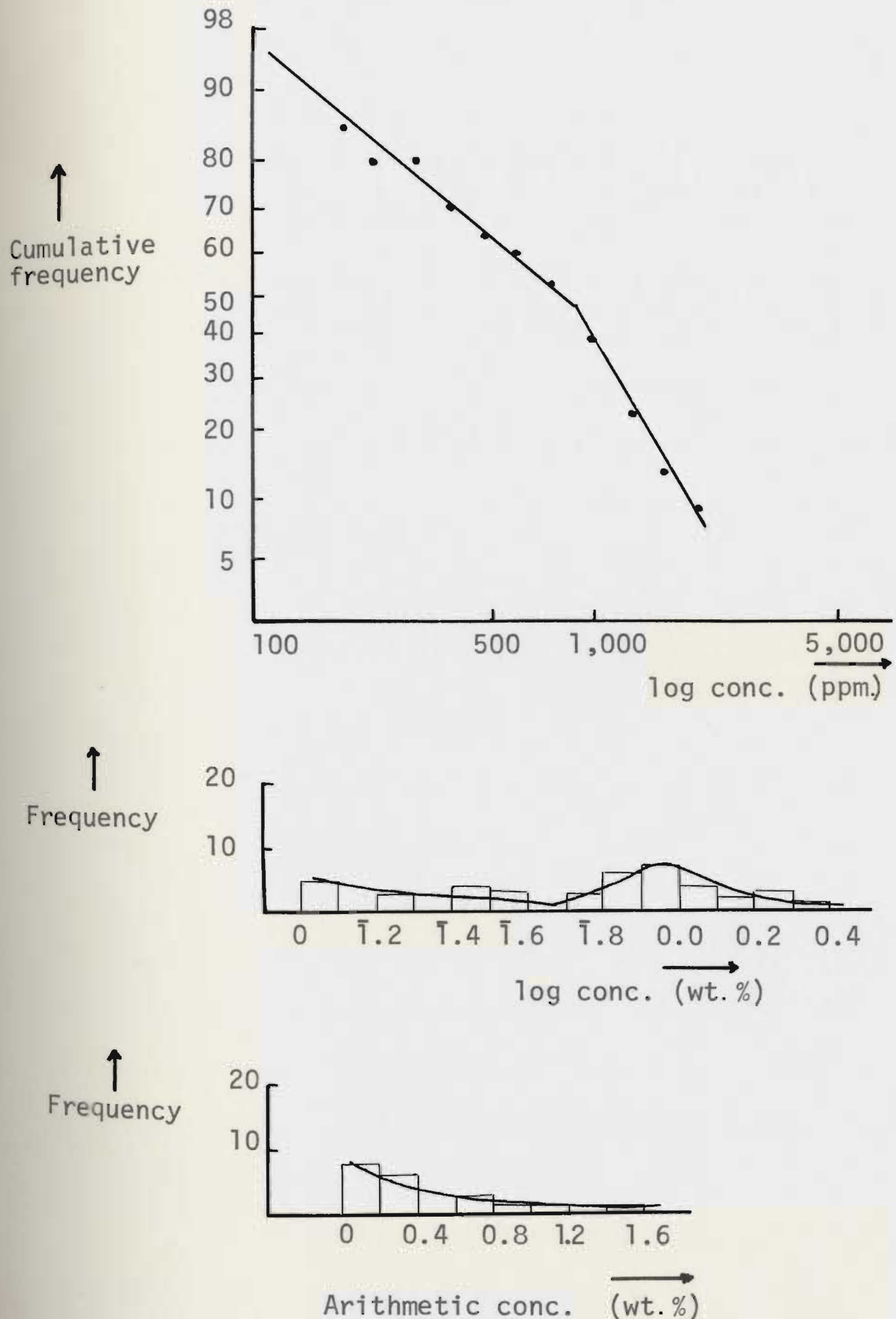


Figure 23: Histograms, frequency curves and cumulative frequency distribution curve for MgO.

cumulative frequency curves which suggest two populations. Hence, the distributions are not log-normal contrary to Ahren's (1954) generalisation.

The frequency curve for TiO_2 (Fig. 24) shows that the distribution is complex having two or possibly three peaks. The cumulative frequency distribution curve shows two breaks, a negative and a positive one. The negative skewness indicates an abundance of low values also shown by MnO and MgO. The positive skewness at high concentration shows an abundance of high values. The high values are caused by the enrichment of TiO_2 from alteration of the granite in contact with the country rocks.

5.3.2. Trace elements

The distribution of trace elements is more complex. The simplest distribution is shown by zinc (Fig. 25). When the abscissa is of arithmetic concentration interval, the frequency distribution curve shows a slightly negative skewness. The frequency distribution curve for log-concentration interval shows a bell-shaped distribution. The cumulative frequency distribution also shows an approximate straight line. Hence, the distribution for zinc is log-normal.

The frequency distribution curve for Rb shows two peaks (Fig. 26) and cumulative frequency distribution curve shows a break at around 90 per cent. The negative skewness

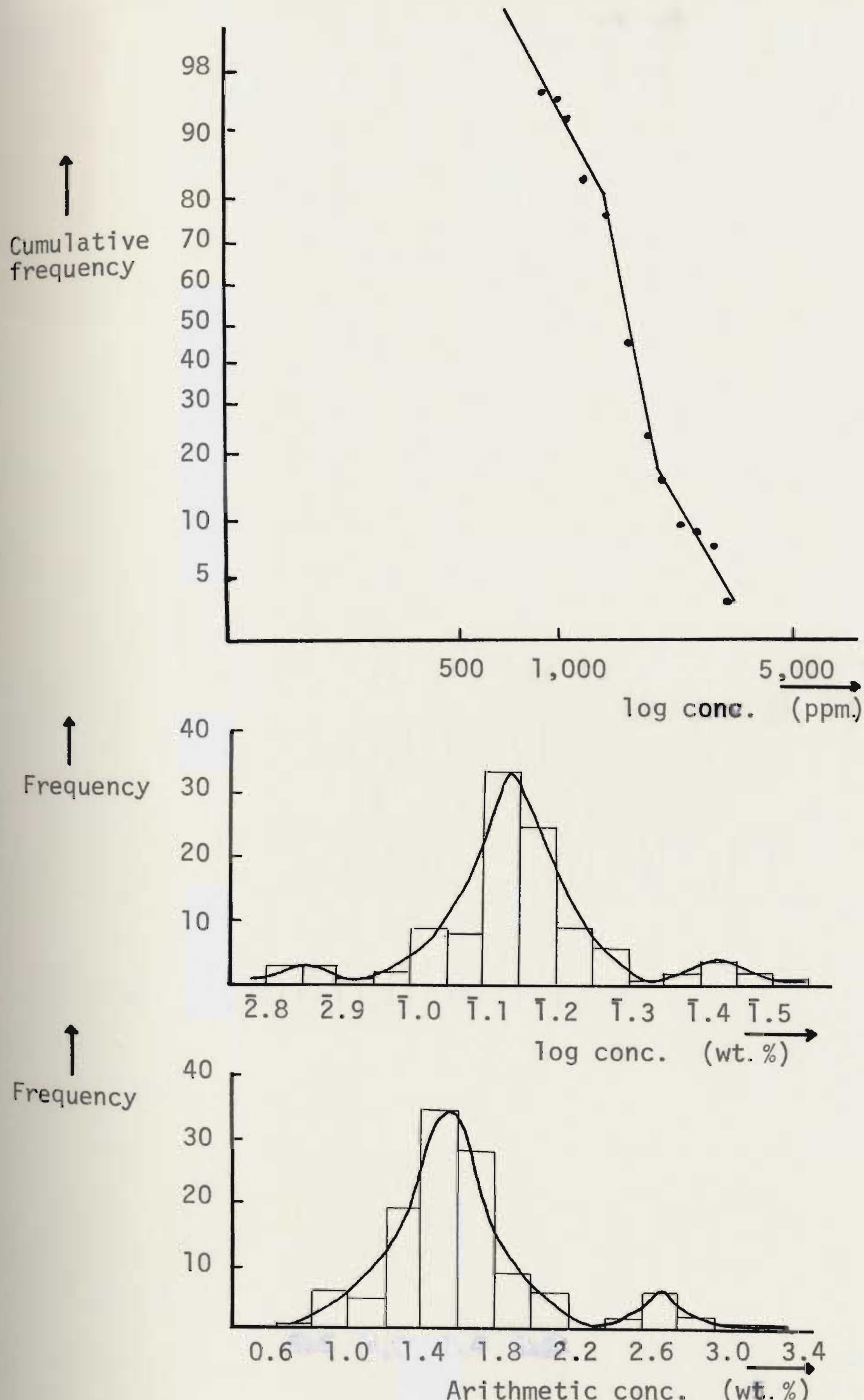


Figure 24: Histograms, frequency curves and cumulative frequency distribution curve for TiO_2.

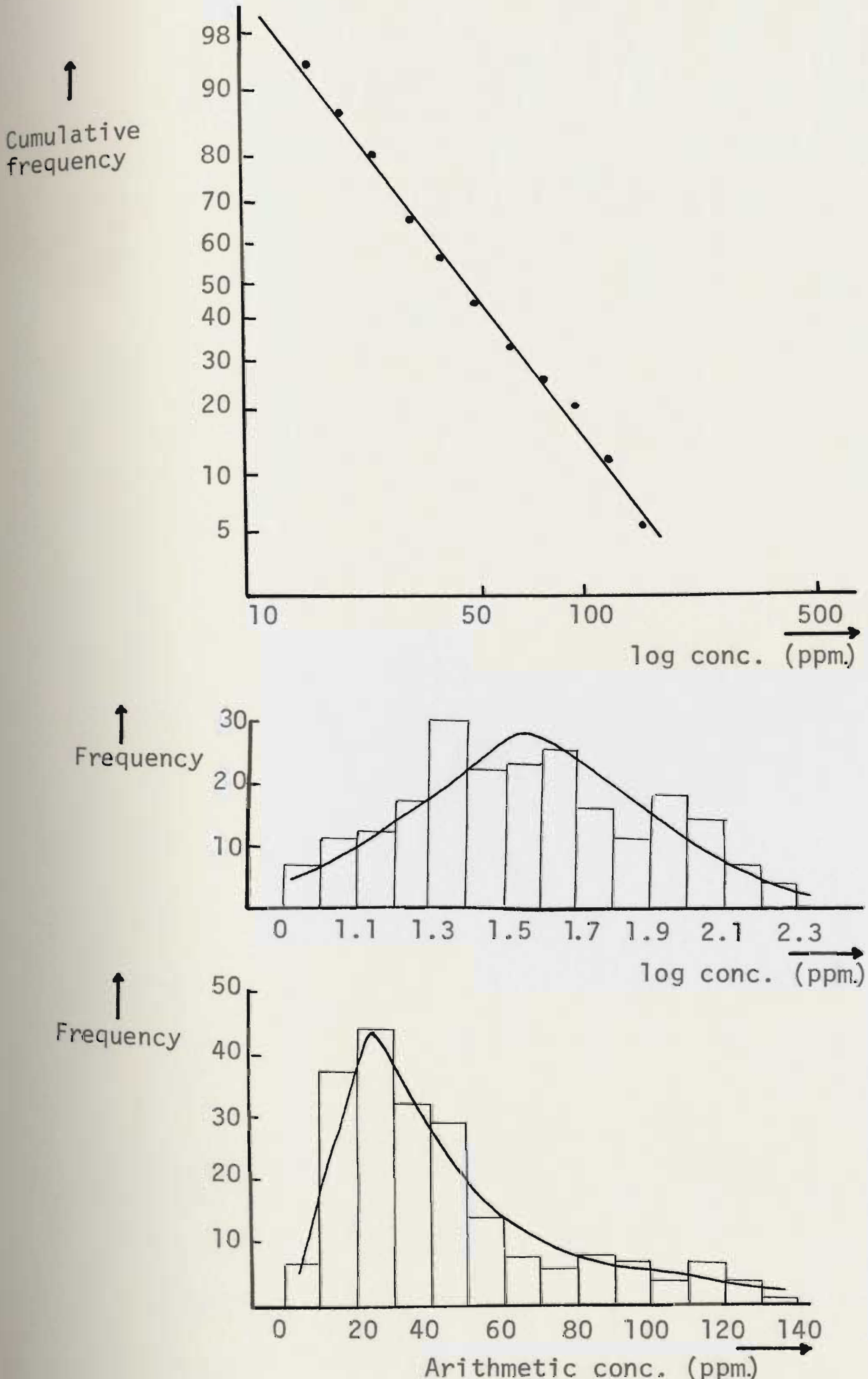


Figure 25: Histograms, frequency curves and cumulative frequency distribution curve for Zn.

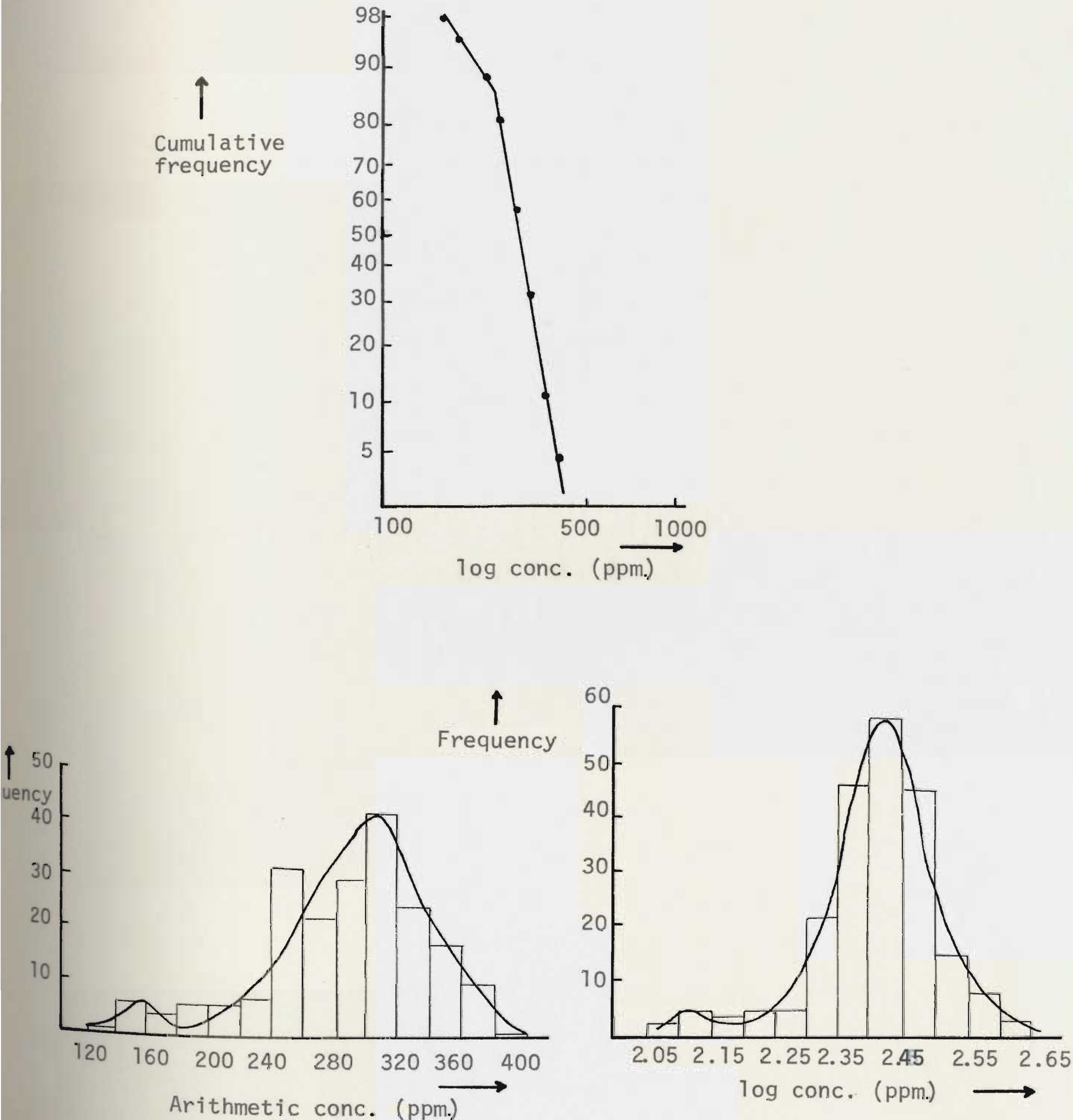
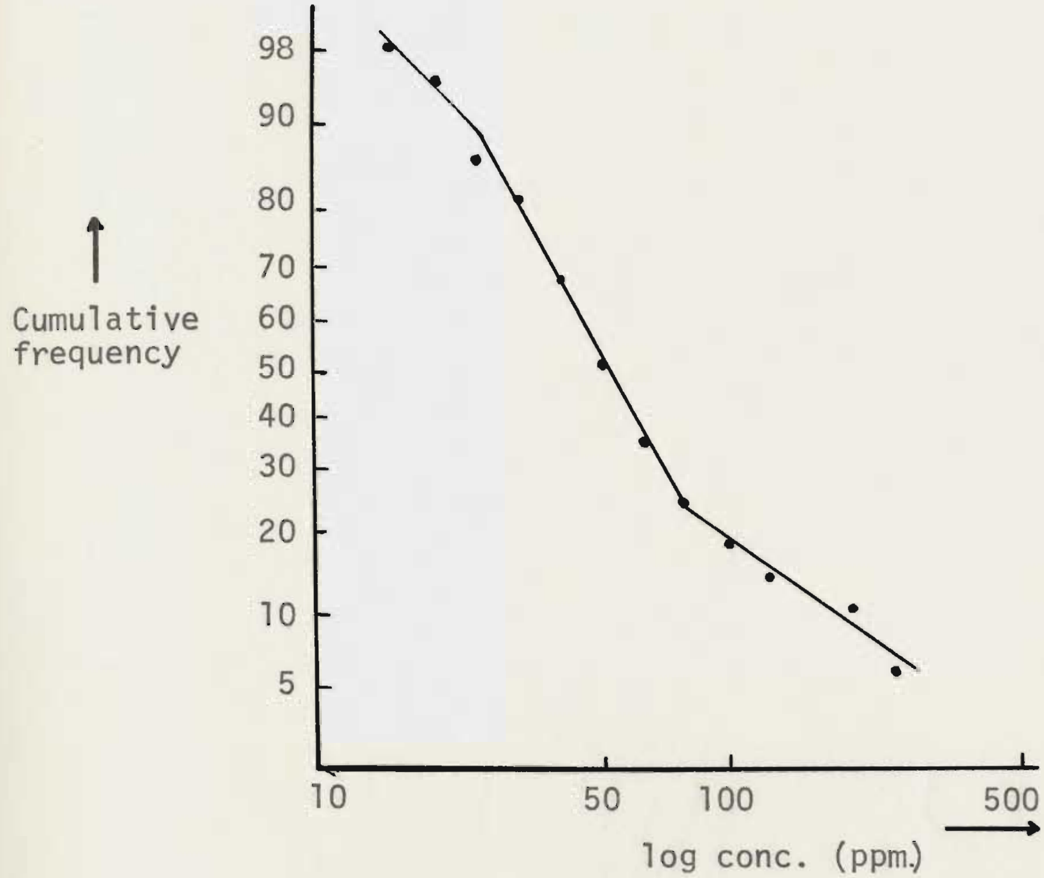


Figure 26: Histograms, frequency curves and cumulative frequency distribution curve for Rb.

shows an excess of low values as shown by the small peak in the frequency distribution curve. It does not interfere with the interpretation that Rb is log-normally distributed, since it is about 10 per cent deviation.

The frequency distribution curve for Ba (Fig. 27) is slightly negatively skewed for the arithmetic concentration interval, and shows two peaks on the log-concentration interval. The cumulative frequency distribution curve has two breaks, a negative and a positive one. The negative skewness indicates an excess of low values, but the values are not abundant enough (less than 10 per cent) to form a peak in the frequency distribution curve. The positive skewness indicates an excess of high values, large enough to form a different peak. The high values are found in the Ba-rich marginal phases of the granite.

Fluorine and zirconium are volatile elements, hence their distributions should be very complex (Figs. 28 and 29). The frequency distribution curves for both fluorine and zirconium have three peaks. These peaks are shown in the cumulative frequency distribution curves by three breaks. The first two breaks in the fluorine curve are positively skewed, followed by a third break which is negatively skewed. The first break in the zirconium curve is positively skewed followed by two successive negatively skewed breaks. Such graphs show that there are more than two populations, possibly three in the set



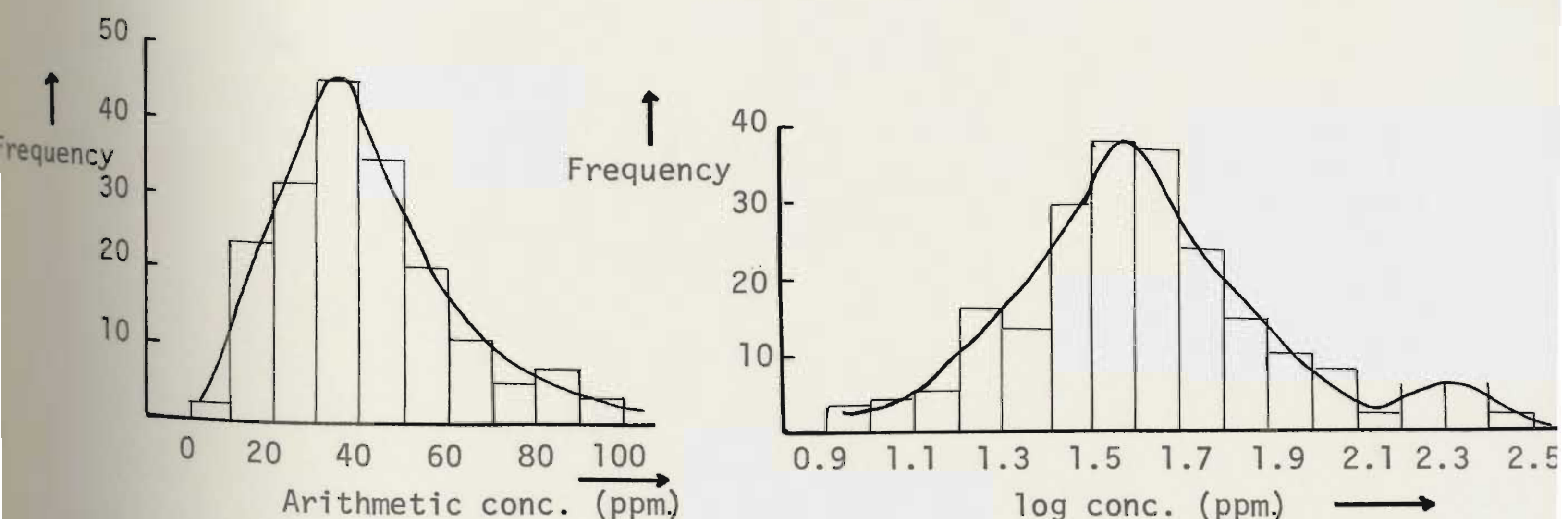


Figure 27: Histograms, frequency curves and cumulative frequency distribution curve for Ba.

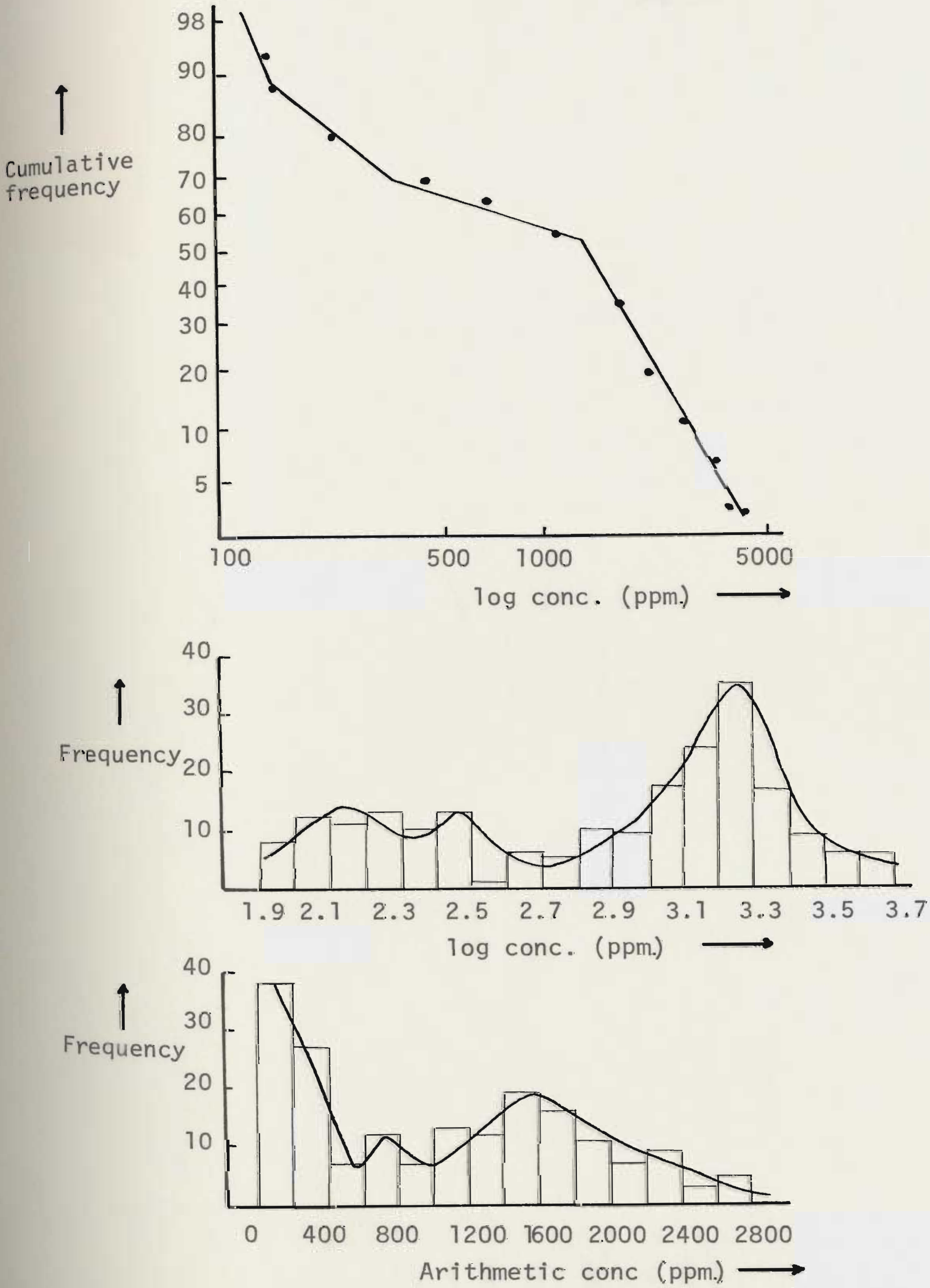


Figure 28: Histograms, frequency curves and cumulative frequency distribution curve for F.

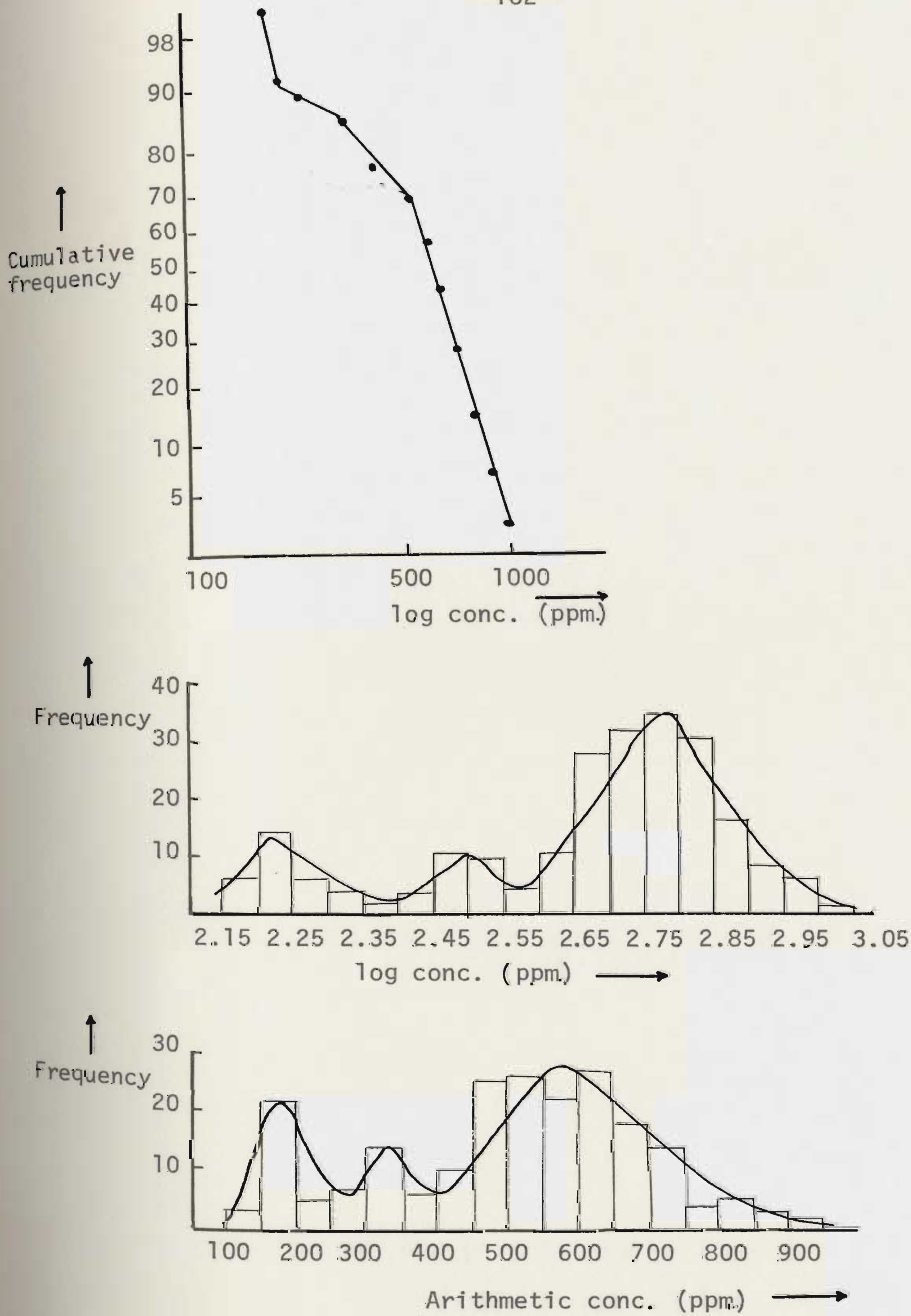


Figure 29: Histograms, frequency curves and cumulative frequency distribution curve for Zr.

of data considered, although it is possible that the third population is caused by a mixture of the first two populations. Regardless of the cause, it is still a third population.

5.4. Correlation matrix of the St. Lawrence granite

Table 5 shows the critical values of the correlation coefficient (r). For 99 per cent confidence based on 92 samples the critical value is shown to be 0.242. In other words, a value of ± greater than 0.242 would indicate a correlation between variables that could be predicted with 99% confidence. Table 6 shows the correlation matrix of the St. Lawrence granite based on 90 rock samples and most of the elements show correlations at 99% confidence apart from fluorine and zirconium.

Fluorine, with the exception of CaO, has a correlation coefficient value less than 0.242% with the other elements. The good correlation between CaO and fluorine can be explained by the presence of fluorite (CaF_2). Similarly, zirconium has all the correlation coefficient values less than 0.242%.

The lack of correlation of fluorine and zirconium with the other elements can be explained by the volatility of fluorine and zirconium. Being volatile, these elements are able to escape during the crystallization of the magma.

Since fluorine and zirconium are volatile elements, they are expected to have a good correlation. Zirconium halides, with the exception of ZrF_4 are water-soluble compounds which pass into the vapour phase without melting. Fluorine and zirconium form complex compounds of type $M_2(ZrF_6)$, (Vlasov, 1964). Hence, fluorine may act as a carrier of zirconium.

TABLE 5

Critical Values of r

n	$r_{.025}$	$r_{.010}$	$r_{.005}$	n	$r_{.025}$	$r_{.010}$	$r_{.005}$
3	0.997			18	0.468	0.543	0.590
4	0.950	0.990	0.999	19	0.456	0.529	0.575
5	0.878	0.934	0.959	20	0.444	0.516	0.561
6	0.811	0.882	0.917	21	0.433	0.503	0.549
7	0.754	0.833	0.875	22	0.423	0.492	0.537
8	0.707	0.789	0.834	27	0.381	0.445	0.487
9	0.666	0.750	0.798	32	0.349	0.409	0.449
10	0.632	0.715	0.765	37	0.325	0.381	0.418
11	0.602	0.685	0.735	42	0.304	0.358	0.393
12	0.576	0.658	0.708	47	0.288	0.338	0.372
13	0.553	0.634	0.684	52	0.273	0.322	0.354
14	0.532	0.612	0.661	62	0.250	0.295	0.325
15	0.514	0.592	0.641	72	0.232	0.274	0.302
16	0.497	0.574	0.623	82	0.217	0.256	0.283
17	0.482	0.558	0.606	92	0.205	0.242	0.267

This table is abridged from Table VI of R. A. Fisher and F. Yates, "Statistical Tables for Biological, Agricultural, and Medical Research", published by Oliver and Boyd Ltd., Edinburgh, 1963, p. 5.

n = number of samples.

$r_{.025}$ = values of r at confidence level of 97.5%.

$r_{.010}$ = values of r at confidence level of 99.0%.

$r_{.005}$ = values of r at confidence level of 99.5%.

TABLE 6

Correlation matrix based on 90 samples

	Fe_2O_3	TiO_2	SiO_2	CaO	K_2O	MgO	Al_2O_3	Na_2O	MnO	Zr	Rb	Zn	Cu	Ba	F
F	.20	.22	.01	.40	-.10	-.04	-.18	.05	-.26	-.05	.13	-.20	-.13	-.16	1.00
Ba	.34	.79	-.58	.42	-.40	.12	.74	.46	.26	-.11	-.53	.08	.26	1.00	
Cu	.26	.29	-.24	.08	-.07	.12	.15	.04	.18	.19	-.26	.14	1.00		
Zn	.44	.25	-.17	.00	-.03	0	.18	.22	.54	.08	-.21	1.00			
Rb	-.62	-.59	.46	-.30	.50	-.14	-.37	-.34	-.42	.10	1.00				
Zr	.26	.03	-.09	-.11	-.06	.03	-.12	-.02	.06	1.00					
MnO	.51	.47	-.42	-.16	0	-.05	-.26	-.25	1.00						
Na_2O	.30	.44	-.55	.50	-.56	.25	.66	1.00							
Al_2O_3	.21	.76	-.56	.62	-.38	.32	1.00								
MgO	.10	.25	-.32	.35	-.41	1.00									
K_2O	-.30	-.42	.42	-.54	1.00										
CaO	.03	.56	-.52	1.00											
SiO_2	-.48	-.70	1.00												
TiO_2	.48	1.00													
Fe_2O_3	1.00														

However, this is not shown in the St. Lawrence granite where the correlation coefficient value is -.05 between fluorine and zirconium. This lack of correlation may be due to the reactivity of fluorine. Although zirconium and fluorine are volatiles and one acts as a carrier for the other, fluorine may be reacting with other elements forming minerals, e.g. Ca forming CaF_2, leaving an excess zirconium in the vapour phase. This depletion of fluorine may cause the low correlation with zirconium.

CHAPTER 6

ECONOMIC GEOLOGY

6.1. General

Mining of fluorite commenced in 1933 with shipment of acid grade fluorspar from Black Duck vein by the St. Lawrence Corporation. The Newfoundland Fluorspar Company Limited began mining in 1940 and made its first shipment in 1942. The total production in 1970 amounted to 137,000 tons valued at $4.6 million.

6.2. Fluorite veins

About 40 distinct fluorite veins have been discovered in the St. Lawrence area, but not all of these are commercial deposits. Production is currently obtained from the Director, Tarefare and Blue Beach Mines. Most of the veins discovered so far lie to the west and north of the town of St. Lawrence, with the exception of the Herring Cove vein. None of the veins are found on the east side of the granite. Almost all the veins lie entirely within the granite or its related "rhyolite porphyry" dykes.

All the fluorite veins are true fissure fillings located in tension cracks that developed as a result of regional movements and contraction during the cooling of the granite (see section 4). The vein lengths vary from a few hundred to well over 7 km, although because of their irregular form and dilution by the wall rocks, commercial grade ore does not occur throughout the entire length of the veins.

Two major groups of fluorite veins are recognized:

(i) The low grade veins are characterised by the greatest widths, averaging 7 m. The CaF_2 content is about 70 per cent. Their strike varies from 140°Az to 160°Az, e.g. Director, Tarefare and Blue Beach veins.

(ii) The high grade veins have an average width of 1 m or less. They are characterised by acid grade ore averaging 95 per cent CaF_2. Their strike varies from 70°Az to 110°Az, e.g. Lord and Lady Gulch, Black Duck and Canal veins.

No two major veins are known to intersect. The fluorite is mostly massive and coarsely crystalline, filling veins from wall to wall (plate 25). Fluorite close to the vein walls is commonly finely banded, suggestive of rhythmic deposition. This is characteristic of high grade veins.

Vugs and openings are commonly lined with beautiful crystals of fluorite. The most common form of the crystals observed is a cube which may reach 12 inches along an edge. The other most common form is octahedral and this is restricted in occurrence to veins in rhyolite porphyry dykes and the country rocks, notably the Grebes Nest and Mine Cove veins. The octahedra are often formed by stacking of cubes parallel to octahedral faces. Modifications produced by combination of the cube and the octahedron are rare.

The fluorite colours are pale blue, green, grey, yellow, red, violet, white and colourless. The colour is variable from vein to vein and within veins. Deep purple varieties evidently belong to the earliest phase of mineralisation, as they are found in contact with vein walls, as a cement in brecciated rocks, and also lining miarolitic cavities in the granite where there is no connection with any vein structures. Colour banding is extremely common in high grade veins. Common sequences of colours are deep purple, red, yellow, red and white. The regularity of this banding which is parallel to vein walls is frequently disturbed by small breaks produced by minor offsets and brecciation.

Perfect examples of comb and ribbon structures emphasized by colour banding are frequently present in veins on the walls of Lord and Lady Gulch vein. Colloform structures are seen in Grebes Nest vein. Nodular or orbicular ores are found in some locations in the Director and Blue Beach veins.

It is interesting to note that fluorite found in granite near the country rocks possesses a green colour which on exposure to light bleaches to white, e.g. Grebes Nest and Mine Cove veins. It is only this green fluorite that fluoresces under ultraviolet light.

The cause of colour banding in fluorite veins may be explained by periodic fluctuation in either an anion-vacancy-producing agent or the colloid aggregating condition or both (MacKenzie, et al., 1971). Anion vacancies could be produced by radiation, presence of Na^+, K^+ or oxygen, oxidation of variable valence impurities, pressure induced damage or a combination of all four. Colloid-calcium is the chief colouring material

(MacKenzie, et al., 1971). These colloids apparently aggregate in natural fluorides during formation but can be dispersed by thermal treatment. The actual occurrence of banding may depend on a complex balance of several of the above factors.

6.3. Gangue minerals

6.3.1. Quartz

The most important but less desirable gangue mineral is quartz because it occurs in the material locally known as blastonite. The blastonite consists of brecciated fluorite cemented by a mixture of microcrystalline quartz and fluorite. This mixture contains up to 85 per cent of the quartz-fluorite matrix. The fluorite may have blue, green and red colour whilst the quartz is white and massive. It is believed that the fluorite in the blastonite is secondary and has been derived from pre-existing fluorite by a process of brecciation and minimum solution. Replacement effects are negligible.

Fluorite-free quartz veins are rarely seen in the field. They commonly strike at 0°Az to 10°Az.

6.3.2. Calcite

Calcite occurs in nearly all the fluorite veins. It is common in nodular ores where it alternates with fluorite bands. Much of the calcite associated with the nodular ores fluoresces a bright red colour in ultraviolet light. Calcite mineralisation must have started shortly after that of fluorite but continued during and after it. This is seen in nodular ores and later development of calcite coating fluorite cubes.

6.3.3. Barite

Barite is a comparatively rare gangue mineral. The Iron Spring and Canal veins occurrence have beautiful honey yellow tabular crystals intimately intergrown with the fluorite. At Lord and Lady Gulch, Meadow Wood and Chamber's Cove veins, barite occurs as white and pale red platy aggregates intergrown with fluorite.

6.3.4. Sulphide minerals

Galena and sphalerite are the most abundant sulphides. They are locally abundant either near the granite contact or in veins cutting into the country rocks, e.g. Grebes Nest, Meadow Wood, Mines Cove, Lead and Chamber's Cove veins (Plate 26). Sphalerite is generally red and is locally named "ruby blende". Upon weathering, the sphalerite becomes coated with a grey sub-metallic film.

Chalcopyrite occurs in minor quantities as irregular grains embedded in the fluorite. Alteration of the chalcopyrite to malachite and chrysocolla is common. It is virtually absent at the periphery of the granite but developed in veins in the granite, e.g. Black Duck and Lord and Lady Gulch veins.

The only other sulphide mineral is pyrite. It is quite rare and is seen only in veins of Director and Blue Beach Mines. It occurs as cubes and pyritohedra. Limonite, presumably altered from pyrite, is fairly common in Grebes Nest vein.

There is no apparent mineral zoning in the St. Lawrence area.

6.4. Ore Genesis

There is a spatial as well as a genetic relationship between the granite, "rhyolite porphyry" and the fluorite veins. This is shown by the occurrence of fluorite in miarolitic cavities and as an accessory in the granite. There can be little doubt that they are derived from the same source, i.e. a granitic magma rich in volatiles, that during crystallisation become highly differentiated.

The cooling of the magma at higher level was accompanied by contraction. This set up a stress system which resulted in the development of a number of prominent fractures along which horizontal shearing took place from time to time. It was during this period that the directions of future mineralising solutions were firmly established.

Continued movement along these fractures produced varying degrees of brecciation of the wall rocks. Later volatile materials were separated and escaped along innumerable channelways to be deposited in veins in the structure already developed in the upper part of the granite. Their escape beyond the boundaries of the granite was largely prevented by the denseness of overlying hornfels which effectively impounded them.

The mechanism of fluorite mineralisation at St. Lawrence was dominantly of repeated fissure fillings producing veins that possess all the features of typical epithermal deposits. The lack of replacement phenomena, the presence of perfect comb structures, the banding from wall to wall, presence of vugs and clean cut vein walls may be taken for fissure fillings along open fractures. Horizontal but intermittent movement along fractures in the granite controlled the path taken by the ore solution. The movements also produced brecciation of earlier fluorite deposits. It is important to note that the mechanism requires repeated movement along fissures accompanied by filling of open spaces with additional fluorite. Otherwise, it is difficult to account for the brecciation parallel to vein walls without wholesale replacement of the wall rocks.

Although fluorite veins are sporadically found in the sedimentary rocks, it is believed that the sedimentary rocks reacted to stress somewhat differently than the granite, where the former produce tighter and smaller fissures. This is consistent with the observation that the fissures narrow considerably and in some cases peter out when passing from the granite to the sedimentary rocks.

CHAPTER 7

SUMMARY AND EXPLORATION APPLICATION

7.1. Summary

The following is a brief summary of the findings of this study:

(1) The St. Lawrence granite is composed essentially of quartz, orthoclase and albite with minor amounts of riebeckite, aegirine, biotite, fluorite, magnetite and hematite.

(2) The St. Lawrence granite is a riebeckite-aegirine-bearing peralkaline granite.

(3) The St. Lawrence granite is a shallow intrusion, i.e. epigranite.

(4) The St. Lawrence granite is distinctly high in SiO_2 (average 76.7%), Zr (average 516 ppm.), Rb (average 295 ppm.), and F (average 1308 ppm.), and low in Al_2O_3 (average 10.9%), CaO (average 0.36%), Sr (less than 10 ppm.) and Ba (average 70 ppm.).

(5) The K/Rb ratios indicate the St. Lawrence granite to be a "late stage" granite.

(6) The St. Lawrence granite is of a composition and age which could be related to the Belleoram and possibly Red Island granites.

(7) The St. Lawrence granite crystallized under a low water pressure of about 0.5 kb.

(8) The temperature of crystallisation of the St. Lawrence granite was around 780°.

(9) The St. Lawrence granite is a hypersolvus granite.

(10) The St. Lawrence granite was probably formed by limited fractional melting at the base of continental crust or by fractionation of a rather uniform and relatively calc-alkaline acid parent.

(11) The St. Lawrence granite is mineralogically and chemically very similar to the riebeckite-aegirine bearing granites of Kudaru and Liruei of Nigeria.

(12) The St. Lawrence granite is chemically different from the Traytown granite, mainly in trace element concentrations.

(13) Fluorine and zirconium have complex distributions and graphical analysis shows that there are more than two populations.

(14) Fluorine and zirconium have low correlations with other elements.

(15) Fluorite veins occur in the granite as true fissure fillings.

(16) Two groups of fluorite veins are recognized:

i. Low grade veins striking at 140° to 160°Az.

ii. High grade veins striking at 70° to 110°Az.

(17) There is a spatial as well as a genetic relationship between the granite, "rhyolite porphyry" and the fluorite veins.

(18) The St. Lawrence granite is dated isotopically by rubidium-strontium at 330 $\pm$ 10 million years (K. Bell, pers. comm., 1974).

(19) The "rhyolite porphyries" are granitic dykes and not rhyolite in the sense of being extrusive.

7.2. Exploration Application

On the basis of the findings of this study, further detailed geochemical-geological studies appear justified to outline areas of potential mineralisation.

In general, one must look for a shallow granitic intrusion which is alkaline to peralkaline, containing high F, Zr and Rb values and low Ba, CaO and Sr concentrations.

In the St. Lawrence area, it is apparent that the fluorite veins are structurally controlled by tension fractures and fault systems. Hence, detailed mapping of the various structures in the granite should be carried out.

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Plate 1: Lee and stoss profile of Mount Margaret, (looking east) an upper Cambrian alkali basalt plug.

Plate 2: St. Lawrence Harbour, (looking south) showing the high cliffs of sedimentary rocks and the lower coastline of granite.

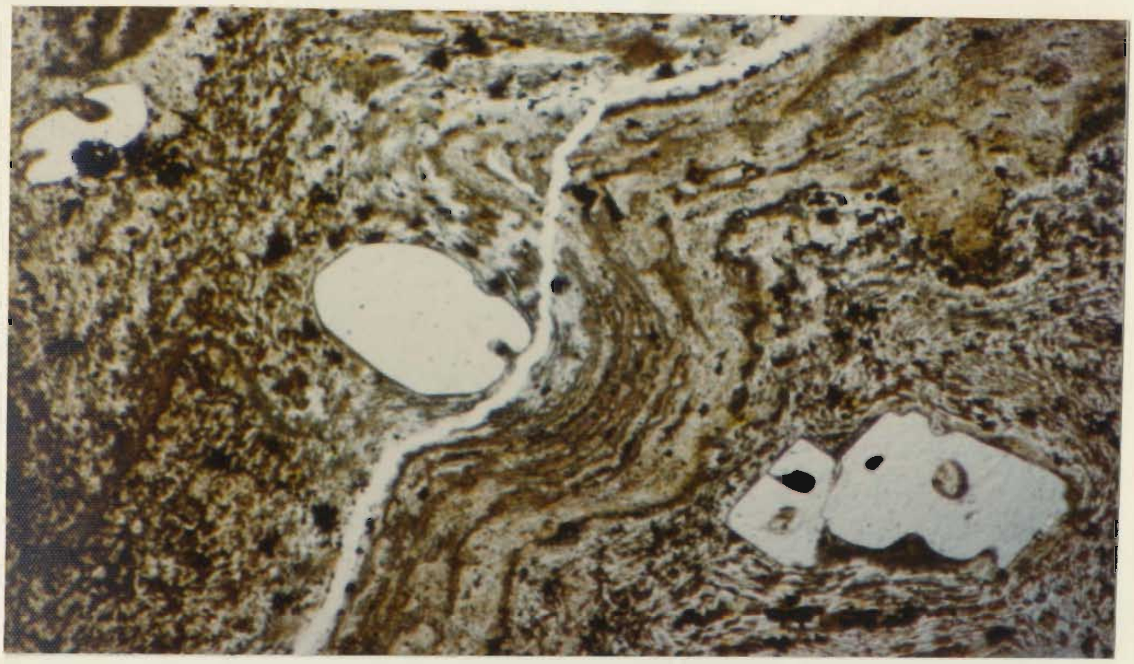

Plate 3: Photomicrograph showing flow-banding and spherulitic structure in rhyolite of the Harbour Main Volcanic Series (plane light). Thin section no. 39. Field of view 3 mm. by 2 mm.

Plate 4: Typical thinly-laminated tuffaceous sediments of the Burin Series at St. Lawrence Point.

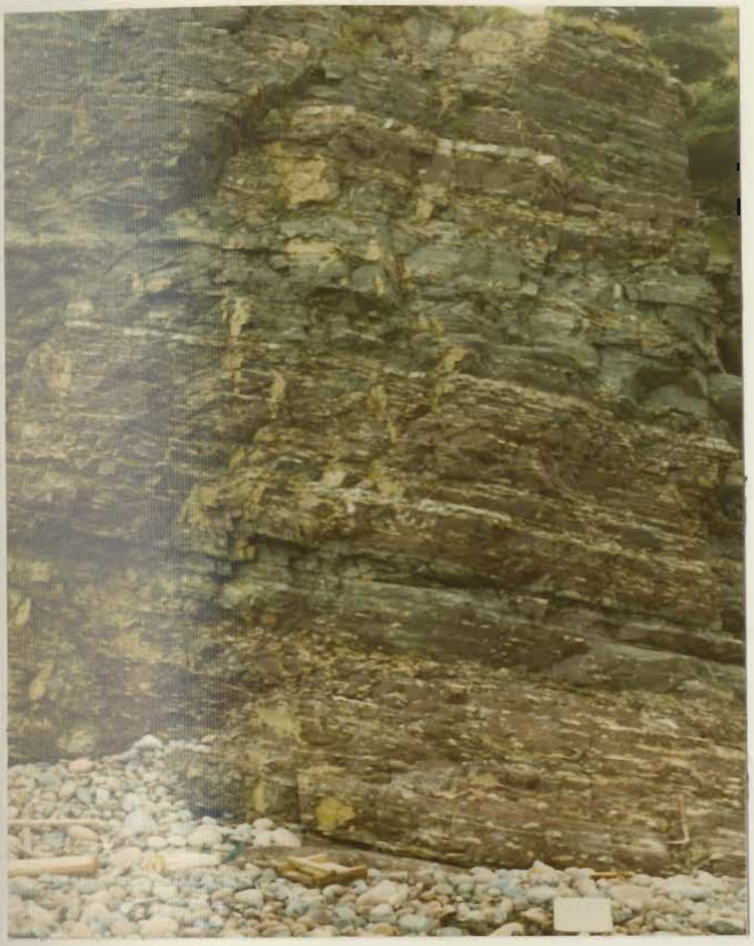

Plate 5: Nodular limestone (thin white units) at the top of the Brigus Formation at Three Sticks Cove.

Plate 6: Thinly bedded shale of the Little Lawn Formation at Murphy's Cove.

Plate 7: Conglomerate at the base of the Brigus Formation resting on an uneven surface of the Harbour Main Volcanic Series at Three Sticks Cove.

Plate 8: Irregular silicification zones in the hornfels of Little Lawn Formation at 2 km south-east of Welch's Pond. Note the white and green zones, for which analyses are presented in Table 2.

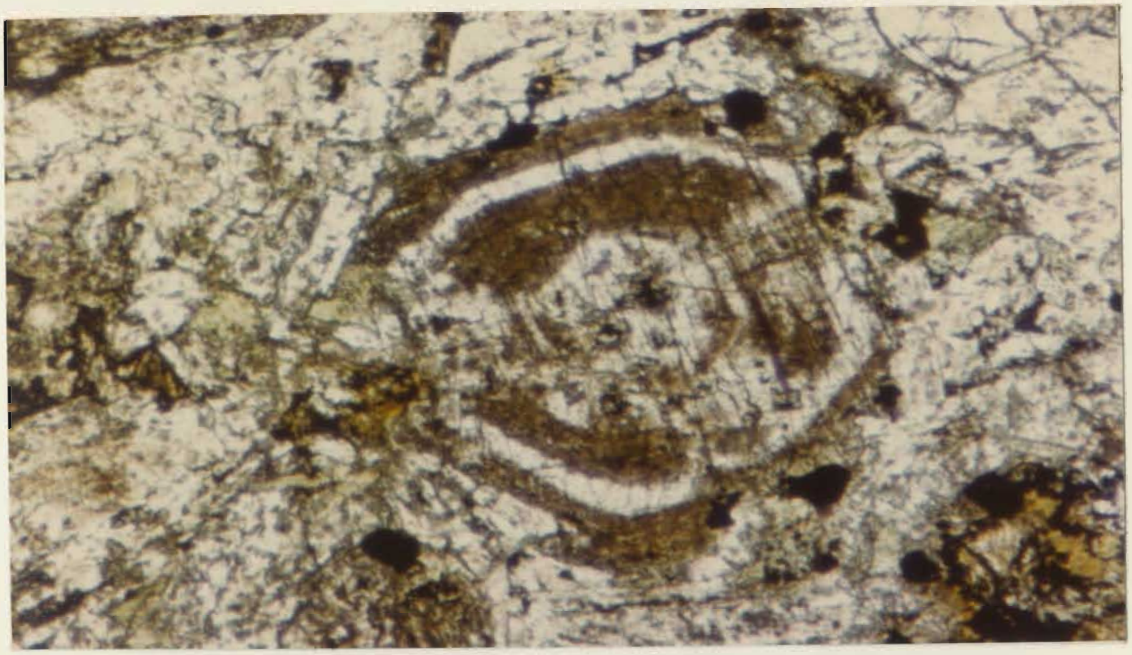

Plate 9: Photomicrograph showing zoned titanaugite in the Mount Margaret Volcanics (plane light). Thin section no. 25. Field of view 2 mm. by 1.3 mm.

Plate 10: Diabase dyke intruded the St. Lawrence granite at Shoal Cove.

Plate 11: Intrusive contact between the St. Lawrence granite and the Little Lawn Formation at Chamber's Cove.

Plate 12: Granitic veins in the Little Lawn Formation at Red Head.

Plate 13: Three phases of granite at Hares Ears. Note the characteristic red weathering of k-feldspar phenocrysts.

Plate 14: Tuffisites (gas breccia) at Red Head.

Plate 15: Quartz-feldspar porphyry dykes (offshoots of the St. Lawrence granite) dipping gently north on the top of the Little Lawn Formation at Little Lawn Harbour.

Plate 16: Photomicrograph showing granophyric texture in the St. Lawrence granite (cross-nicols). Thin section no. 3. Field of view 2 mm. by 1.3 mm.

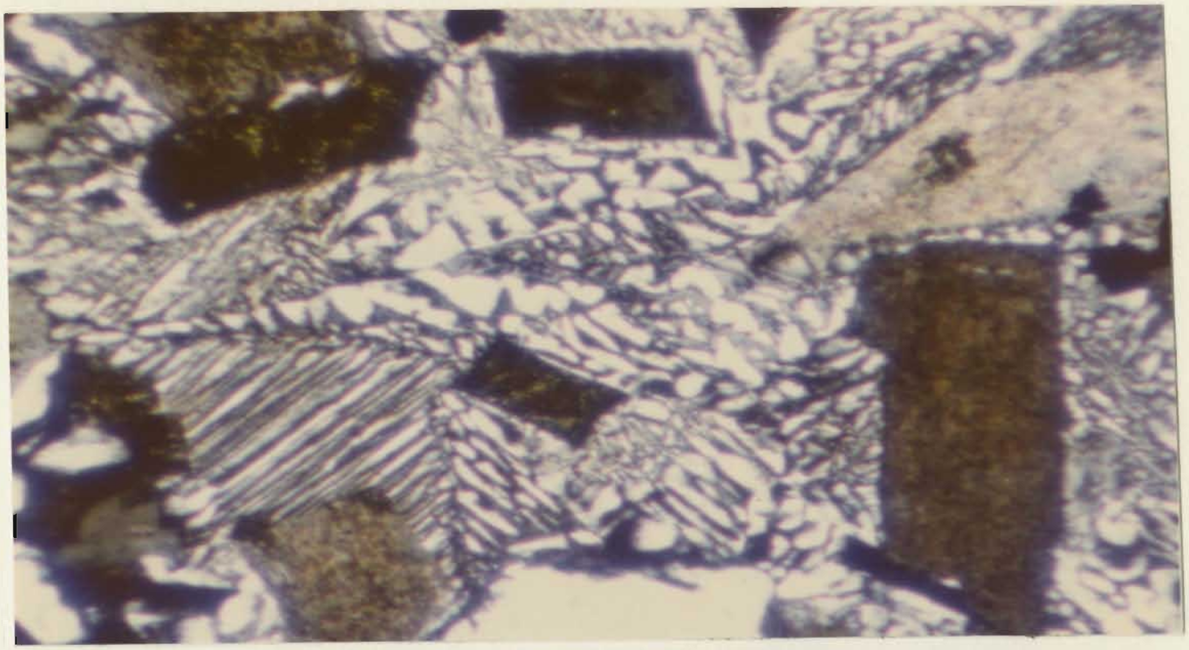

Plate 17: Photomicrograph showing perthitic and granophyric textures in the St. Lawrence granite (cross-nicols). Thin section no. 22. Field of view 1 mm. by 0.6 mm.

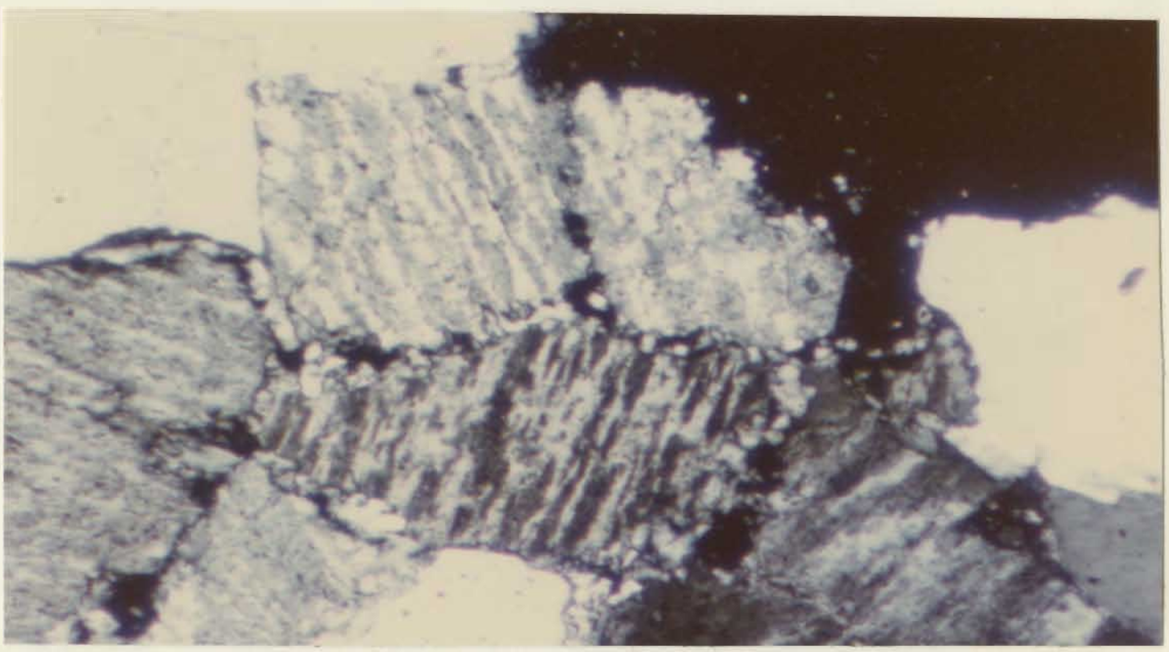

Plate 18: Photomicrograph showing deuteric albitisation rims on perthitic feldspars in the St. Lawrence granite (cross-nicols). Thin section no. 22. Field of view 1 mm. by 0.6 mm.

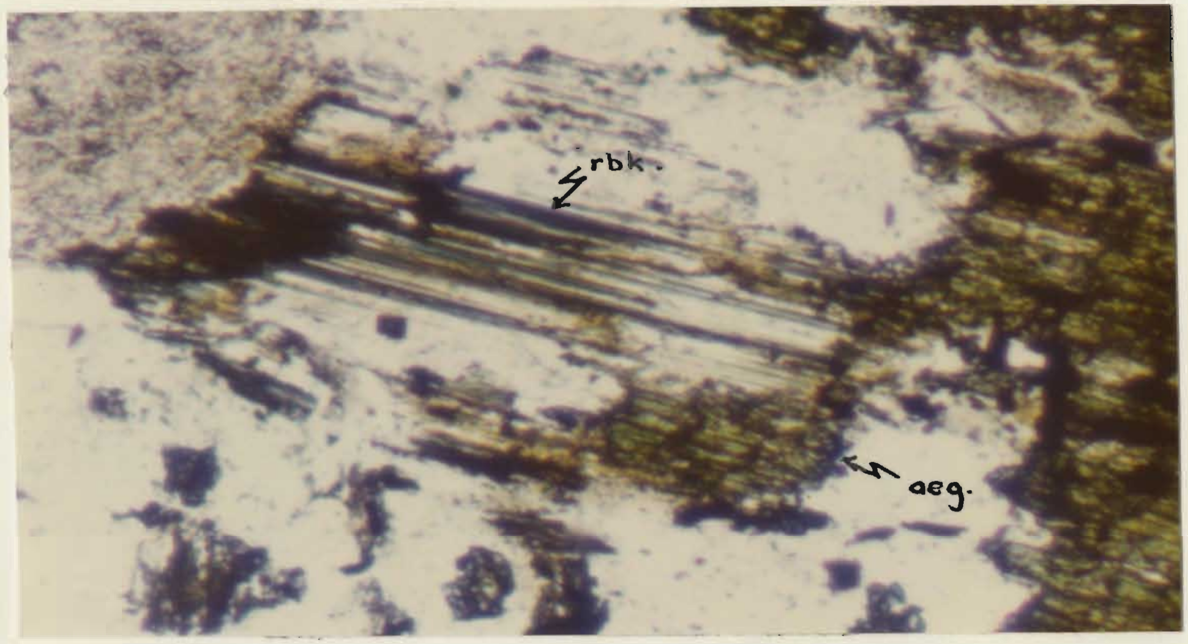

Plate 19: Photomicrograph showing riebeckite (rbk.) growing along the cleavages of the aegirine (aeg.) crystal in the St. Lawrence granite (plane light). Thin section no. 245. Field of view 1 mm. by 0.6 mm.

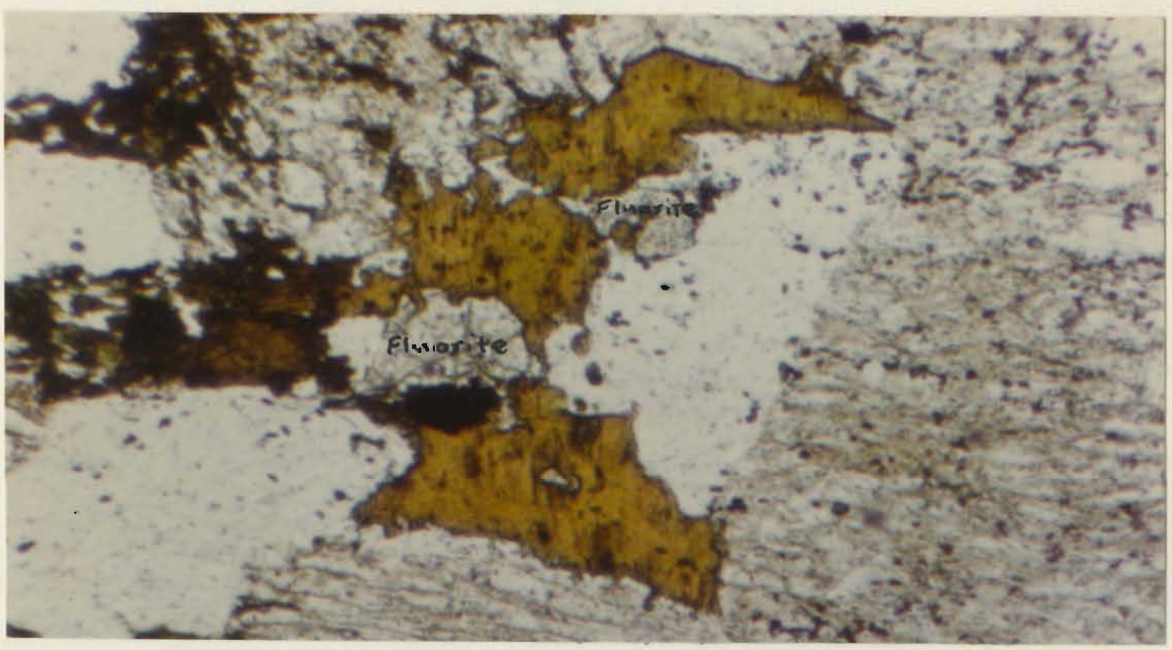

Plate 20: Photomicrograph showing fluorite crystals associated with biotite in the St. Lawrence granite (plane light). Thin section no. 142. Field of view 1 mm. by 0.6 mm.

Plate 21: Photomicrograph showing fluorite crystals as accessory minerals in the St. Lawrence Granite (plane light). Thin section no. 142. Field of view 1 mm. by 0.6 mm.

Plate 22: Photomicrograph showing euhedral quartz with embayed boundaries in the St. Lawrence granite (plane light). Thin section no. 94. Field of view 2 mm. by 1.3 mm.

Plate 23: Slickensided surface coated with red hematite and purple fluorite at Little St. Lawrence quarry.

Plate 24: Two phases of the St. Lawrence granite at Chamber's Cove. Note the darker colour contains higher volatile content than the lighter.

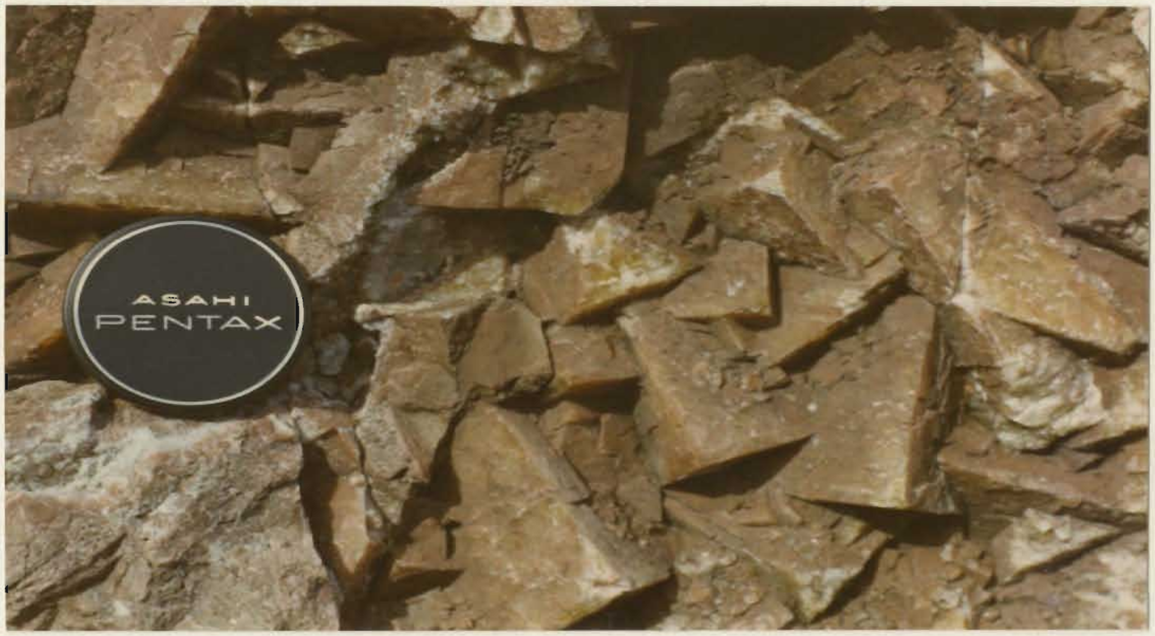

Plate 25: Typical cubic fluorite crystals at Lord and Lady Gulch vein.

Plate 26: Sulphide minerals at the contact between the St. Lawrence granite and the Little Lawn Formation at Chamber's Cove. Galena (gn.), sphalerite (sph.) and fluorite (fl.).

APPENDIX I

1.1. Sampling Methods

The sampling programme was planned to permit assessment to the geochemical variability at and around outcrops, the overall variability within plutons, the variability between plutons and the variability within the St. Lawrence granite. An attempt was made at obtaining about two samples per square km, but in many cases this was not possible because of poor exposure and inaccessibility (see Fig. 8).

Eight-pound sledge hammers were used to collect single and duplicate rock samples of 5 to 10 kg, depending on grain-size (cf. Wager and Brown, 1960). The specimens were described according to a format adapted from R. G. Garrett, Geological Survey of Canada, with the intention of using his computer programmes developed for a similar study of Yukon granitoids (Garrett, 1973). This format is shown in Fig. 30.

1.2. Laboratory Methods

1.2.1. Sample Preparation

All the samples were crushed according to the following procedure:

1) Each sample was broken into chips using a small sledge hammer on a thick plywood board. A slab was saved for sectioning.

2) A clean, representative sample of chips was crushed to 1-2 cm or smaller pieces in a steel jaw crusher.

COL. 28-31

DLMT Dolomite
LMSN Limestone
BKSH Black Shale
SHLE Shale
SLSN Siltstone
SNDS Sandstone
ARKS Arkose
CGLM Conglomerate
QRTZ Quartzite
CHRT Chert
GRCK Greywacke
SLTE Slate
SPDS Spotted Slate
HRFL Hornfels
SKRN Skarn
GRSN Greisen
QRZD Qtz. Diorite
GRDR Granodiorite
QZMZ Qtz. Monzonite
ALSK Alaskite
GRNT Granite
SDCG Sodic Granite
DORT Diorite
MNZN Monzonite
SENT Syenite
ALKS Alkali Syenite
QZPP Qtz. Porphyry
FPPP Feld. Porphyry
QZFP Qtz.-Feld.Porphyry
DCIT Dacite
RDCT Rhyodacite
RYLT Rhyolite
ANDS Andesite
TRCD Trachyandesite
TRCT Trachyte
TUFF Tuff
BSLT Basalt
DIBS Diabase
GBBR Gabbro
SRPN Serpentinite
VEIN Vein Material

COL. 32-33

04 Protbiozoic
10 Paleozoic
12 Cambrian
14 Ordovician
16 Silurian
18 Devonian
20 Carboniferous
24 Permian
30 Mesozoic
32 Triassic
34 Jurassic
36 Cretaceous
42 Tertiary

COL. 34

1 Single grab sample
2 Channel sample
3 Composite sample
4 Drill Core
5 Other

COL. 35

0	White	< 20%
1	White & Black	20-40%
2	White-Black	40-60%
3	Black&White	60-80%
4	Black	> 80%
5	Grey	
6	Green	
7	Buff	
8	Orange or Yellow	
9	Red or Purple	

COL. 36

0	<.004	clay	glassy
1	.004- .025	silt	aphanitic
2	.025- .062	v.f.sand	aphanitic
3	.062- .250	f. sand	v.f. grained
4	0.25-0.50	m.c. sand	v.f. grained
5	0.50-1.00	c. sand	fine grained
6	1.00-2.00	v.c. sand	med. grained
7	2.00-5.00	granules	med. grained
8	5.00-20.0	pebbles	coarse grained
9	>20.0	boulders	v.c. grained

COL. 37

0 Uniform
1 variable
2 Aplitic
3 Poikilitic
4 Miarolitic
5 Myrmekitic
6 Megacrystic
7 Pegmatitic
8 Cataclasite
9 Other

COL. 38

0 Massive
1 Bedded
2 Crossbedded
3 Slump structured
4 Oriented megacrysts
5 Trachytic

COL. 39

0 Fresh
1 Weathered
2 Gossanous
3 Hydrothermal, white
4 Hydrothermal, rusty

COL. 40

0 Feldspars clear
1 Feldspars cloud

Col. 41

0 No megacrysts
1 Feld. megacrysts
2 Qtz. megacrysts
3 Qtz.&Feld. megacrysts
4 Metamorphic porphyroblasts
5 Other

COL. 42-43

Hb. & Biot. content of total dark minerals, on scales of 0-9

COL. 44

0 Sulphides absent
1 Sulphides present

COL. 45-49

Approx. outcrop area in sq. miles

COL. 50-54

Altitude above sea level

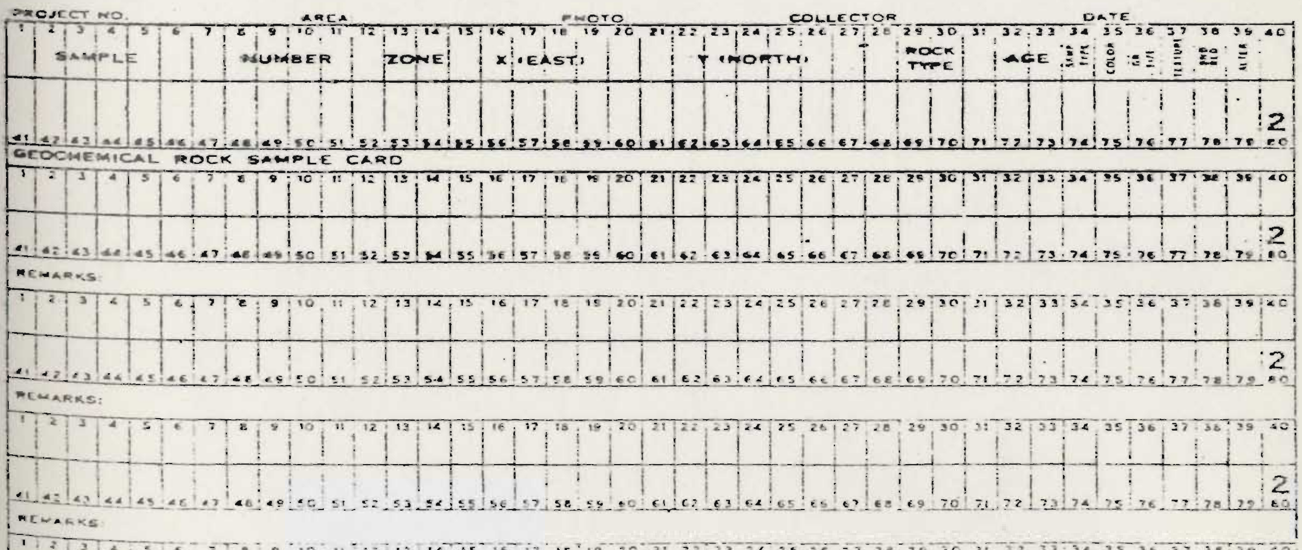

Figure 30: Computer format used to describe granitic rocks in the field.

3) A representative sample of these pieces was crushed in a tungsten-carbide Siebtechnik swing mill for three to four minutes producing a rock powder of -100 mesh, as determined by random sieving checks.

4) The powder was put into 4 oz. jars and dried overnight in an oven at 110°C.

1.2.2. Major and Trace Element Analysis

Eight major and six trace elements were determined by X-ray fluorescence analysis of discs pressed from the rock powder using a Phillips 1220-C computerised spectrometer. Approximately 1/3 of the samples were analysed by a method modified from that of Rose, *et al.*, (1962). The sample discs were prepared in the following manner.

1) 1.5 g of rock powder was thoroughly mixed with two to three drops of N-30-88 Mowiol binding agent until the colour was uniform.

2) Using a boric acid backing, this powder was pressed into a disc for one minute at 15 tons per square inch.

The eight major elements determined using fused powders were prepared by the following method:

1) 0.7500 g of rock powder + 0.7500 g of La_2O_3 + 6.00 g of $Li_2B_4O_7$ were carefully weighed out, mixed together, and put in a graphite crucible.

2) A dozen crucibles at a time were put in a muffle furnace pre-heated to 1,000°C and left to fuse for 30-35 minutes.

3) After fusion the resulting glass beads were allowed to cool for 1 minute and put in clean glass jars.

4) The weight of each bead was readjusted to exactly 7.5000 g with dried $Li_2B_4O_7$, compensating for weight lost during fusion and thus giving an exact dilution.

5) Each bead plus the $Li_2B_4O_7$ was placed in a tungsten-carbide ball mill vial,cracked with a steel cylinder, and then crushed in the ball mill to -100 mesh.

6) The powder was then put in bottles and dried overnight at 110°C.

7) The sample discs were then prepared as outlined above.

Na and Mn were analysed using a Perkin Elmer 303 Atomic Absorbtion Spectrometer using a method similar to Langmhyr and Paus (1968). The solutions were prepared by the following method:

1) 0.2000 g of powder was mixed with 5 ml of concentrated HF and heated on a steam bath for 20 minutes until completely dissolved.

2) Each sample was diluted with 50 ml of saturated boric acid and made up to 200 ml with distilled water.

3) Analyses were done by comparison with international rock standards.

1.2.3. Loss on Ignition

Loss on ignition was calculated by measuring a known amount of powder into a porcelain crucible, heating at 1050°C for two hours, weighing again and expressing the difference in percent. It is assumed that the loss on ignition represents predominantly H_2O and CO_2.

1.3. Precision and Accuracy

The precision and accuracy of major and trace element analyses are shown in Tables 7 and 8. It will be readily seen that analytical errors are significantly less than the chemical variation discussed in the text.

TABLE 7

(a) Precision of analytical methods for Major Elements

ELEMENT	FUSED SAMPLE (CD-371)				UNFUSED SAMPLE (LD-75)			
	Range (%)	Mean	S. Dev.	N	Range (%)	Mean	S. Dev.	N
SiO_2	10.70	76.58	1.94	41	6.90	76.21	1.91	13
TiO_2	0.10	0.17	0.03	41	0.02	0.03	0.01	13
Al_2O_3	1.40	12.28	0.36	41	1.37	14.13	0.35	13
Fe_2O_3	0.34	1.15	0.08	41	0.57	1.45	0.20	13
MgO	5.80	0.30	0.94	41	1.66	0.91	0.45	13
CaO	0.76	0.87	0.10	41	0.24	1.11	0.08	13
K_2O	0.17	1.73	0.03	41	0.58	2.43	0.23	13
P_2O_5	0.01	0.005	0.002	41	0.10	0.04	0.09	13

(b) Precision of analytical methods for Trace Elements (from 9 independent discs of LD-75).

ELEMENT	RANGE	MEAN	S. DEV.
Zr	33	68	10
Sr	21	138	9
Rb	8	106	3
Zn	9	37	3
Cu	16	4	6
Ba	197	755	74

TABLE 8

(a) Accuracy of Major Element Analysis as determined by fit of standards to calibration curve.

ELEMENT	FUSED SAMPLES			UNFUSED SAMPLES		
	Range(%)	S. Dev.	No. Stds.	Range(%)	S. Dev.	No. Stds.
SiO_2	38.5	0.67	21	23.3	1.63	10
TiO_2	4.59	0.03	23	1.08	0.06	9
Al_2O_3	23.35	0.37	23	4.20	0.67	11
Fe_2O_3	27.83	0.16	20	7.50	0.20	9
MgO	49.70	0.89	18	3.33	0.27	7
CaO	13.63	0.10	21	7.70	0.55	8
K_2O	11.78	0.07	21	4.52	0.14	9
P_2O_5	1.90	0.09	18	-	-	-

(b) Accuracy of Major Element Analysis as determined by comparison of 24 samples analysed by X-ray fluorescence and atomic absorption.

ELEMENT	RANGE (%)	S. DEV.
SiO_2	7.74	0.99
TiO_2	0.71	0.02
Al_2O_3	7.40	0.30
Fe_2O_3	5.06	0.10
MgO	0.34	0.05
CaO	0.55	0.05
K_2O	5.00	0.04
P_2O_5	0.23	0.04

TABLE 8 (Cont'd)

(c) Accuracy of Trace Elements analysis by fit of standards to calibration curve.

	TRACE ELEMENTS		
ELEMENT	Range (p.p.m.)	S. Dev.	No. Stds.
Zr	490	13	16
Sr	784	18	19
Rb	245	6	23
Zn	161	12	24
Cu	105	5	23
Ba	1,803	33	18

APPENDIX II

2.1. Representative normative and modal analyses

SAMPLE NO.	TH. 2	TH. 6	TH. 9	TH. 11	TH. 12
CIPW Norms (wt. %)					
Q	41.08	37.17	29.66	36.07	35.22
Or	28.01	30.10	31.33	26.71	30.33
Ab	25.15	27.54	32.42	30.06	30.16
An	1.93	--	0.80	--	--
C	0.21	--	--	--	--
En	1.74	0.86	3.16	--	0.79
Il	0.43	0.09	0.43	--	0.06
Ac	--	1.93	--	0.22	0.26
Ru	0.09	0.09	0.17	0.14	0.14
Di	--	0.86	0.24	3.77	1.57
Ap	--	--	--	--	--
Wo	--	--	--	1.78	--
Hm	1.55	1.35	2.17	1.25	1.46
Modes (Vol. %)					
Qtz	36	35	30	31	40
K-feld.	39	42	44	57	57
Plag.	20	13	20	--	--
Hbl.	--	--	--	6	--
Rbk.	--	1	--	--	--
Aeg.	--	--	--	2	--
Chl.	2	4	2	1	--
Biot.	--	--	--	--	--
Fl	--	1	--	--	--
Magn.	3	4	4	3	2
Zir.	--	--	--	--	1

SAMPLE NO.	TH. 22	TH. 47	TH. 54	TH. 65	TH. 68
CIPW Norms (wt. %)					
Q	36.59	39.20	16.58	38.04	40.38
Or	28.84	26.96	11.29	29.02	29.26
Ab	32.24	31.01	46.29	27.84	25.70
An	--	0.21	12.32	2.21	2.28
C	--	0.533	0.02	--	--
En	--	--	7.06	--	--
Il	--	--	0.39	0.06	0.06
Ac	0.63	--	--	--	--
Ru	0.08	0.081	0.58	0.14	0.09
Di	--	--	--	--	--
Ap	--	--	0.28	--	--
Wo	0.85	--	--	0.43	0.10
Hm	0.77	2.01	5.20	2.25	2.12

Modes (Vol. %)	TH. 22	TH. 47	TH. 54	TH. 65	TH. 68
Qtz	43	30	22	34	33
K-feld.	55	59	12	43	49
Plag.	--	6	23	13	12
Hbl.	--	--	13	--	--
Rbk.	--	--	--	--	--
Aeg.	--	--	--	--	--
Chl.	--	--	--	2	2
Biot.	--	1	18	--	--
Fl.	--	--	--	--	--
Magn.	2	3	2	8	4
Zir.	--	--	--	--	--

SAMPLE NO.	TH. 74	TH. 87	TH. 92	TH.106	TH.113
CIPW Norms (wt. %)					
Q	43.95	39.81	41.28	39.73	38.03
Or	29.72	29.02	28.18	28.11	29.45
Ab	23.60	27.22	28.03	27.14	26.98
An	0.28	--	0.81	--	--
C	--	--	--	--	--
En	--	--	--	2.11	--
Il	0.09	0.02	--	--	--
Ac	--	2.40	0.02	1.00	3.41
Ru	0.13	0.15	0.15	0.15	0.15
Di	--	--	--	0.95	0.02
Ap	--	--	--	--	--
Wo	0.73	0.33	0.03	--	1.09
Hm.	1.49	1.03	1.49	0.80	0.31
Modes (Vol. %)					
Qtz.	39	30	35	30	38
K-feld.	42	61	40	60	56
Plag.	14	--	20	5	4
Hbl.	--	--	--	--	--
Rbk.	--	2	--	1	1
Aeg.	--	--	--	--	--
Chl.	--	1	1	2	--
Biot.	--	--	--	--	--
Fl.	--	--	--	--	--
Magn.	5	6	4	2	1
Zir.	--	--	--	--	--

SAMPLE NO.	TH.119	TH.120	TH.124	TH.130	TH.144
CIPW Norms (wt. %)					
Q	38.90	37.07	37.98	40.56	37.80
Or	26.93	27.71	29.21	26.35	29.95
Ab	29.20	30.03	29.50	30.78	27.55
An	--	--	0.46	--	--
C	--	--	--	--	--
En	--	--	--	--	2.23
Il	0.08	0.07	0.08	--	0.02
Ac	2.59	1.71	--	0.64	0.79
Ru	0.10	0.09	0.11	0.15	--
Di	--	1.66	--	--	--
Ap	--	--	--	--	--
Wo	2.11	0.33	0.35	0.50	0.19
Hm	0.09	1.33	2.29	1.03	1.55
Modes (Vol. %)					
Qtz.	40	21	30	30	33
K-feld.	43	45	50	55	56
Plag.	10	24	14	--	--
Hbl.	--	--	--	--	--
Rbk.	1	--	--	3	--
Aeg.	2	--	--	6	--
Chl.	--	2	3	2	2
Biot.	--	1	--	--	--
Fl.	--	1	--	1	--
Magn.	4	5	2	3	8
Zir.	--	1	1	--	1

2.2. Chemical analyses of the St. Lawrence granite

NOTE: 1. The Devonian age of the St. Lawrence granite as shown in the field data is incorrect. The St. Lawrence granite has been dated isotopically by rubidium-strontium at 330 ± 10 million years, i.e. Carboniferous age.

2. Major elements in weight per cent.

Trace elements in ppm.

Except Hg in ppb.

ST. LAWRENCE

SAMPLE NO.	TH 1	TH 2	TH 3	TH 4	TH 5	TH 6	TH 7
COORDINATES	1L14 9 862	1L14 9 862	1L14 9 802	1L14 9 762	1L14 9 762	1L14 0 022	1L14 0 102
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	RED	RED	RED	RED	GREY
GRAIN SIZE	MED	V.F.	CORS	CORS	MED	MED	FINE
TEXTURE	UNIFORM	UNIFORM	UNIFORM	CATACLAST	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	C-MEG	O-MEG	NO MEG	NO MEG	NO MEG	NO MEG
FLUORI	0	C	0	0	0	0	C
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SS.MI	180	180	180	180	180	180	180
PCNT	100	100	50	100	100	100	250
SIO2	72.20	78.70	80.30	73.00	74.10	76.40	73.10
TIO2	0.28	0.11	0.11	0.23	0.26	0.13	0.28
AL2O3	14.00	11.00	9.40	13.40	13.00	10.70	10.70
FE2O3	1.72	1.55	0.81	1.30	1.40	1.99	3.80
FEO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MNO	.05	.02	.01	.04	.05	.04	.11
MGO	1.00	0.70	0.60	0.50	0.80	0.50	0.70
CAO	0.65	0.39	0.66	0.57	0.58	0.22	0.42
NA2O3	4.42	2.98	2.91	4.48	3.11	3.46	4.00
K2O	4.68	4.78	4.04	4.55	4.44	5.01	4.55
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	99.00	100.23	98.84	98.07	97.74	98.45	97.66
RB	159	345	260	132	141	278	166
BA	711	25	48	584	569	31	96
SR	79	00	00	2	34	0	0
PB							
CU	3	4	2	0	2	5	17
ZN	42	105	38	27	29	98	254
CO							
CR	16	15	3	14	15	15	17
NI	3	5	5	3	2	4	3
V							
ZR	208	525	722	148	189	471	670
SN							
MO							
BI							
NB							
F	200	2100	4100	220	210	1300	440
HG	86	321	117	86	47	53	53
S							

ST. LAWRENCE

SAMPLE NO.	TH 8	TH 9	TH 10	TH 11	TH 12	TH 13	TH 14
OORDINATES	IL14 0 102	IL14 0 102	IL14 9 982	IL14 9 282	IL14 9 292	IL14 9 242	IL14 9 242
OCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
GE	DEVCNIAN	DEVCNIAN	DEVCNIAN	DEVONIAN	DEVONIAN	DEVCNIAN	DEVONIAN
AMPLE TYPE	GRAB	GPAB	GRAB	GRAB	GRAB	GRAB	GRAB
OLOUR	RED	RED	YELLOW	RED	RED	RED	RED
RAIN SIZE	FINE	FINE	MED	MED	CORS	MED	CORS
EXTURE	UNIFCRM	UNIFORM	UNIFORM	UNIFCRM	POIKILITIC	UNIFCRM	MYRMEKITIC
TRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
LTERATION	WEATH	FRESH	WEATH	WEATH	WEATH	WEATH	WEATH
ELDSPARS	CLOUDY	CLEAR	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
RYSTALS	NO MEG	NC MEG	NO MEC	NC MEG	NO MEG	NO MEG	F-MEG
B:BI	3	0	0	C	0	1	0
LLF.	ABSENT	APSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
Q.MI	180	160	180	180	180	180	180
IGHT	250	250	250	50	50	50	50
SIO2	63.40	73.80	69.20	76.90	75.60	75.10	74.60
TIO2	0.88	0.19	0.26	C.14	0.17	0.13	0.13
AL2O3	14.00	12.20	14.40	10.70	11.20	11.10	10.50
FE2O3	6.03	2.15	1.60	1.32	1.52	2.21	2.02
FEO	0.00	0.00	0.00	C.00	0.00	0.00	0.00
MNO	.16	.02	.04	.00	.03	.02	.01
MGO	1.80	1.30	0.80	C.70	0.60	0.70	0.60
CAO	1.98	0.22	0.83	1.83	0.40	0.35	0.24
NA2O3	4.89	3.79	3.21	3.57	3.53	3.71	3.25
K2O	4.72	5.24	5.37	4.50	5.03	4.43	4.54
P2O5	0.20	0.00	0.15	0.00	0.00	0.00	0.00
H2O	0.00	0.C0	0.00	C.00	0.00	0.00	0.00
TOTAL	98.06	98.91	95.86	99.66	98.08	97.75	95.89
RB	117	200	361	308	281	325	304
BA	797	273	299	32	59	36	31
SR	96	0	0	0	0	0	0
PB							
CU	17	0	21	5	3	C	14
ZN	72	51	60	15	34	87	12
CO							
CR	20	15	16	13	14	15	15
NI	4	3	5	5	4	5	4
V							
ZR	305	334	101	505	462	864	563
SN							
MO							
BI							
NE							
F	930	150	960	9999	1600	1800	1400
HG	171	139	86	53	385	600	600
S							

ST. LAWRENCE

SAMPLE NO.	TH 15	TH 16	TH 17	TH 18	TH 19	TH 20	TH 21
COORDINATES	1L14 0 222	1L14 0 222	1L14 0 222	1L14 0 221	1L13 0 091	1L13 0 411	1L13 0 441
ROCK TYPE	BASALT	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	PALEOZOIC	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	BLACK	RED	RED	RED	BUFF	GREEN	YELLOW
GRAIN SIZE	FINE	MED	FINE	MED	MED	MED	CORS
TEXTURE	UNIFORM	UNIFORM	MIAROLITIC	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	FRESH	WEATH	WEATH	FRESH	WEATH	WEATH	WEATH
FELDSPARS	CLEAR	CLOUDY	CLOUDY	CLEAR	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
FOCAL	0	0	1	2	1	1	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	730	180	180	180	180	180	180
HGHT	250	250	250	250	250	150	150
SIO2		74.60	73.40	73.20	73.50	76.00	77.70
TIO2		0.14	0.26	0.07	0.07	0.06	0.10
AL2O3		11.10	10.50	11.20	10.70	11.00	10.30
FE2O3		1.77	2.88	1.33	1.47	1.66	0.96
FEO		0.00	0.00	0.00	0.00	0.00	0.00
MNO		.05	.08	.01	.03	.06	.01
MGO		0.00	0.70	0.70	0.40	0.00	0.00
CAO		0.09	0.19	0.20	0.32	0.36	0.28
NA2O3		3.57	3.30	3.88	3.65	3.80	3.31
K2O		5.04	5.00	4.29	4.29	4.48	4.35
P2O5		0.00	0.00	0.00	0.00	0.00	0.00
H2O		0.00	0.00	0.00	0.00	0.00	0.00
TOTAL		96.36	96.31	94.88	94.43	97.42	97.51
RB		258	177	381	351	404	245
BA		67	169	5	17	13	16
SR		0	0	0	0	0	0
PB							
CU		7	10	0	9	0	0
ZN		113	108	47	80	207	69
CO							
CR		15	15	15	17	16	15
NI		4	4	5	5	6	5
V							
ZR		652	559	278	229	203	224
SN							
MO							
BI							
NB							
F		310	150	1800	2100	2400	1800
HG		53	107	86	32	96	53
S							

SAMPLE NO.	TH 22	TH 23	TH 24	TH 25	TH 26	TH 27	TH 28
COORDINATES	1L13 0 481	1L14 0 202	1L14 0 202	1L14 C 072	1L14 0 152	1L14 0 162	1L14 0 152
ROCK TYPE	GRANITE	GRANITE	GRANITE	BASALT	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	CAMBRIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	YELLOW	RED	BLACK	BUFF	BUFF	YELLOW
GRAIN SIZE	FINE	MED	CORS	MED	MED	MED	MED
TEXTURE	APLITIC	UNIFORM	UNIFORM	UNIFORM	MIAROLITIC	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	FRESH	WEATH	WEATH	FRESH	WEATH	WEATH	WEATH
FELDSPARS	CLEAR	CLOUDY	CLOUDY	CLEAR	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HP:NI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	2	180	180	180
HGHT	200	400	400	650	250	250	400
SIO2	76.50	75.60	76.70		78.00	76.10	78.00
TIO2	0.28	0.19	0.20		0.14	0.11	0.11
AL2O3	11.30	10.80	10.20		10.80	11.00	10.80
FE2O3	0.97	1.32	2.11		1.88	1.92	2.13
FEO	0.00	0.00	0.00		0.00	0.00	0.00
MNO	.00	.00	.00		.00	.03	.01
MGO	0.00	0.00	0.00		0.00	0.00	1.70
CAO	0.40	0.06	0.18		0.26	0.26	0.13
NA2O3	3.81	3.19	3.29		3.34	3.40	3.40
K2O	4.77	5.18	4.91		5.11	5.18	4.79
P2O5	0.00	0.00	0.00		0.00	0.00	0.00
H2O	0.00	0.00	0.00		0.00	0.00	0.00
TOTAL	97.83	96.34	97.59		99.53	98.00	101.07
RB	334	353	314		292	339	368
BA	6	46	49		22	27	58
SR	0	0	0		0	0	0
PB							
CU	0	0	1		0	0	1
ZN	70	56	66		15	80	131
CO							
CR	15	15	15		14	19	19
NI	4	6	5		5	5	4
V							
ZR	62	629	585		509	490	763
SN							
MO							
BI							
NB							
F	2500	230	1100		1600	1500	500
HG	49	67	86		107	67	11
S							

SAMPLE NO.	TH 29	TH 30	TH 31	TH 32	TH 33	TH 34	TH 35
COORDINATES	1L14 0 232	1L14 0 222	1L14 0 222	1L14 C 162	1L14 0 142	1L14 C 112	1L14 0 182
ROCK TYPE	GRANITE	HORNFELS	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	CAMBRIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	GREY	RED	RED	RED	RED	BUFF
GRAIN SIZE	MED	V.F.	FINE	FINE	V.F.	FINE	FINE
TEXTURE	MIAROLITIC	UNIFORM	VARIABLE	UNIFORM	MIAROLITIC	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	FRESH	FRESH	WEATH	WEATH	FRESH	FRESH
FELDSPARS	CLOUDY	CLEAR	CLEAR	CLOUDY	CLOUDY	CLEAR	CLEAR
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	0-MEG	NO MEG
HF:HI	0	C	0	0	0	0	C
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	280	180	180	180	180	180
HGHT	250	250	250	200	200	200	250
SIO2	76.70		72.10	70.90	72.90	74.90	72.20
TIO2	0.19		0.38	0.25	0.31	0.29	0.43
AL2O3	11.50		14.20	12.70	12.80	10.30	11.60
FE2O3	2.62		1.67	1.45	1.85	3.57	4.94
FEO	0.00		0.00	0.00	0.00	0.00	0.00
MNO	.05		.08	.01	.02	.09	.12
MGO	0.00		0.00	1.10	0.00	0.00	0.00
CAO	0.38		0.35	0.36	0.39	0.18	0.48
NA2O3	3.49		5.05	3.90	3.53	3.20	3.21
K2O	5.33		5.32	5.90	4.89	4.54	4.98
P2O5	0.00		0.00	0.00	0.00	0.00	0.00
H2O	0.00		0.00	0.00	0.00	0.00	0.00
TOTAL	100.26		99.15	96.57	96.69	97.07	97.96
RB	283		183	240	196	201	193
BA	114		684	395	427	23	211
SR	0		93	17	31	C	0
PB							
CU	10		11	3	0	3	2
ZN	62		52	34	30	113	158
CO							
CR	29		16	17	17	18	19
NI	3		4	3	2	2	1
V							
ZR	607		337	297	310	987	699
SN							
MO							
BI							
NE							
F	1580		250	300	240	130	250
HG	32		128	107	96	86	67
S							

SAMPLE NO.	TH 36	TH 37	TH 38	TH 39	TH 40	TH 41	TH 42
COORDINATES	1L14 0 182	1L14 0 192	1L14 0 192	1L14 0 471	1L14 0 471	1L14 0 471	1L14 0 471
ROCK TYPE	GRANITE	HORNFELS	GRANITE	BASALT	BASALT	GRANITE	GRANITE
AGE	DEVONIAN	CAMBRIAN	DEVONIAN	PALEOZOIC	PALEOZOIC	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	BUFF	GREEN	RED	BLACK	BLACK	BUFF	BUFF
GRAIN SIZE	FINE	V.F.	V.F.	V.F.	V.F.	V.F.	V.F.
TEXTURE	UNIFORM	VARIABLE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	FRESH	FRESH	WEATH	FRESH	FRESH	WEATH	WEATH
FELDSPARS	CLEAR	CLEAR	CLOUDY	CLEAR	CLEAR	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	1	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	280	180	780	780	180	180
HGHT	250	300	300	450	450	450	450
SIO2	79.30	66.20	71.70			66.40	72.50
TIO2	0.38	0.65	0.40			0.35	0.22
AL2O3	14.30	16.80	14.00			13.30	10.00
FE2O3	2.28	3.10	3.89			5.14	2.53
FEO	0.00	0.00	0.00			0.00	0.00
MNO	.04	.05	.04			.12	.09
MGO	0.00	0.10	0.00			2.30	0.00
CAO	5.83	1.53	0.64			5.17	2.13
NA2O3	0.64	5.65	1.37			3.84	3.51
K2O	1.39	3.51	5.19			0.77	1.51
P2O5	0.02	0.01	0.00			0.00	0.00
H2O	0.00	0.00	0.00			0.00	0.00
TOTAL	104.23	97.60	97.23			97.39	92.49
RB	64	116	236			78	93
BA	176	1147	848			166	385
SR	458	324	37			552	764
PB							
CU	5	12	9			66	12
ZN	57	64	74			109	111
CO							
CR	21	22	24			29	23
NI	5	4	4			14	4
V							
ZR	289	425	171			154	128
SN							
MO							
BI							
NB							
F	240	310	680			4700	430
HG	21	11	21			257	11
S							

SAMPLE NO.	TH 43	TH 44	TH 45	TH 46	TH 47	TH 48	TH 49
CO-ORDINATES	1L14 0 471	1L14 0 471	1L14 0 471	1L14 0 451	1L14 0 261	1L14 C 281	1L14 0 291
ROCK TYPE	GRANITE	GRANITE	DIABASE	GRANITE	GRANITE	GRANITE	DIABASE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	GREY	BUFF	RED	YELLOW	GREY
GRAIN SIZE	MED	FINE	V.F.	MED	FINE	MED	V.F.
TEXTURE	UNIFORM	VARIABLE	UNIFORM	VARIABLE	MIAROLITIC	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	FRESH	FRESH	WEATH	WEATH	WEATH	FRESH
FELDSPARS	CLOUDY	CLEAR	CLEAR	CLOUDY	CLOUDY	CLOUDY	CLEAR
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	1	1	0	1	0	1	1
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI	180		180	180	180	180	180
HGHT	450	450	450	450	250	300	350
SIO2	69.00	68.10			76.90	76.50	
TIO2	0.38	0.37			0.08	0.08	
AL2O3	14.20	14.70			11.40	11.80	
FE2O3	3.12	3.10			1.98	1.22	
FEO	0.00	0.00			0.00	0.00	
MNO	.09	.12			.00	.01	
MGO	1.80	2.50			0.00	0.00	
CAO	1.99	2.17			0.04	0.03	
NA2O	4.58	4.41			3.61	4.26	
K2O	2.86	3.05			4.49	4.40	
P2O5	0.00	0.00			0.00	0.00	
H2O	0.00	0.00			0.00	0.00	
TOTAL	98.02	98.52			98.50	98.30	
RB	128	172			443	467	
BA	650	732			11	18	
SR	501	638			0	0	
PB							
CU	6	18			6	15	
ZN	86	88			128	97	
CO							
CR	24	19			20	16	
NI	5	5			3	4	
V							
ZR	177	175			326	215	
SN							
MO							
BI							
NE							
F	660	3000			240	560	
HG	107	86			86	67	
S							

SAMPLE NO.	TH 50	TH 51	TH 52	TH 53	TH 54	TH 55	TH 56
COORDINATES	1L14 0 291	1L14 0 251	1L14 0 251	1M3 0 651	1M3 0 651	1M3 0 651	1M3 0 651
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	BASALT
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	PALEOZOIC
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	BUFF	YELLOW	YELLOW	GREEN	GREEN	GREEN	GREEN
GRAIN SIZE	V.F.	MED	MED	MED	V.F.	FINE	FINE
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	FRESH	WEATH	WEATH	FRESH	FRESH	FRESH	FRESH
FELDSPARS	CLEAR	CLOUDY	CLOUDY	CLEAR	CLOUDY	CLEAR	CLEAR
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	0	0	3	1	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	PRESEN	ABSENT	ABSENT
SC.MI	180	180	180	180	180	180	180
HGHT	350	200	200	250	250	200	200
SIO2	74.80	74.10	74.80	51.00	64.40	66.20	
TIO2	0.07	0.09	0.10	1.07	0.77	0.69	
AL2O3	11.00	11.00	11.20	15.60	15.40	16.80	
FE2O3	2.56	0.98	1.44	9.85	5.13	2.42	
FEO	0.00	0.00	0.00	0.00	0.00	0.00	
MNO	.05	.01	.05	.23	.18	.07	
MGO	0.00	0.00	0.00	5.20	2.80	2.60	
CAO	0.01	0.29	0.23	6.54	2.61	3.27	
NA2O3	4.55	4.29	4.88	4.35	5.40	5.49	
K2O	4.29	4.34	4.60	1.91	1.88	1.47	
P2O5	0.00	0.00	0.00	0.26	0.12	0.09	
H2O	0.00	0.00	0.00	0.00	0.00	0.00	
TOTAL	97.33	95.10	97.30	96.01	98.69	99.10	
RB	465	404	420	76	78	80	
BA	10	12	15	542	769	453	
SR	0	0	0	753	621	900	
PB							
CU	33	0	22	64	21	11	
ZN	72	47	36	159	142	82	
CO							
CR	23	18	19	54	22	20	
NI	4	3	4	20	2	13	
V							
ZR	351	303	294	215	234	572	
SN							
MO							
BI							
NB							
F	450	2240	1900	740	1050	320	
HG	67	214	78	107	117	43	
S							

ST. LAWRENCE

SAMPLE NO.	TH 57	TH 58	TH 59	TH 60	TH 61	TH 62	TH 63
COORDINATES	1M3 0 651	1M3 0 641	1L14 0 511	1L14 0 511	1L14 0 511	1M3 1 332	1M3 0 781
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	GREEN	RED	RED	RED	GREY	RED	RED
GRAIN SIZE	MED	MED	MED	MED	V.F.	MED	MED
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	FRESH	FRESH	FRESH	FRESH	WEATH	WEATH
FELDSPARS	CLOUDY	CLEAR	CLEAR	CLEAR	CLEAR	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
MF:CI	1	0	0	0	2	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI	180	180	180	180	180	180	180
HCFT	200	200	200	200	200	500	450
SIO2			78.90	79.10			
TIO2			0.10	0.11			
AL2O3			12.10	11.70			
FE2O3			1.38	1.01			
FEO			0.00	0.00			
MNO			.03	.10			
MGO			0.00	0.00			
CAO			0.27	0.45			
NA2O3			0.21	3.44			
K2O			3.87	3.90			
P2O5			0.00	0.00			
H2O			0.00	0.00			
TOTAL			96.86	99.81			
RB			289				
BA			76				
SR							
PB							
CU			11				
ZN			35				
CO							
CR			20				
NI			4				
V							
ZR			275				
SN							
MO							
BI							
NB							
F			190				
HG			107				
S							

ST. LAWRENCE

AMPLE NO.	TH 64	TH 65	TH 66	TH 67	TH 68	TH 69	TH 70
ORDINATES	1H3 C 781	1L14 9 191	1L14 9 201	1L14 9 201	1L14 5 211	1L14 5 211	1L14 9 231
CK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
GE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
AMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
OLOUR	RED	RED	RED	RED	RED	RED	RED
AIN SIZE	MED	MED	MED	MED	FINE	MED	V.F.
EXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
RUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
TERATION	WEATH	FRESH	WEATH	WEATH	FRESH	WEATH	FRESH
LDSPARS	CLOUDY	CLEAR	CLOUDY	CLOUDY	CLEAR	CLOUDY	CLEAR
YSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
E:PI	0	0	0	0	0	0	1
LL.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
U.MI	180	180	180	180	180	180	180
CHT	450	50	50	50	50	50	50
IO2		76.90	79.80	77.00	78.10	78.90	
IO2		0.17	0.17	0.12	0.12	0.16	
L2O3		11.50	11.30	10.60	11.20	11.10	
E2O3		2.25	2.53	1.98	2.12	2.00	
EO		0.00	0.00	0.00	0.00	0.00	
NO		.03	.04	.07	.03	.05	
GO		0.00	0.00	0.00	0.00	0.00	
AO		0.65	0.52	0.55	0.51	0.26	
A2O		3.28	3.58	4.57	3.04	4.31	
2O		4.89	4.60	4.86	4.95	4.79	
2O5		0.00	0.00	0.29	0.00	0.00	
2O		0.00	0.00	0.00	0.00	0.00	
OTAL		99.67	102.54	100.04	100.07	101.57	
I		202	238	249	249	238	
A		97	114	28	38	180	
R		0	0	0	0	0	
E							
U		11	13	0	0	1	
N		48	167	28	33	141	
C							
K		15	15	15	15	15	
I		4	4	4	3	4	
V							
K		457	650	526	480	432	
N							
C							
I							
F							
F		960	1530	1300	1180	1500	
G		21	67	150	43	150	
S							

ST. LAWRENCE

SAMPLE NO.	TH 71	TH 72	TH 73	TH 74	TH 75	TH 76	TH 77
COORDINATES	1L14 9 231	1L14 9 231	1L14 9 221	1L14 9 221	1L14 9 251	1L14 9 251	1L14 9 251
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	RED	RED	RED	YELLOW	RED
GRAIN SIZE	V.F.	FINE	MED	MED	MED	MED	V.F.
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	VARIABLE	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	FRESH	FRESH	WEATH	FRESH	WEATH	WEATH	WEATH
FELDSPARS	CLEAR	CLEAR	CLOUDY	CLEAR	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	0	0	0	0	1	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	100	100	100
SIO2	76.50	78.80	78.20	76.50	81.40	81.30	76.80
TIO2	0.24	0.16	0.25	0.17	0.15	0.13	0.20
AL2O3	11.30	10.60	10.70	9.70	10.40	9.60	11.30
FE2O3	3.03	1.91	1.65	1.43	1.41	1.46	1.69
FEO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MNO	.08	.02	.02	.04	.02	.04	.07
MGO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAO	0.22	0.13	0.41	0.39	0.02	0.00	0.01
NA2O3	4.66	3.60	1.98	2.67	1.96	2.50	3.83
K2O	5.25	4.33	5.06	4.81	5.80	4.99	4.79
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	101.28	99.55	98.27	95.71	101.16	100.02	98.69
RB	215	217	257	285	315	242	172
BA	114	56	65	161	86	67	58
SR	0	0	0	0	0	0	0
PB							
CU	13	18	10	31	0	0	0
ZN	144	75	12	33	16	13	23
CO							
CR	17	16	15	14	14	14	15
NI	3	5	5	5	5	4	3
V							
ZR	772	594	556	689	639	495	64
SN							
MO							
BI							
NB							
F	120	620	470	2700	110	190	99
HG	96	107	107	600	43	53	67
S							

ST. LAWRENCE

SAMPLE NO.	TH 78	TH 79	TH 80	TH 81	TH 82	TH 83	TH 84
COORDINATES	IL14 9 261	IL14 9 281	IL14 9 231	IL14 9 231	IL14 9 231	IL14 9 231	IL14 9 251
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	YELLOW	YELLOW	YELLOW	RED	YELLOW	RED
GRAIN SIZE	MED	MED	MED	MED	MED	MED	MED
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HF:PI	1	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI	180	180	180	180	180	180	180
HGHT	50	100	50	50	50	50	50
SIO2	78.00	78.00	74.80	76.80	76.60	70.80	76.70
TIO2	0.15	0.17	0.13	0.16	0.18	0.16	0.15
AL2O3	10.80	10.90	10.00	10.10	10.70	10.20	10.80
FE2O3	1.83	1.46	1.55	1.54	2.36	1.48	2.38
FEO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MNO	.05	.01	.01	.06	.06	.05	.01
MGO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAO	0.01	0.18	1.16	0.20	0.05	0.00	0.24
NA2O3	3.16	3.61	3.70	2.70	3.57	3.48	3.06
K2O	5.23	4.86	4.76	5.50	4.84	4.84	5.39
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	99.23	99.19	96.11	97.06	98.36	91.01	98.73
RB	258	260	259	271	257	298	271
BA	55	169	61	110	103	113	56
SR	0	0	0	0	0	0	0
PB							
CU	0	0	0	0	0	8	2
ZN	10	8	12	20	18	16	46
CO							
CR	15	14	14	16	17	17	17
NI	5	6	4	9	11	12	4
V							
ZR	603	698	632	456	675	762	665
SN							
MO							
BI							
NB							
F	130	1480	8200	6400	200	190	1800
HG	67	43	21	32	43	21	21
S							

SAMPLE NO.	TH 85	TH 86	TH 87	TH 88	TH 89	TH 90	TH 91
CO-ORDINATES	1L14 9 251	1L14 9 262	1L14. 9 262	1L14 9 272	1L14 9 272	1L14 9 262	1L14 9 232
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	YELLOW	YELLOW	YELLOW	YELLOW	GREEN	YELLOW
GRAIN SIZE	MED	MED	MED	MED	MED	MED	MED
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	FRESH	FRESH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLEAR	CLEAR	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
BR:PI	0	1	1	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SI.MI	180	180	180	180	180	180	180
FGPT	50	50	50	50	50	50	50
SIO2	76.10	78.50	77.20	77.10	77.80	81.40	79.60
TIO2	0.17	0.16	0.16	0.15	0.13	0.14	0.12
AL2O3	10.50	10.60	10.40	10.50	10.40	8.60	11.00
FE2O3	2.71	1.68	1.83	1.56	1.72	0.72	1.21
FEO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MNO	.01	0.01	0.01	0.01	0.01	0.00	0.01
MGO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CAO	0.36	0.00	0.16	0.49	0.00	0.00	0.34
NA2O3	3.36	3.42	3.47	3.27	3.27	1.16	3.55
K2O	4.88	4.76	4.81	4.86	4.86	4.99	4.75
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	98.09	99.13	98.04	97.94	98.19	97.01	100.58
RB	249	244	275	254	255	329	316
BA	39	31	30	52	38	83	18
SR	0	0	0	0	0	0	0
PB							
CU	3	4	6	0	1	0	3
ZN	46	32	40	21	36	44	29
CO							
CR	20	17	21	19	17	18	18
NI	4	3	4	3	4	7	5
V							
ZR	877	356	613	491	454	470	751
SN							
MO							
BI							
NB							
F	2400	180	1380	3600	270	210	2300
FC	86	32	67	128	86	107	11
S							

SAMPLE NO.	TP 92	TP 93		TH 941	TH 942	TH 943	TP 95
COORDINATES	1L14 5 232	1L14 9 232		1L14 9 232	1L14 5 232	1L14 9 232	1L14 9 252
ROCK TYPE	GRANITE	GRANITE		GRANITE	GRANITE	QTZ. PORPH	GRANITE
AGE	DEVONIAN	DEVONIAN		DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB		GRAB	GRAB	GRAB	GRAB
COLOUR	YELLOW	RED		RED	RED	GREY	RED
GRAIN SIZE	MED	MED		MED	FINE	FINE	MED
TEXTURE	UNIFORM	UNIFORM		MEGACRYST	UNIFORM	OTHER	UNIFORM
STRUCTURE	MASSIVE	MASSIVE		MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	FRESH		WEATH	FRESH	FRESH	WEATH
FELDSPARS	CLOUDY	CLEAR		CLOUDY	CLEAR	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG		F-MEG	F-MEG	F-MEG	NO MEG
FOSSI	0	0		0	0	0	0
SULF.	ABSENT	ABSENT		ABSENT	ABSENT	ABSENT	ABSENT
SO.MI	180	180		180	180	180	180
HGHT	50	50		50	50	50	50
SIO2	79.10			81.40	75.20	78.70	76.30
TIO2	0.16			0.11	0.15	0.13	0.14
AL2O3	10.90			10.20	10.00	9.90	10.80
FE2O3	1.49			1.90	2.40	2.43	1.62
FEO	0.00			0.00	0.00	0.00	0.00
MNO	0.01			0.01	0.01	0.01	0.01
MGO	0.00			0.00	0.00	0.00	0.00
CAO	0.18			0.17	0.10	0.12	0.17
NA2O3	3.31			3.24	1.08	3.49	3.81
K2O	4.76			4.36	7.50	3.94	4.52
P2O5	0.00			0.00	0.00	0.00	0.00
H2O	0.00			0.00	0.00	0.00	0.00
TOTAL	99.91			101.39	96.44	98.72	97.37
RB	326		92	276	456	254	254
BA	20			26	48	23	49
SR	0		1L14	0	0	0	0
PB							
CU	0			4	23	8	0
ZN	69		3206	25	32	27	24
CO							
CR	15			18	16	19	22
NI	5		50	5	5	5	4
V							
ZR	628			983	745	1023	416
SN							
MO							
BI							
NB							
F	1200			1280	660	930	1210
HG	43			43	67	43	21
S			2				

SAMPLE NO.	TH 96	TH 97	TH 98	TH 99	TH 100	TH 101	TH 102
COORDINATES	IL14 9 252	IL14 9 272	IL14 9 272	IL14 9 292	IL14 9 292	IL14 9 332	IL14 9 332
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	YELLOW	RED	RED	YELLOW	YELLOW	YELLOW	YELLOW
GRAIN SIZE	MED	MED	MED	MED	MED	CORS	MED
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HP:BL	0	0	0	1	1	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	50
SIO2	76.50			76.20	75.50	75.50	77.40
TIO2	0.15			0.16	0.15	0.14	0.17
AL2O3	10.40			10.60	11.60	10.60	10.80
FE2O3	1.74			1.76	1.59	1.70	1.84
FEO	0.00			0.00	0.00	0.00	0.00
MNO	0.01			0.00	0.02	0.00	0.01
MGO	0.20			1.10	1.60	1.30	0.00
CAO	0.27			0.00	0.33	0.04	0.06
NA2O	3.74			3.36	3.76	3.27	3.68
K2O	4.29			4.95	4.94	4.96	4.70
P2O5	0.00			0.00	0.00	0.00	0.00
H2O	0.00			0.00	0.00	0.00	0.00
TOTAL	97.30			98.13	99.49	97.51	98.66
RB	234	220		275	252	292	251
BA	72	68		53	37	47	43
SR	0	0		0	0	0	0
PB							
CU	1	0		0	0	21	1
ZN	21	11		22	22	34	36
CO							
CR	19	20		20	22	19	18
NI	4	5		6	5	54	3
V							
ZR	442	845		602	483	723	398
SN							
MO							
BI							
NB							
F	1840	4400		140	1420	330	470
HG	43	27		43	43	21	26
S							

ST. LAWRENCE

SAMPLE NO.	TH 103	TH 104	TH 105	TH 106	TH 107	TH 108	TH 109
COORDINATES	1L14 9 372	1L14 9 372	1L14 9 222	1L14 5 222	1L14 9 222	1L14 9 222	1L14 9 252
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	YELLOW	YELLOW	YELLOW	YELLOW	RED
GRAIN SIZE	MED	MED	MED	MED	MED	MED	MED
TEXTURE	UNIFORM	MIAROLITIC	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:MI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	50
SIO2	76.30	77.70	73.90	77.20	74.80	74.20	80.60
TIO2	0.14	0.15	0.19	0.15	0.15	0.15	0.11
AL2O3	10.60	11.20	10.10	10.20	10.40	10.10	10.20
FE2O3	1.59	1.73	4.01	1.12	3.84	4.21	1.90
FEO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MNO	0.01	0.01	0.02	0.00	0.01	0.00	0.01
MGO	0.00	1.20	0.80	1.00	0.70	1.00	0.00
CAO	0.19	0.24	0.37	0.24	0.44	0.59	0.24
NA2O3	3.55	3.41	3.34	3.27	3.64	4.68	3.10
K2O	4.91	5.16	4.35	4.65	4.17	1.16	4.77
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	97.29	100.80	97.08	97.83	98.15	96.09	100.93
RB	296	267	314	320	243	77	340
BA	49	53	53	32	148	134	34
SR	0	0	0	0	0	· 28	0
PB							
CU	0	0	10	7	9	0	7
ZN	26	20	71	38	27	20	22
CO							
CR	21	23	27	20	23	25	16
NI	4	4	3	5	3	6	5
V							
ZR	601	496	1346	624	683	673	680
SN							
MO							
BI							
NF							
F	1160	1520	2600	1720	2800	4100	1600
HG	32	21	38	67	21	32	43
S							

SAMPLE NO.	TH 110	TH 111	TH 112	TH 113	TH 114	TH 115	TH 116
CO-ORDINATES	1L14 5 252	1L14 9 272	1L14 9 272	1L14 5 292	1L14 5 292	1L14 5 322	1L14 5 322
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	RED	RED	RED	RED	RED
GRAIN SIZE	V.F.	MED	MED	MED	MED	MED	MED
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	MIAROLITIC	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	FRESH	WEATH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
FE:FE	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
FOOT	50	50	50	50	50	50	50
SIO2	77.80		73.00	75.80	76.10	76.80	78.40
TIO2	0.15		0.13	0.16	0.12	0.13	0.12
AL2O3	11.30		10.10	10.30	10.50	10.80	10.90
FE2O3	2.09		2.05	1.44	1.04	1.20	1.47
FEO	0.00		0.00	0.00	0.00	0.00	0.00
MNO	0.01		0.02	0.01	0.01	0.00	0.00
MGO	0.00		0.00	0.10	0.10	0.00	0.00
CAO	0.26		0.24	0.65	0.83	0.51	0.24
NA2O3	3.52		3.62	3.53	3.50	3.64	3.51
K2O	4.80		4.57	4.82	4.66	4.70	4.79
P2O5	0.00		0.00	0.00	0.00	0.00	0.00
H2O	0.00		0.00	0.00	0.00	0.00	0.00
TOTAL	99.93		93.73	96.81	96.86	97.78	99.43
RB	327	307	297	317	333	327	359
BA	34	36	35	27	23	36	30
SR	0	0	0	0	0	0	0
PB							
CU	23	0	0	0	0	0	6
ZN	47	26	23	24	25	12	18
CO							
CR	21	30	19	17	19	24	25
NI	5	5	4	5	5	5	5
V							
ZR	803	607	599	536	474	619	577
SN							
MO							
BI							
NB							
F	1700	2400	1580	3800	5400	3200	1760
HG	43	43	53	67	32	30	11
S							

SAMPLE NO.	TH 117	TH 118	TH 119	TH 120	TH 121	TH 122	TH 123
COORDINATES	IL14 S 252	IL14 S 252	IL14 9 262	IL14 9 262	IL14 S 282	IL14 S 282	IL14 9 272
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVCNIAN	DEVCNIAN	DEVCNIAN	DEVONIAN	DEVONIAN	DEVCNIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	YELLOW	RED	RED	RED	RED	YELLOW	RED
GRAIN SIZE	MED	CORS	CORS	CORS	MED	CORS	CORS
TEXTURE	UNIFORM	UNIFORM	MIAROLITIC	UNIFORM	UNIFCRM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATICN	WEATH	WEATH	WEATH	FRESH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLEAR	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NC MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
FP:BI	1	1	0	0	0	1	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	50
SIO2	76.00	77.70	76.60	75.40	74.60	76.30	77.40
TIO2	0.14	0.13	0.14	0.12	0.14	0.26	0.14
AL2O3	10.50	11.00	10.30	10.60	10.30	10.30	11.70
FE2O3	1.56	1.30	0.87	1.87	2.42	2.21	1.74
FEO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MNO	0.04	0.03	0.04	0.03	0.03	0.03	0.04
MGO	0.00	0.20	0.00	0.30	0.00	0.00	0.30
CAO	0.38	0.39	0.99	0.57	0.29	0.35	0.70
NA2O3	3.74	3.26	3.73	3.67	3.52	3.46	3.74
K2O	4.55	4.77	4.42	4.55	4.54	4.61	4.96
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	96.91	98.78	97.09	97.11	95.84	97.52	100.72
RB	312	306	361	364	312	314	305
BA	38	51	21	38	33	44	41
SR	0	0	0	0	0	0	0
PB							
CU	0	0	0	0	0	0	0
ZN	92	81	50	47	117	118	82
CO							
CR	15	27	23	22	26	27	19
NI	4	4	4	4	4	4	4
V							
ZR	562	410	643	637	804	711	640
SN							
MO							
BI							
NB							
F	1980	1360	2400	1500	2350	2550	1700
HG	11	21	21	21	21	21	21
S							

SAMPLE NO.	TH 124	TH 125	TH 126	TH 127	TH 128	TH 129	TH 130
COORDINATES	1L14 9 272	1L14 9 312	1L14 9 312	1L14 9 252	1L14 9 252	1L14 9 252	1L14 9 252
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	RED	RED	RED	RED	RED
GRAIN SIZE	CORS	CORS	CORS	MED	MED	FINE	MED
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	FRESH	FRESH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLEAR	CLEAR	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
FP:BI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	50
SIO2	76.50	74.60	74.00	76.70	76.90	78.90	79.30
TIO2	0.16	0.16	0.20	0.11	0.13	0.16	0.15
AL2O3	11.10	10.90	11.50	10.90	11.40	11.20	10.80
FE2O3	2.26	2.06	1.17	0.92	1.34	2.01	1.25
FEO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MNO	0.04	0.04	0.03	0.04	0.04	0.01	0.00
MGO	0.00	0.00	0.00	0.00	0.40	0.00	0.00
CAO	0.26	0.44	1.49	0.82	1.13	0.21	0.24
NA2O	3.44	3.54	3.65	3.68	3.72	3.48	3.72
K2O	4.87	4.82	5.00	4.65	4.76	3.53	4.45
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	98.63	96.56	97.04	97.82	99.82	99.50	99.91
RB	312	290	303	315	316	145	411
BA	47	67	47	40	40	239	50
SR	0	0	0	0	0	0	0
PB							
CU	0	0	2	0	0	0	3
ZN	100	94	29	9	10	61	14
CO							
CR	29	35	23	40	22	19	34
NI	7	6	7	90	5	11	6
V							
ZR	720	586	719	649	567	729	871
SN							
MO							
BI							
NB							
F	1650	1700	3750	1780	1900	400	2320
HG	21	11	21	43	17	21	21
S							

SAMPLE NO.	TH 131	TH 132	TH 133	TH 134	TH 135	TH 136	TH 137
COORDINATES	1L14 9 252	1L14 9 252	1L14 9 252	1L14 9 252	1L14 9 312	1L14 9 312	1L14 9 382
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	RED	RED	BUFF	BUFF	YELLOW
GRAIN SIZE	MED	CORS	MED	MED	MED	MED	CORS
TEXTURE	UNIFORM	MYRMEKITIC	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	F-MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	3	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	200
SIO2	77.00	76.60	78.70	77.00	77.20	79.00	81.90
TIO2	0.12	0.12	0.14	0.14	0.14	0.14	0.14
AL2O3	11.60	10.60	11.40	11.10	10.70	12.10	11.40
FE2O3	1.03	2.28	1.26	1.79	1.37	1.36	1.02
FEO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MNO	0.00	0.03	0.02	0.03	0.03	0.03	0.00
MGO	0.80	0.00	0.00	0.00	0.00	0.00	0.00
CAO	0.31	0.41	0.51	0.68	0.34	0.37	0.05
NA2O3	3.48	3.70	3.89	3.93	3.65	3.72	3.54
K2O	4.89	4.24	4.60	4.46	4.79	5.01	4.94
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	99.23	97.98	100.52	99.13	98.22	101.73	102.99
RB	346	244	260	271	309	317	264
BA	97	40	37	50	38	48	55
SR	0	0	0	0	0	0	0
PB							
CU	0	0	0	0	0	0	0
ZN	15	125	118	117	159	189	15
CO							
CR	24	27	29	19	24	30	27
NI	6	4	5	6	6	5	5
V							
ZR	912	548	491	479	509	478	473
SN							
MO							
BI							
NE							
F	2650	2420	2770	2700	1800	1900	300
HG	21	38	53	32	21	32	26
S							

SAMPLE NO.	TH 138	TH 139	TH 140	TH 141	TH 142	TH 143	TH 144
COORDINATES	1L14 9 382	1L14 9 372	1L14 9 372	1L14 9 282	1L14 9 282	1L14 9 382	1L14 9 382
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	YELLOW	RED	YELLOW	YELLOW	YELLOW	YELLOW	YELLOW
GRAIN SIZE	CORS	MED	CORS	MED	FINE	CORS	CORS
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	FRESH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLEAR	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	200	200	200	200	200	100	100
SIO2	81.20	77.90	80.30	77.40	78.80	78.20	78.30
TIO2	0.13	0.14	0.14	0.13	0.15	0.11	0.13
AL2O3	11.40	10.90	10.90	10.90	10.80	10.30	10.90
FE2O3	1.01	1.23	1.47	1.51	1.75	0.94	1.83
FEO	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MNO	0.01	0.03	0.02	0.02	0.02	0.00	0.01
MGO	0.00	1.10	0.00	0.80	0.10	0.00	0.90
CAO	0.20	0.86	0.11	0.20	0.18	0.52	0.00
NA2O3	3.59	3.77	3.72	3.67	3.72	3.32	3.38
K2O	5.02	4.65	4.90	4.65	4.74	4.59	5.09
P2O5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
H2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	102.56	100.58	101.56	99.28	100.26	97.98	100.54
RB	266	347	352	419	437	351	363
BA	58	37	24	19	13	48	50
SR	0	0	0	0	0	0	0
PB							
CU	0	0	0	0	0	0	0
ZN	20	51	35	69	52	17	19
CO							
CR	16	16	15	19	19	16	16
NI	6	6	6	8	5	6	7
V							
ZR	364	491	510	692	659	524	558
SN							
MO							
BI							
NE							
F	1300	2000	1800	1500	1430	940	290
HG	32	32	32	11	11	21	32
S							

MPLE NO.	TH 145	TH 146	TH 147	TH 148	TH 149	TH 150	TH 151
ORDINATES	IL14 9 292	IL14 9 292	IL14 9 462	IL14 9 462	IL14 9 462	IL14 9 482	IL14 9 482
CK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
GE	DEVCNIAN	DEVCNIAN	DEVCNIAN	DEVONIAN	DEVONIAN	DEVCNIAN	DEVONIAN
MPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
LOUR	YELLCW	YELLOW	RED	RED	RED	RED	RED
AIN SIZE	MED	MED	MED	MED	MED	CORS	V.C.
XTURE	MIARCLITIC	MIAROLITIC	UNIFORM	UNIFORM	UNIFCRM	MIAROLITIC	MIAROLITIC
RUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
LTERATICN	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH
FLDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
YSTALS	NO MEG	NC MEG	NO MEG	NO MEG	NO MEG	NO MEG	CFMEG
M:MI	0	0	0	0	1	0	0
ULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
Q.MI	180	180	180	180	180	180	180
GHT	100	100	50	50	50	50	50
IO2		77.20		77.70			
IO2		0.12		C.11			
L2O3		11.20		1C.50			
FE2O3		1.13		2.00			
FEO		0.00		C.CO			
NO		0.07		0.03			
GO		C.CO		C.40			
AO		0.24		C.22			
A2O3		3.86		3.72			
K2O		4.53		3.92			
P2O5		0.00		0.00			
H2O		C.CO		0.00			
TCTAL		98.35		98.60			
RB	344	343		263	310	324	297
BA	46	58		57	43	55	29
SR	0	0		0	0	0	0
PB							
CU	0	0		0	0	0	0
ZN	21	34		52	45	13	7
CO							
CR	16	19		15	19	17	17
NI	6	5		5	6	6	7
V							
ZR	516	509		548	576	450	517
SN							
MO							
BI							
NB							
F	600	1300		680	140	2200	200
HG	11	0		43	43	21	21
S							

SAMPLE NO.	TH 152	TH 153	TH 154	TH 155	TH 156	TH 157	TH 158
COORDINATES	1L14 9 502	1L14 9 502	1L14 9 532	1L14 9 532	1L14 9 562	1L14 9 562	1L14 9 602
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	RED	RED	RED	RED	RED
GRAIN SIZE	CORS	MED	CORS	CORS	MED	MED	MED
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
FM:MI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	50
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O							
K2O							
P2O5							
H2O							
TOTAL							
RB	374	336	327	341	327	320	363
BA	47	56	51	50	55	50	81
SR	0	0	0	0	0	0	0
PB							
CU	0	0	0	0	0	0	0
ZN	21	22	39	32	25	16	92
CO							
CR	20	22	18	15	16	20	17
NI	5	5	4	7	5	6	5
V							
ZR	573	503	505	610	505	612	621
SN							
MO							
BI							
NF							
F	1600	280	1600	2400	1500	2900	2910
HG	43	11	21	53	43	21	32
S							

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SAMPLE NO.	TH 159	TH 160	TH 161	TH 162	TH 163	TH 164	TH 165
COORDINATES	1L14 9 602	1L14 9 622	1L14 9 622	1L14 9 642	1L14 9 642	1L14 9 662	1L14 9 662
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	BUFF	RED	RED	RED	RED	RED
GRAIN SIZE	MED	MED	MED	MED	MED	CORS	MED
TEXTURE	UNIFORM	UNIFORM	CATACLAST	CATACLAST	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	FRESH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLEAR	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
FD:MI	0	0	00	0	0	0	0
SULF.	ABSENT	ABSENT	XXXXXX	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	50
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB	365	378	319				
BA	72	35	46				
SR	0	0	0				
PB							
CU	0	0	0				
ZN	76	126	81				
CO							
CR	22	19	17				
NI	4	5	5				
V							
ZR	506	340	400				
SN							
MO							
BI							
NB							
F	1600	1200	1630				
HG	86	21	86				
S							

SAMPLE NO.	TH 166	TH 167	TH 168	TH 169	TH 170	TH 171	TH 172
COORDINATES	1L14 9 662	1L14 9 662	1L14 9 652	1L14 9 652	1L14 9 632	1L14 9 632	1L14 9 752
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	RED	RED	RED	RED	RED
GRAIN SIZE	MED	MED	CORS	CORS	CORS	CORS	V.F.
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	MIAROLITIC
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	FRESH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLEAR
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	50
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB							
BA							
SR							
PB							
CU							
ZN							
CO							
CR							
NI							
V							
ZR							
SN							
MO							
BI							
NB							
F							
HG							
S							

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SAMPLE NO.	TH 173	TH 174	TH 175	TH 176	TH 177	TH 178	TH 179
COORDINATES	1L14 9 752	1L14 9 762	1L14 9 762	1L14 9 782	1L14 9 782	1L14 9 852	1L14 9 852
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	RED	RED	RED	RED	RED
GRAIN SIZE	V.F.	MED	MED	MED	FINE	CORS	CORS
TEXTURE	MIAROLITIC	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	FRESH	WEATH	FRESH	WEATH	FRESH	FRESH	FRESH
FELDSPARS	CLEAR	CLOUDY	CLEAR	CLOUDY	CLEAR	CLEAR	CLEAR
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
FBIPI	0	0	0	0	0	1	1
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	50
SIO2	*	*	*	*	*	*	*
TIO2	*	*	*	*	*	*	*
AL2O3	*	*	*	*	*	*	*
FE2O3	*	*	*	*	*	*	*
FEO	*	*	*	*	*	*	*
MNO	*	*	*	*	*	*	*
MGO	*	*	*	*	*	*	*
CAO	*	*	*	*	*	*	*
NA2O3	*	*	*	*	*	*	*
K2O	*	*	*	*	*	*	*
P2O5	*	*	*	*	*	*	*
H2O	*	*	*	*	*	*	*
TOTAL	*	*	*	*	*	*	*
RB	*	*	*	*	*	*	*
BA	*	*	*	*	*	*	*
SR	*	*	*	*	*	*	*
PB	*	*	*	*	*	*	*
CU	*	*	*	*	*	*	*
ZN	*	*	*	*	*	*	*
CO	*	*	*	*	*	*	*
CR	*	*	*	*	*	*	*
NI	*	*	*	*	*	*	*
V	*	*	*	*	*	*	*
ZR	*	*	*	*	*	*	*
SN	*	*	*	*	*	*	*
MO	*	*	*	*	*	*	*
BI	*	*	*	*	*	*	*
NB	*	*	*	*	*	*	*
F	*	*	*	*	*	*	*
HG	*	*	*	*	*	*	*
[illegible]	*	*	*	*	*	*	*

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SAMPLE NO.	TH 180	TH 181	TH 182	TH 183	TH 184	TH 185	TH 186
COORDINATES	1L14 9 832	1L14 9 832	1L14 9 782	1L14 9 782	1L14 9 672	1L14 9 672	1L14 9 741
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVCNIAN	DEVCNIAN	DEVCNIAN	DEVCNIAN	DEVONIAN	DEVCNIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	YELLOW	YELLCW	YELLCW	YELLOW	YELLOW	RED	RED
GRAIN SIZE	MED	MED	CORS	CORS	CORS	MED	V.F.
TEXTURE	UNIFCRM	UNIFORM	UNIFORM	UNIFORM	UNIFCRM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	FRESH	FRESH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLEAR	CLEAR
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	100	100	100
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB							
BA							
SR							
PB							
CU							
ZN							
CO							
CR							
NI							
V							
ZR							
SN							
MO							
BI							
NE							
F							
HG							
S							

ST. LAWRENCE

SAMPLE NO.		TH 187	TH 188	TH 189	TH 190	TH 191	TH 192
COORDINATES		1L14 9 741	1L14 9 751	1L14 9 751	1L14 9 781	1L14 9 781	1L14 9 791
ROCK TYPE		QTZ. PORPH	QTZ. PORPH	GRANITE	GRANITE	GRANITE	GRANITE
AGE		DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE		GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR		RED	RED	RED	RED	RED	RED
GRAIN SIZE		APH	APH	FINE	FINE	FINE	FINE
TEXTURE		MEGACRYST	MEGACRYST	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE		MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION		FRESH	FRESH	WEATH	FRESH	FRESH	FRESH
FELDSPARS		CLEAR	CLEAR	CLOUDY	CLEAR	CLEAR	CLEAR
CRYSTALS		QFMEG	QFMEG	NO MEG	NO MEG	NO MEG	NO MEG
FE:SI		0	1	0	0	0	0
SULF.		ABSENT	PRESEN	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI		180	180	180	180	180	180
HGHT		100	100	100	50	50	50
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
AR	339	431	153	284	295	305	2
BA	28	43	68	39	38	37	126
SR	0	0	0	0	0	0	0
PB							
CU	0	45	185	0	0	0	0
ZN	64	52	46	35	21	19	16
CO							
CR	16	18	16	17	14	14	18
NI	4	7	7	5	5	5	8
V							
ZR	162	314	292	161	167	167	139
SN							
MO							
BI							
NB							
F	160	120	120	0	1200	1100	700
HG	11	43	21	21	128	67	32
S							

SAMPLE NO.	TH 193	TH 194	TH 195	TH 196	TH 197	TH 198	TH 199
COORDINATES	1L14 9 791	1L14 9 791	1L14 9 831	1L14 9 831	1L14 9 821	1L14 9 821	1L14 9 841
ROCK TYPE	QTZ. PORPH	QTZ. PORPH	GRANITE	GRANITE	QTZ. PORPH	QTZ. PORPH	QTZ. PORPH
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	YELLOW	YELLOW	RED	RED	RED	RED	RED
GRAIN SIZE	V.F.	V.F.	V.F.	V.F.	V.F.	V.F.	V.F.
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	FRESH	FRESH	FRESH	FRESH	FRESH	FRESH	FRESH
FELDSPARS	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	0	0	C	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	50
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB	61	152	328	253	344		308
BA	39	50	44	35	40		33
SR	0	0	0	0	0		0
PB							
CU	0	0	0	0	0		0
ZN	22	18	13	22	48		24
CO							
CR	17	18	14	19	15		15
NI	7	5	6	6	6		5
V							
ZR	175	171	812	173	156		157
SN							
MO							
BI							
NB							
F	170	190	100	0	110		280
HG	21	21	21	11	21		21
S							

SAMPLE NO.	TH 200	TH 201	TH 202	TH 203	TH 204	TH 205	TH 206
COORDINATES	1L14 9 841	1L14 9 891	1L14 9 891	1L14 9 891	1L14 9 921	1L14 9 921	1L14 0 052
ROCK TYPE	QTZ. PORPH	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	RED	RED	RED	RED	RED
GRAIN SIZE	V.F.	V.F.	V.F.	V.F.	FINE	FINE	FINE
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	FRESH	WEATH	FRESH	FRESH	FRESH	FRESH	FRESH
FELDSPARS	CLEAR	CLOUDY	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	50	200
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB	364	282	321	327	264	242	280
BA	49	26	43	30	86	81	47
SR	0	0	0	0	0	0	0
PB							
CU	0	0	4	0	8	11	0
ZN	40	9	25	27	16	18	23
CO							
CR	15	17	17	14	19	16	17
NI	4	7	5	4	5	6	5
V							
ZR	155	519	315	161	320	307	1050
SN							
MO							
BI							
NB							
F	0	110	1250	1550	1880	2200	570
HG	67	67	171	43	86	43	21
S							

ST. LAWRENCE

MPLE NO.	TH 207	TH 208	TH 209	TH 210	TH 211	TH 212	TH 213
RDINATES	1L14 0 052	1L14 0 052	1L14 0 072	1L14 0 072	1L14 0 072	1L14 0 062	1L14 0 062
CK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
GE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
MPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
LOUR	RED	RED	RED	RED	RED	YELLOW	RED
AIN SIZE	MED	MED	FINE	FINE	MED	MED	MED
XTURE	MEGACRYST	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	MIAROLITIC
RUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
TERATION	FRESH	WEATH	FRESH	FRESH	WEATH	WEATH	WEATH
LDSPARS	CLOUDY	CLOUDY	CLOUDY	CLEAR	CLOUDY	CLOUDY	CLOUDY
YSTALS	F-MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
:NI	0	1	2	0	1	0	1
ULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
L.MI	180	180	180	180	180	180	180
GHT	200	200	200	200	200	150	150
IO2							
IO2							
L2O3							
E2O3							
EO							
NO							
GO							
AO							
A2O3							
2O							
2O5							
2O							
OTAL							
P	473	401		123	227	286	305
A	31	34		67	86	29	36
P	0	0		0	0	0	0
B							
U	0	0		0	0	0	0
N	25	27		22	56	60	88
C							
R	15	18		17	18	23	16
I	4	7		6	6	5	6
V							
O	696	1287		1001	609	547	674
N							
O							
I							
E							
F	680	330		320	1100	160	740
G	21	11		11	21	43	86
S							

ST. LAWRENCE

SAMPLE NO.	TH 214	TH 215	TH 216	TH 217	TH 218	TH 219	TH 220
COORDINATES	1L14 0 042	1L14 0 042	1L14 9 992	1L14 9 992	1L14 9 972	1L14 9 972	1L14 0 112
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	YELLOW	YELLOW	BUFF	BUFF	BUFF	BUFF	YELLOW
GRAIN SIZE	MED	MED	FINE	FINE	FINE	FINE	MED
TEXTURE	MIAROLITIC	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
FR:BI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI	180	180	180	180	180	180	180
FCFT	150	150	100	100	100	100	200
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB	277	295	305	293	273	312	258
BA	35	31	25	16	22	14	26
SR	0	0	0	0	0	0	0
PB							
CU	0	0	0	0	0	0	0
ZN	55	57	10	11	12	22	13
CO							
CR	16	16	17	19	17	17	17
NI	5	5	6	6	6	5	5
V							
ZR	491	525	608	651	610	571	501
SN							
MO							
BI							
NB							
F	820	660	200	180	130	130	280
HG	43	53	86	43	21	21	21
S							

ST. LAWRENCE

SAMPLE NO.	TH 221	TH 222	TH 223	TH 224	TH 225	TH 226	TH 227
COORDINATES	1L14 0 112	1L14 0 072	1L14 0 072	1L14 0 052	1L14 0 052	1L14 0 002	1L14 0 002
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	BUFF	RED	RED	YELLOW	YELLOW	YELLOW	YELLOW
GRAIN SIZE	MED	MED	MED	FINE	FINE	MED	MED
TEXTURE	UNIFORM	UNIFORM	UNIFORM	MIAROLITIC	MIAROLITIC	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
FF:MI	1	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI	180	180	180	180	180	180	180
HGHT	200	150	150	150	150	100	100
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB	339	276	312		195	294	307
BA	20	51	20		30	40	25
SR	0	0	0		0	0	0
PB							
CU	2	0	3		0	0	0
ZN	28	44	27		13	37	16
CO							
CR	15	17	17		19	16	15
NI	6	5	5		6	5	4
V							
ZR	672	578	685		486	530	444
SN							
MO							
BI							
NB							
F	740	260	2200		120	600	640
HG	86	21	53		11	21	21
S							

ST. LAWRENCE

SAMPLE NO.	TH 228	TH 229	TH 230	TH 231	TH 232	TH 234	TH 233
COORDINATES	1L14 9 932	1L14 9 932	1L14 9 902	1L14 9 902	1L14 9 872	1L14 9 812	1L14 9 872
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	YELLOW	RED	YELLOW	YELLOW	RED	YELLOW	RED
GRAIN SIZE	MED	MED	MED	MED	CORS	FINE	MED
TEXTURE	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	CATACLAST	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SO.MI	180	180	180	180	180	180	180
HGHT	50	50	50	50	50	250	50
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB	300	294	304	259	316		310
BA	32	26	29	43	33		34
SR	0	0	0	0	0		0
PB							
CU	0	0	0	0	0		0
ZN	23	20	28	22	56		82
CO							
CR	19	19	17	21	17		18
NI	3	5	4	5	5		5
V							
ZR	452	557	422	624	634		542
SN							
MO							
BI							
NB							
F	210	400	110	800	1180		1850
HG	11	128	32	11	11		11
S							

ST. LAWRENCE

SAMPLE NO.	TH 235	TH 236	TH 237	TH 238	TH 239	TH 240	TH 241
COORDINATES	1L14 9 812	1L14 9 831	1L14 9 831	1L14 9 881	1L14 9 881	1L14 0 582	1L14 0 582
ROCK TYPE	GRANITE	GRANITE	GRANITE	QTZ. PORPH	QTZ. PORPH	GRANITE	GRANITE
AGE	DEVCNIAN	DEVCNIAN	DEVONIAN	DEVCNIAN	DEVCNIAN	DEVCNIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	YELLOW	RED	RED	BUFF	BUFF	BUFF	RED
GRAIN SIZE	FINE	MED	MED	V.F.	V.F.	MED	V.F.
TEXTURE	CATACLAST	UNIFORM	UNIFORM	MEGACRYST	MEGACRYST	UNIFORM	MIAROLITIC
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	FRESH	FRESH	FRESH	FRESH	WEATH	WEATH
FELDSPARS	CLOUDY	CLEAR	CLEAR	CLEAR	CLEAR	CLOUDY	CLOUDY
CRYSTALS	NO MEG	QFMEG	NO MEG	QFMEG	QFMEG	NO MEG	NO MEG
FE:TI	0	C	0	C	0	1	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	250	300	300	100	100	450	450
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB	292	266					
BA	17	59					
SR	0	0					
PB							
CU	0	0					
ZN	61	40					
CO							
CR	17	16					
NI	5	7					
V							
ZR	709	954					
SN							
MO							
BI							
NB							
F	120	0					
HG	86	21					
S							

ST. LAWRENCE

AMPLE NO.	TH 242	TH 243	TH 244	TH 245	TH 246	TH 247	TH 248
COORDINATES	1L14 0 582	1L14 0 562	1L14 0 532	1L14 0 532	1L14 0 502	1L14 0 502	1L14 0 472
OCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
GE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
AMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
OLOUR	RED	RED	RED	RED	RED	RED	RED
RAIN SIZE	FINE	MED	MED	MED	MED	MED	MED
TEXTURE	MIAROLITIC	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	FRESH	FRESH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLEAR	CLEAR	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
[illegible]	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	450	450	450	450	400	400	400
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB							
BA							
SR							
PB							
CU							
ZN							
CO							
CR							
NI							
V							
ZR							
SN							
MO							
BI							
NB							
F							
HG							
S							

ST. LAWRENCE

SAMPLE NO.	TH 249	TH 250	TH 251	TH 252	TH 253	TH 254	TH 255
COORDINATES	1L14 0 472	1L14 0 462	1L14 0 462	1L14 0 382	1L14 0 382	1L14 0 352	1L14 0 352
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	RED	BUFF	YELLOW	RED	BUFF	BUFF
GRAIN SIZE	MED	V.F.	V.F.	MED	MED	FINE	MED
TEXTURE	UNIFORM	UNIFORM	CATACLAST	UNIFORM	UNIFORM	MIAROLITIC	MIAROLITIC
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	HYDRUS	WEATH	WEATH	WEATH	WEATH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY
CRYSTALS	NO MEG	NO MEG	Q-MEG	NO MEG	NO MEG	NO MEG	NO MEG
FR:GI	0	0	0	1	1	0	0
SULF.	ABSENT	ABSENT	PRESEN	ABSENT	ABSENT	ABSENT	ABSENT
SC.HI	180	180	180	180	180	180	180
HGHT	400	350	350	300	300	350	350
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB							
BA							
SR							
PB							
CU							
ZN							
CO							
CR							
NI							
V							
ZR							
SN							
MO							
BI							
NE							
F							
HG							
S							

ST. LAWRENCE

SAMPLE NO.	TH 256	TH 257	TH 258	TH 259	TH 260	TH 261	TH 262
COORDINATES	1M3 0 682	1M3 0 682	1M3 0 682	1M3 0 702	1M3 0 702	1M3 0 702	1M3 0 732
ROCK TYPE	GRANITE	BASALT	GRANITE	GRANITE	GRANODIORITE	GRANITE	GRANITE
AGE	DEVONIAN	PALEOZOIC	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	BUFF	GREY	RED	BUFF	GREY	GREY	RED
GRAIN SIZE	MED	V.F.	FINE	V.F.	V.F.	V.F.	V.F.
TEXTURE	MIAROLITIC	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	FRESH	WEATH	FRESH	FRESH	FRESH	FRESH
FELDSPARS	CLOUDY	CLEAR	CLOUDY	CLEAR	CLEAR	CLEAR	CLEAR
CRYSTALS	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG	NO MEG
FE:BI	0	0	0	0	5	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	780	180	180	180	180	180
HGHT	600	600	600	650	550	550	750
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB							
BA							
SR							
PB							
CU							
ZN							
CO							
CR							
NI							
V							
ZR							
SN							
MO							
BI							
NB							
F							
HG							
S							

ST. LAWRENCE

SAMPLE NO.	TH 263	TH 264	TH 265	TH 266	TH 267	TH 268	TH 269
COORDINATES	1M3 0 732	1M3 0 742	1M3 0 772	1M3 0 772	1M3 0 672	1M3 0 672	1114 0 622
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	QTZ. PORPH
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	RED	GREY	BLACK	BLACK	RED	RED	RED
GRAIN SIZE	V.F.	MED	FINE	MED	APH	FINE	V.F.
TEXTURE	UNIFORM	UNIFORM	VARIABLE	UNIFORM	CATACLAST.	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	FRESH	FRESH	WEATH	FRESH	FRESH	FRESH	FRESH
FELDSPARS	CLEAR	CLEAR	CLOUDY	CLEAR	CLEAR	CLEAR	CLEAR
CRYSTALS	NO MEG	NO MEG	QFMEG	NO MEG	NO MEG	NO MEG	NO MEG
HB:BI	0	0	0	0	0	0	0
SULF.	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SC.MI	180	180	180	180	180	180	180
HGHT	750	750	700	700	450	450	450
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O							
K2O							
P2O5							
H2O							
TOTAL							
RB							
BA							
SR							
PB							
CU							
ZN							
CO							
CR							
NI							
V							
ZR							
SN							
MO							
BI							
NB							
F							
HG							
S							

ST. LAWRENCE

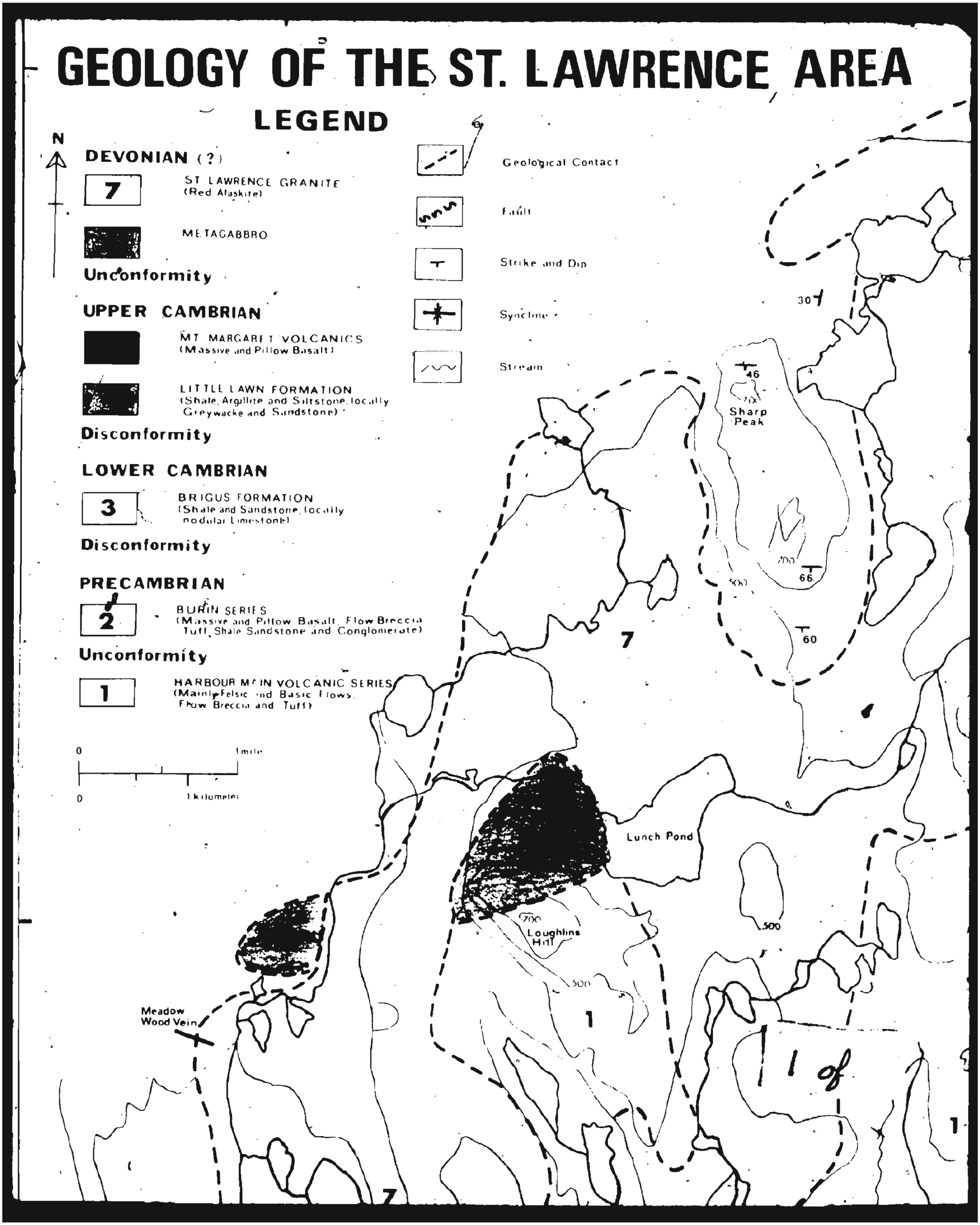
SAMPLE NO.	TH 270	TH 271	TH 272	TH 273	TH 274	TH 275	TH 276
COORDINATES	1L14 C 572	1L14 0 532	1L14 0 532	1L14 C 462	1L14 0 462	1L14 0 031	1L14 0 031
ROCK TYPE	GRANITE	GRANITE	GRANITE	GRANITE	GRANITE	QTZ. PORPH	QTZ. PORPH
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	BUFF	BUFF	BUFF	GREEN	BUFF	YELLOW	RED
GRAIN SIZE	FINE	FINE	FINE	V.F.	MED	V.F.	V.F.
TEXTURE	CATACLAST	CATACLAST	CATACLAST	UNIFORM	UNIFORM	UNIFORM	MEGACRYST
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	WEATH	WEATH	WEATH	WEATH	WEATH	FRESH
FELDSPARS	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLOUDY	CLEAR
CRYSTALS	NO MEG	NC MEG	NO MEG	F-MEG	NO MEG	OFMEG	CFMEG
MF:MI	0	1	0	1	1	0	C
SULF.	ABSENT	PRESEN	ABSENT	PRESEN	PRESEN	ABSENT	APSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	550	500	500	500	500	200	200
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB							
BA							
SR							
PB							
CU							
ZN							
CO							
CR							
NI							
V							
ZR							
SN							
MO							
BI							
NB							
F							
HG							
S							

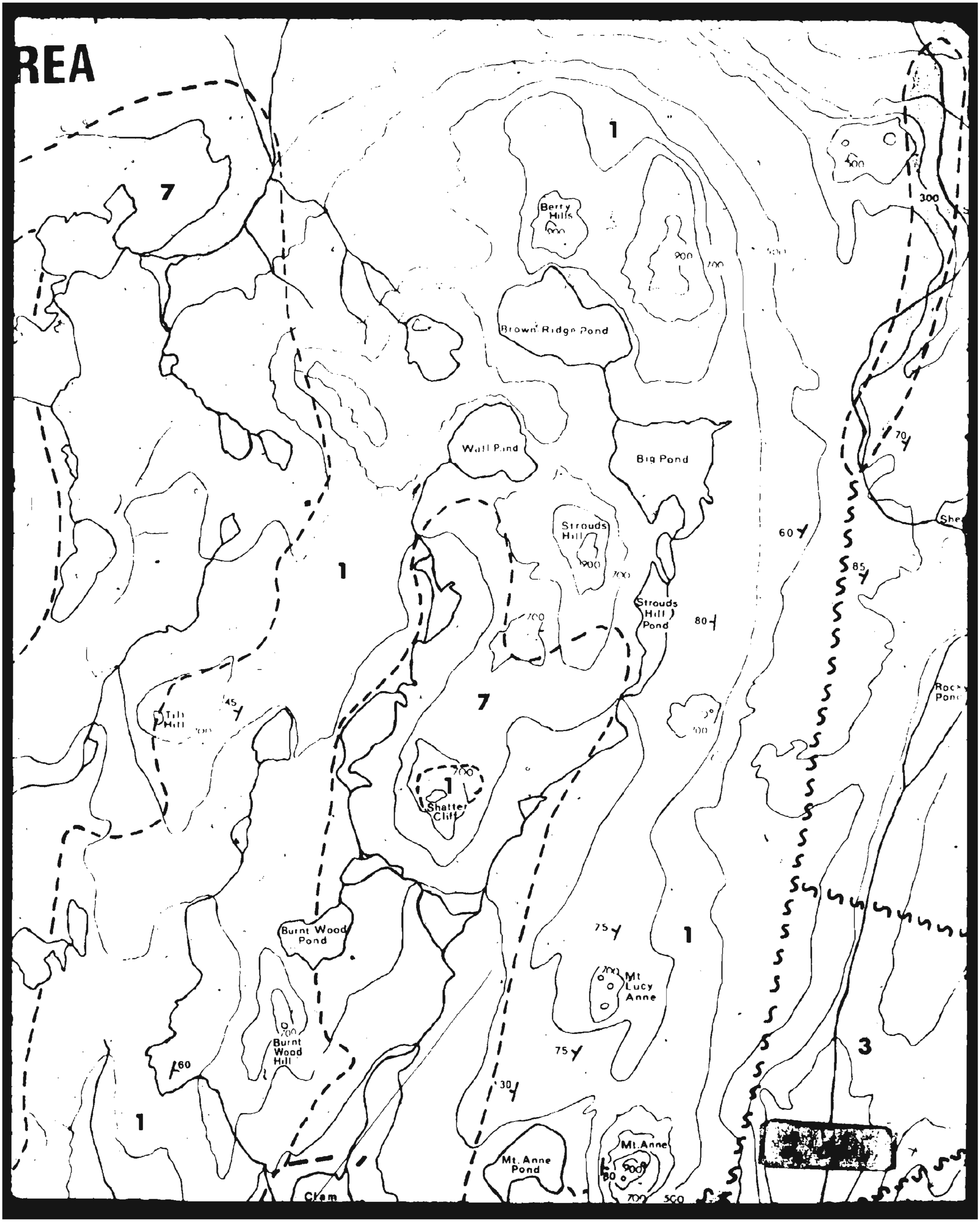
ST. LAWRENCE

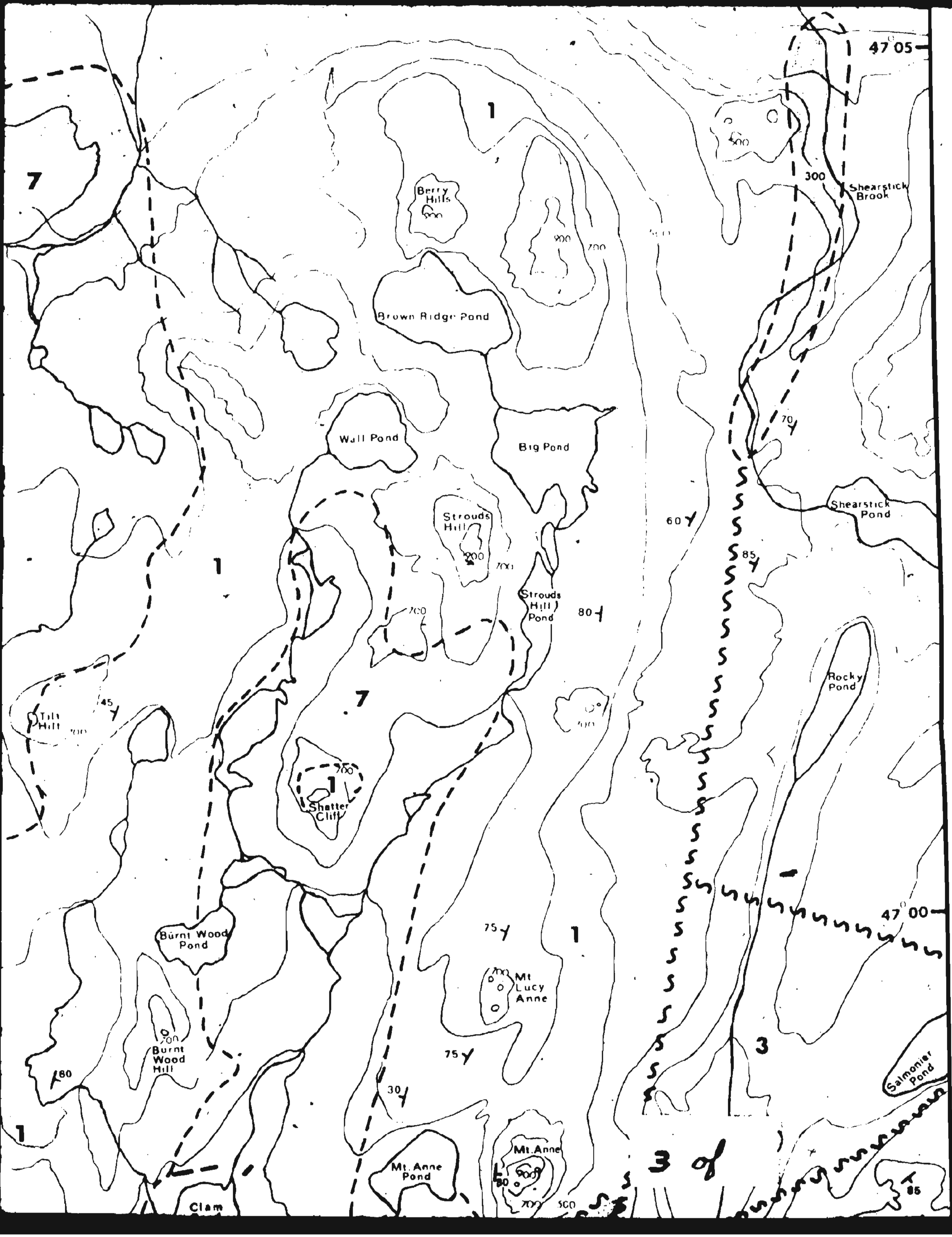
SAMPLE NO.	TH 277	TH 278	TH 279	TH 280	TH 281	TH 282	TH 283
COORDINATES	1L14 0 011	1L14 0 001	1L14 0 001	1L14 9 991	1L14 9 991	1L14 0 001	1L14 0 001
ROCK TYPE	GRANITE	QTZ. PORPH	QTZ. PORPH	GRANITE	GRANITE	QTZ. PORPH	QTZ. PORPH
AGE	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB	GRAB
COLOUR	GREY	RED	RED	RED	RED	RED	RED
GRAIN SIZE	V.F.	V.F.	V.F.	MED	FINE	V.F.	V.F.
TEXTURE	VARIABLE	UNIFORM	MEGACRYST	UNIFORM	UNIFORM	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE	MASSIVE
ALTERATION	WEATH	FRESH	FRESH	WEATH	FRESH	FRESH	FRESH
FELDSPARS	CLOUDY	CLEAR	CLEAR	CLOUDY	CLEAR	CLEAR	CLEAR
CRYSTALS	NO MEG	QFMEG	Q-MEG	NO MEG	QFMEG	QFMEG	QFMEG
FE:BI	0	0	0	0	0	0	0
SULF.	PRESEN	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT
SQ.MI	180	180	180	180	180	180	180
HGHT	200	200	200	150	150	100	100
SIO2							
TIO2							
AL2O3							
FE2O3							
FEO							
MNO							
MGO							
CAO							
NA2O3							
K2O							
P2O5							
H2O							
TOTAL							
RB							
BA							
SR							
PB							
CU							
ZN							
CO							
CR							
NI							
V							
ZR							
SN							
MO							
BI							
NB							
F							
HG							
S							

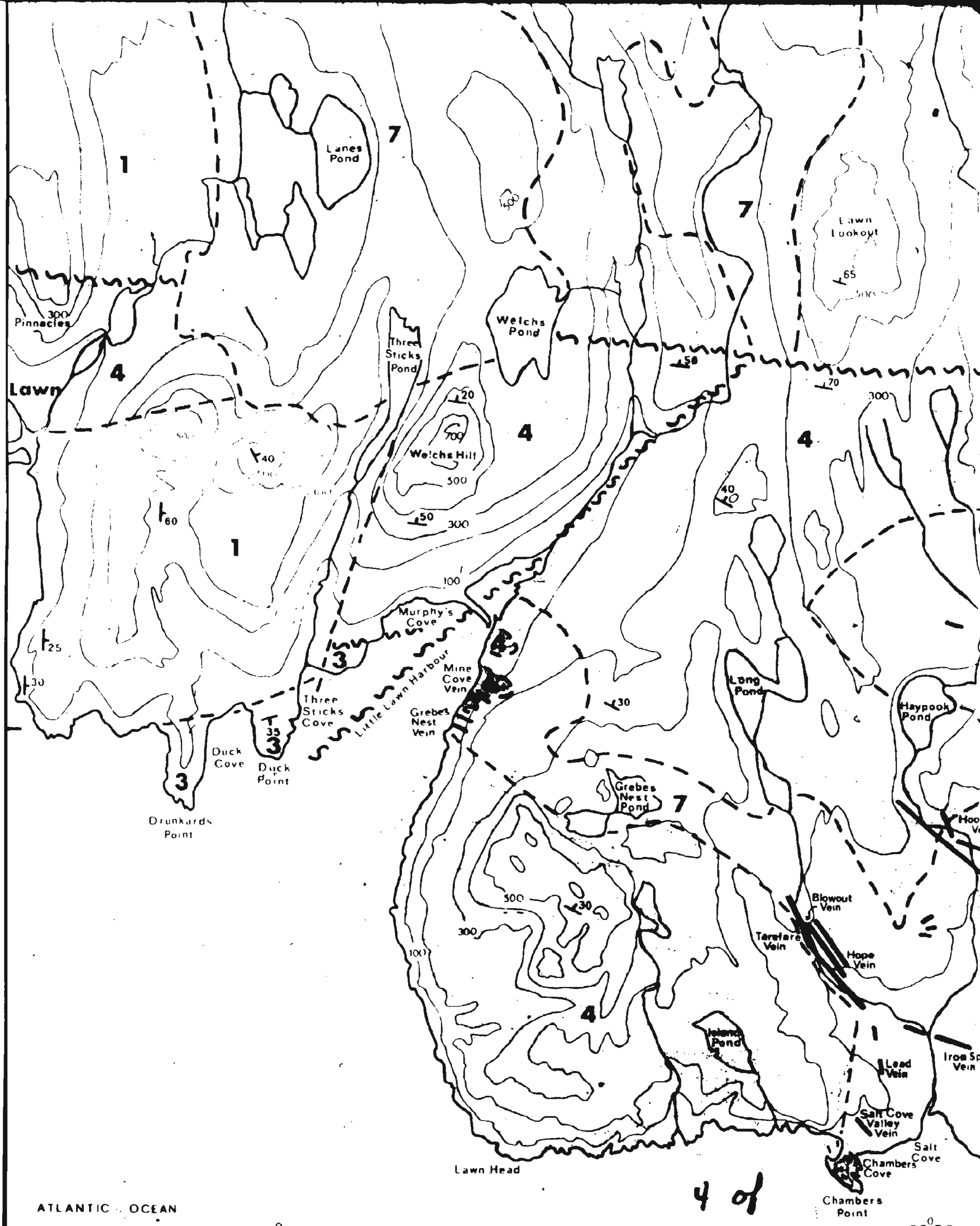
ST. LAWRENCE

SAMPLE NO.	TH 284	TH 285
COORDINATES	1L14 9 971	1L14 9 971
ROCK TYPE	GRANITE	GRANITE
AGE	DEVONIAN	DEVONIAN
SAMPLE TYPE	GRAB	GRAB
COLOUR	RED	RED
GRAIN SIZE	V.F.	V.F.
TEXTURE	UNIFORM	UNIFORM
STRUCTURE	MASSIVE	MASSIVE
ALTERATION	FRESH	FRESH
FELDSPARS	CLEAR	CLEAR
CRYSTALS	Q-MEG	Q-MEG
FE:MI	0	0
SULF.	ABSENT	ABSENT
SQ.MI	180	180
HGHT	50	50
SIO2		
TIO2		
AL2O3		
FE2O3		
FEO		
MNO		
MGO		
CAO		
NA2O3		
K2O		
P2O5		
H2O		
TOTAL		
RB		
BA		
SR		
PB		
CU		
ZN		
CO		
CR		
NI		
V		
ZR		
SN		
MO		
BI		
NB		
F		
HG		
S		


GEOLOGY OF THE ST. LAWRENCE AREA
LEGEND
N
DEVONIAN (?)
7
ST LAWRENCE GRANITE
(Red Alaskite)
METAGABBRO
Unconformity
UPPER CAMBRIAN
MT MARGARET VOLCANICS
(Massive and Pillow Basalt)
LITTLE LAWN FORMATION
(Shale, Argillite and Siltstone, locally Greywacke and Sandstone)
Disconformity
LOWER CAMBRIAN
3
BRIGUS FORMATION
(Shale and Sandstone, locally nodular Limestone)
Disconformity
PRECAMBRIAN
2
BURIN SERIES
(Massive and Pillow Basalt, Flow Breccia, Tuff, Shale, Sandstone and Conglomerate)
Unconformity
1
HARBOUR MAIN VOLCANIC SERIES
(Mainly Felsic and Basic Flows, Flow Breccia and Tuff)
0
1 mile
0
1 kilometer
Geological Contact
Fault
Strike and Dip
Syncline
Stream
30
46
70
Sharp Peak
700
66
500
60
7
Lunch Pond
700
Loughlins Hill
500
500
1
Meadow Wood Vein
1
7


REA
1
7
Berry Hills
900
700
Brown Ridge Pond
Wall Pond
Big Pond
Strouds Hill
Strouds Hill Pond
60
80
85
70
300
Till Hill
45
7
Shatter Cliff
1
Burnt Wood Pond
Burnt Wood Hill
60
75
30
Mt Lucy Anne
3
Mt. Anne Pond
Mt. Anne
500


47 05
47 00
Berry Hills
Brown Ridge Pond
Wall Pond
Big Pond
Strouds Hill
Strouds Hill Pond
Shearstick Brook
Shearstick Pond
Rocky Pond
Tilt Hill
Shatter Cliff
Burnt Wood Pond
Burnt Wood Hill
Mt Lucy Anne
Mt. Anne
Mt. Anne Pond
Salmonier Pond
Clam
3 of


Lanes Pond
7
1
Lawn Lookout
65
500
7
Welchs Pond
Three Sticks Pond
300
Pinnacles
4
Lawn
50
70
300
20
700
Welchs Hill
4
4
40
60
1
500
50
300
40
100
Murphy's Cove
25
30
3
Mine Cove Vein
Three Sticks Cove
Little Lawn Harbour
Grebes Nest Vein
30
Long Pond
Haypook Pond
35
3
Duck Cove
Duck Point
3
Drunkards Point
Grebes Nest Pond
7
500
30
300
100
Blowout Vein
Tarefare Vein
Hope Vein
4
Island Pond
Lead Vein
Iron Sp Vein
Salt Cove Valley Vein
Salt Cove
Chambers Cove
Chambers Point
Lawn Head
ATLANTIC OCEAN
55°25

4 of

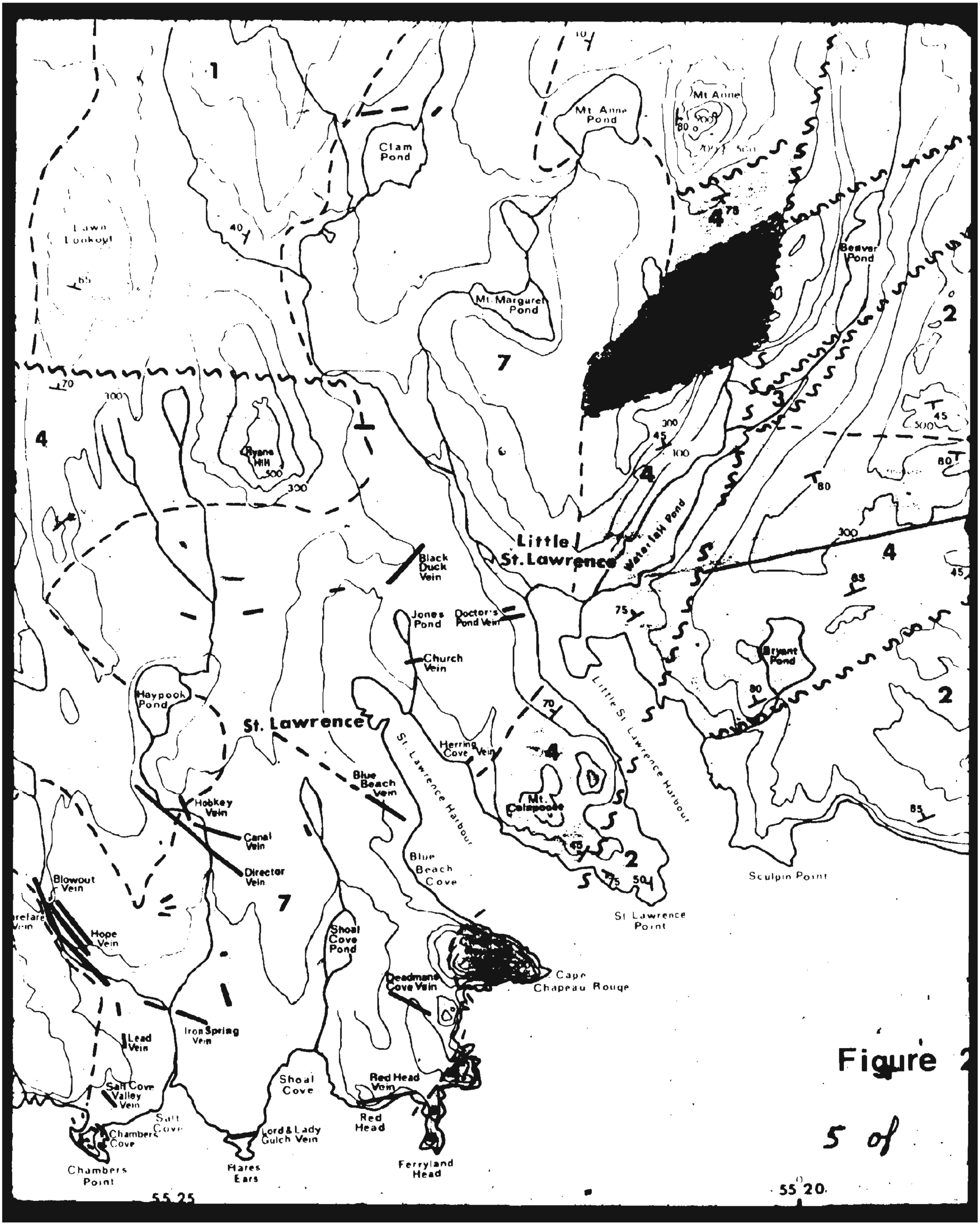

Mt Anne
Mt. Anne Pond
Clam Pond
Lawn Lookout
Mt. Margaret Pond
Beaver Pond
Ryans Hill
Little St. Lawrence
Waterfall Pond
Black Duck Vein
Jones Pond
Doctor's Pond Vein
Church Vein
Haypook Pond
St. Lawrence
St. Lawrence Harbour
Little St. Lawrence Harbour
Bryant Pond
Herring Cove Vein
Mt. Calapoose
Blue Beach Vein
Hobkey Vein
Canal Vein
Director Vein
Blowout Vein
Hope Vein
Blue Beach Cove
Sculpin Point
St Lawrence Point
Shoal Cove Pond
Cape Chapeau Rouge
Deadmans Cove Vein
Lead Vein
Iron Spring Vein
Salt Cove Valley Vein
Shoal Cove
Red Head Vein
Salt Cove
Chambers Cove
Lord & Lady Gulch Vein
Red Head
Chambers Point
Hares Ears
Ferryland Head
55 25
55 20
1
2
3
4
7
300
500
100

Figure 2

5 of

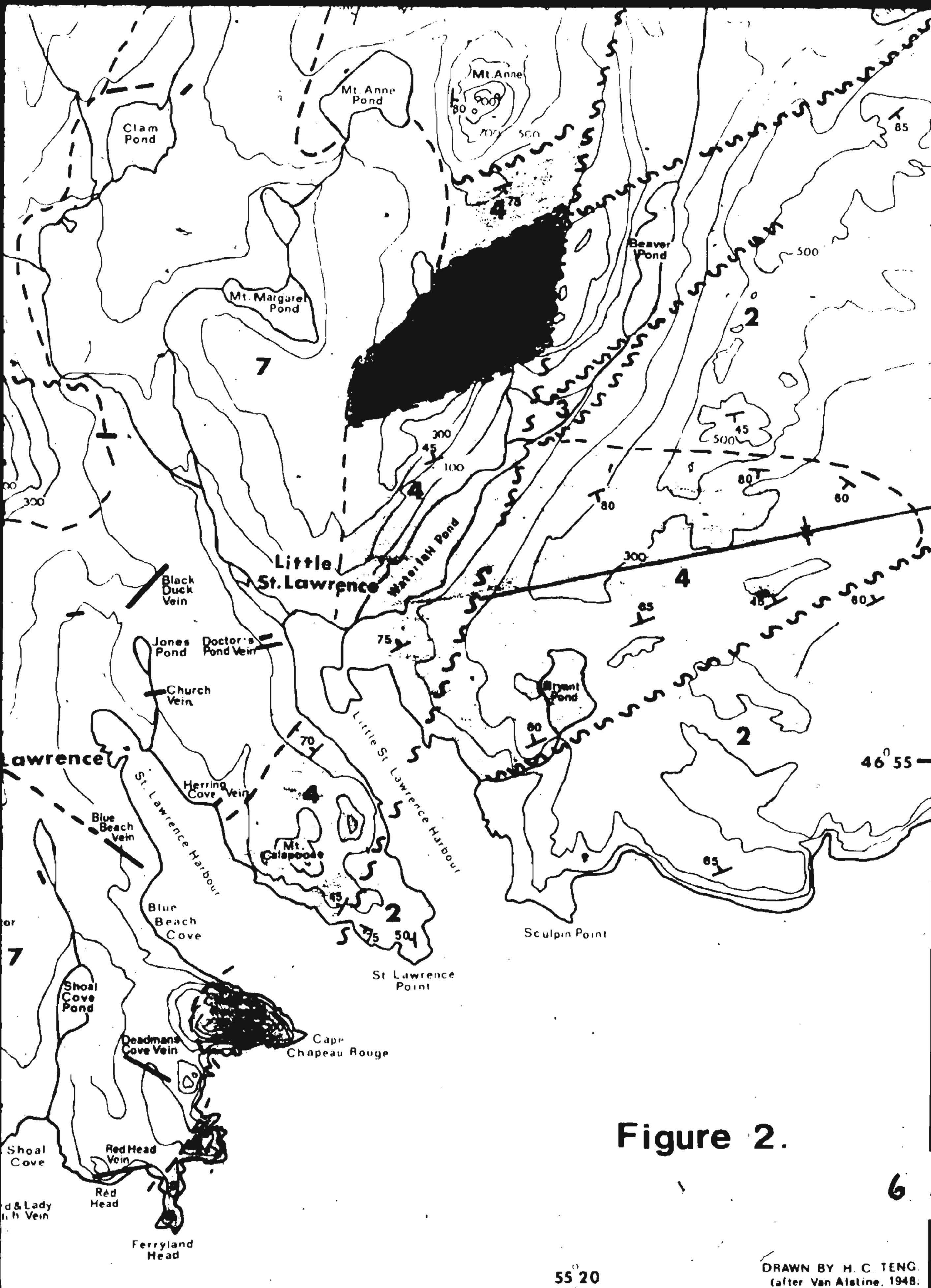

Mt. Anne
Mt. Anne Pond
Clam Pond
Mt. Margaret Pond
Beaver Pond
Little St. Lawrence
Waterfall Pond
Black Duck Vein
Jones Pond
Doctor's Pond Vein
Church Vein
Bryant Pond
Lawrence
St. Lawrence Harbour
Little St. Lawrence Harbour
Herring Cove Vein
Blue Beach Vein
Mt. Calapooce
Blue Beach Cove
Sculpin Point
St. Lawrence Point
Shoal Cove Pond
Deadmans Cove Vein
Cape Chapeau Rouge
Shoal Cove
Red Head Vein
Red Head
Ferryland Head
46°55
55°20
DRAWN BY H. C. TENG
(after Van Alstine, 1948; Williamson, 1958)

Figure 2.

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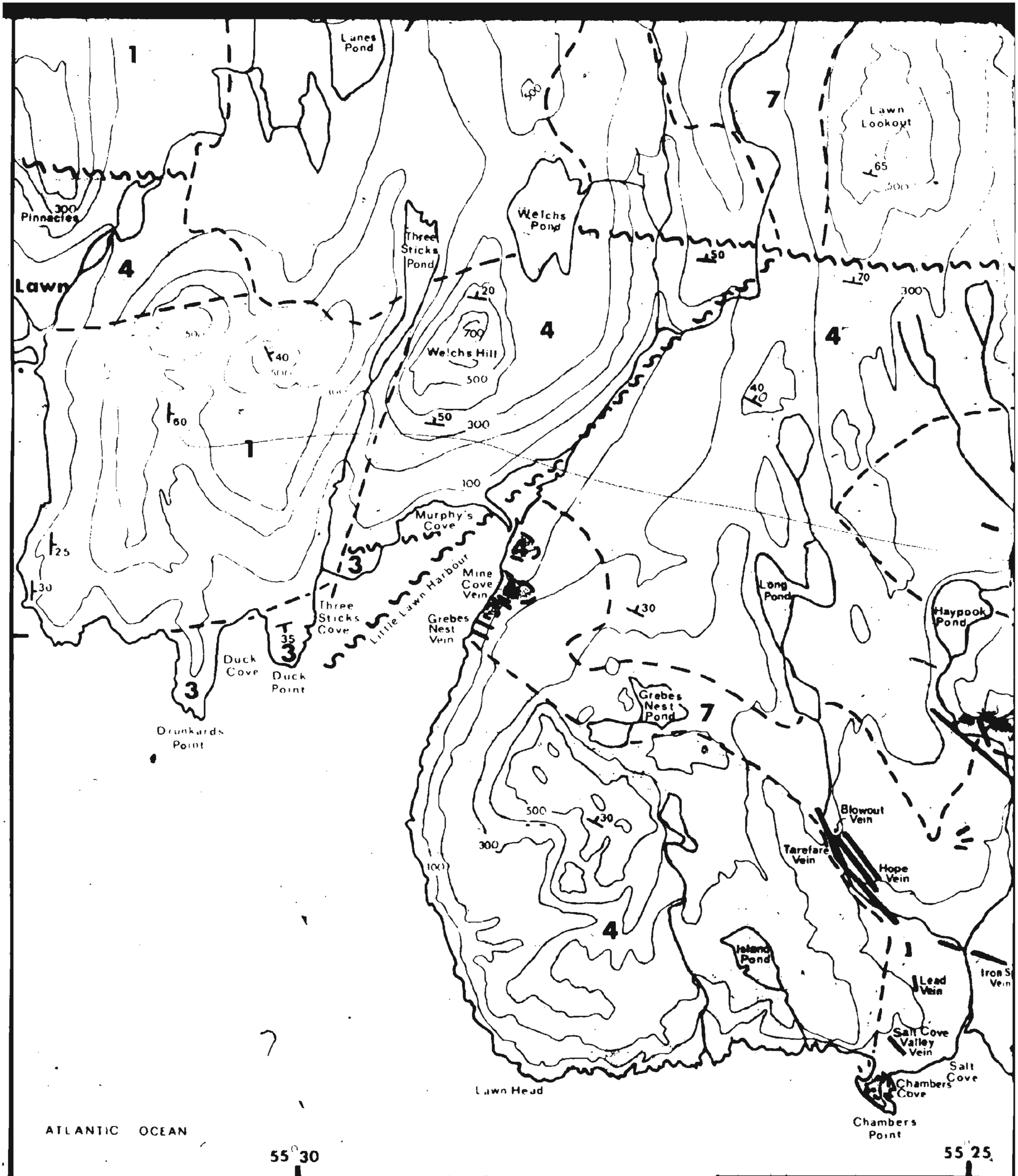
Lanes Pond
Lawn Lookout
Pinnacles
Welchs Pond
Three Sticks Pond
Lawn
Welchs Hill
Murphy's Cove
Mine Cove Vein
Little Lawn Harbour
Grebes Nest Vein
Three Sticks Cove
Duck Cove
Duck Point
Drunkards Point
Long Pond
Haypook Pond
Grebes Nest Pond
Blowout Vein
Tarefare Vein
Hope Vein
Island Pond
Lead Vein
Iron S Vein
Salt Cove Valley Vein
Salt Cove
Chambers Cove
Chambers Point
Lawn Head
ATLANTIC OCEAN
55°30
55 25

7 of

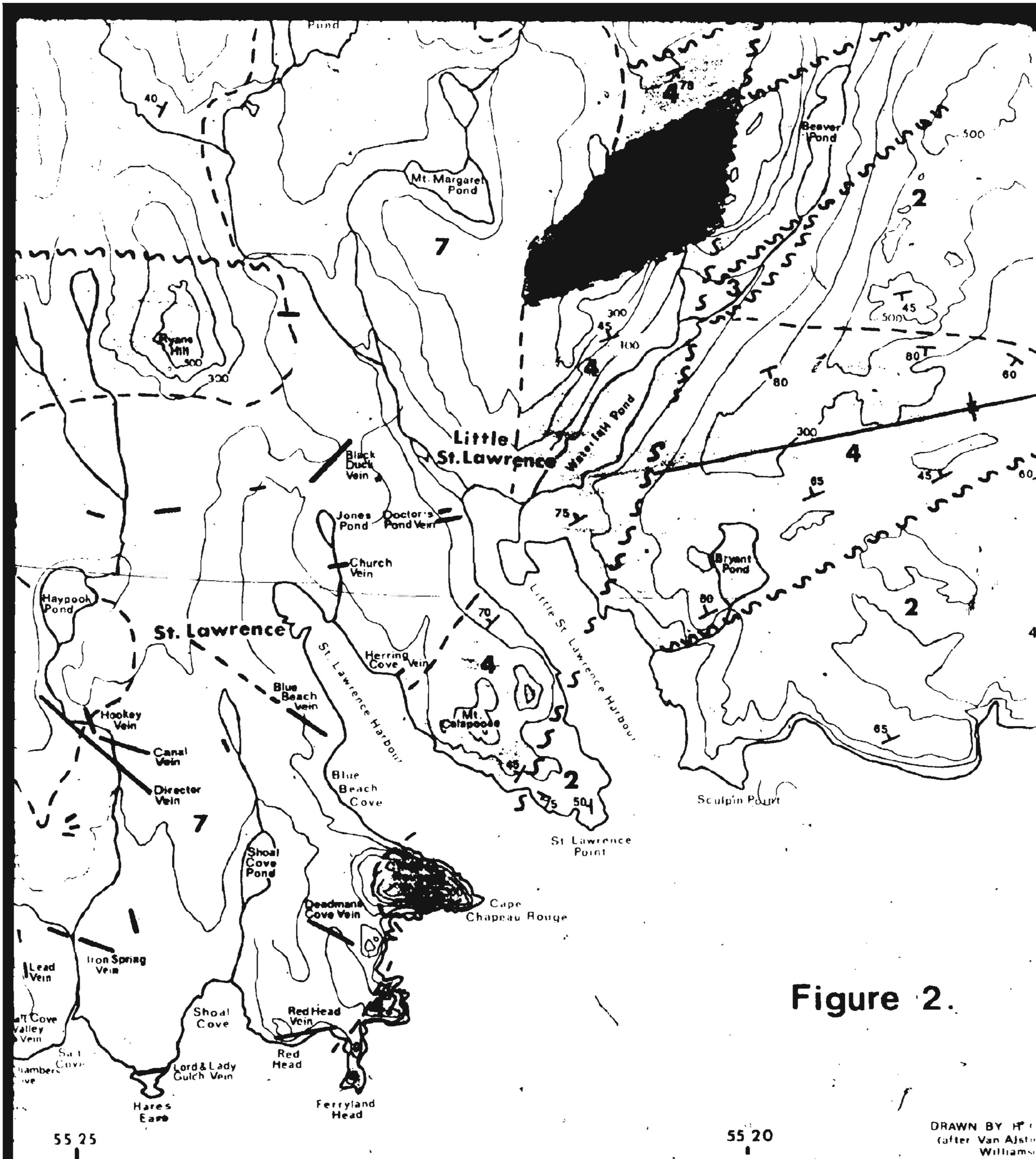
Little St. Lawrence
St. Lawrence
Mt. Margaret Pond
Beaver Pond
Ryans Hill
Waterfall Pond
Black Duck Vein
Jones Pond
Doctor's Pond Vein
Church Vein
Bryant Pond
Haypook Pond
Little St. Lawrence Harbour
St. Lawrence Harbour
Herring Cove Vein
Blue Beach Vein
Hookey Vein
Canal Vein
Directer Vein
Mt. Calapoode
Blue Beach Cove
Sculpin Point
St Lawrence Point
Shoal Cove Pond
Deadmans Cove Vein
Cape Chapeau Rouge
Lead Vein
Iron Spring Vein
Shoal Cove
Red Head Vein
Red Head
Lord & Lady Gulch Vein
Hares Ears
Ferryland Head
55 25
55 20
DRAWN BY

Figure 2.

8 of

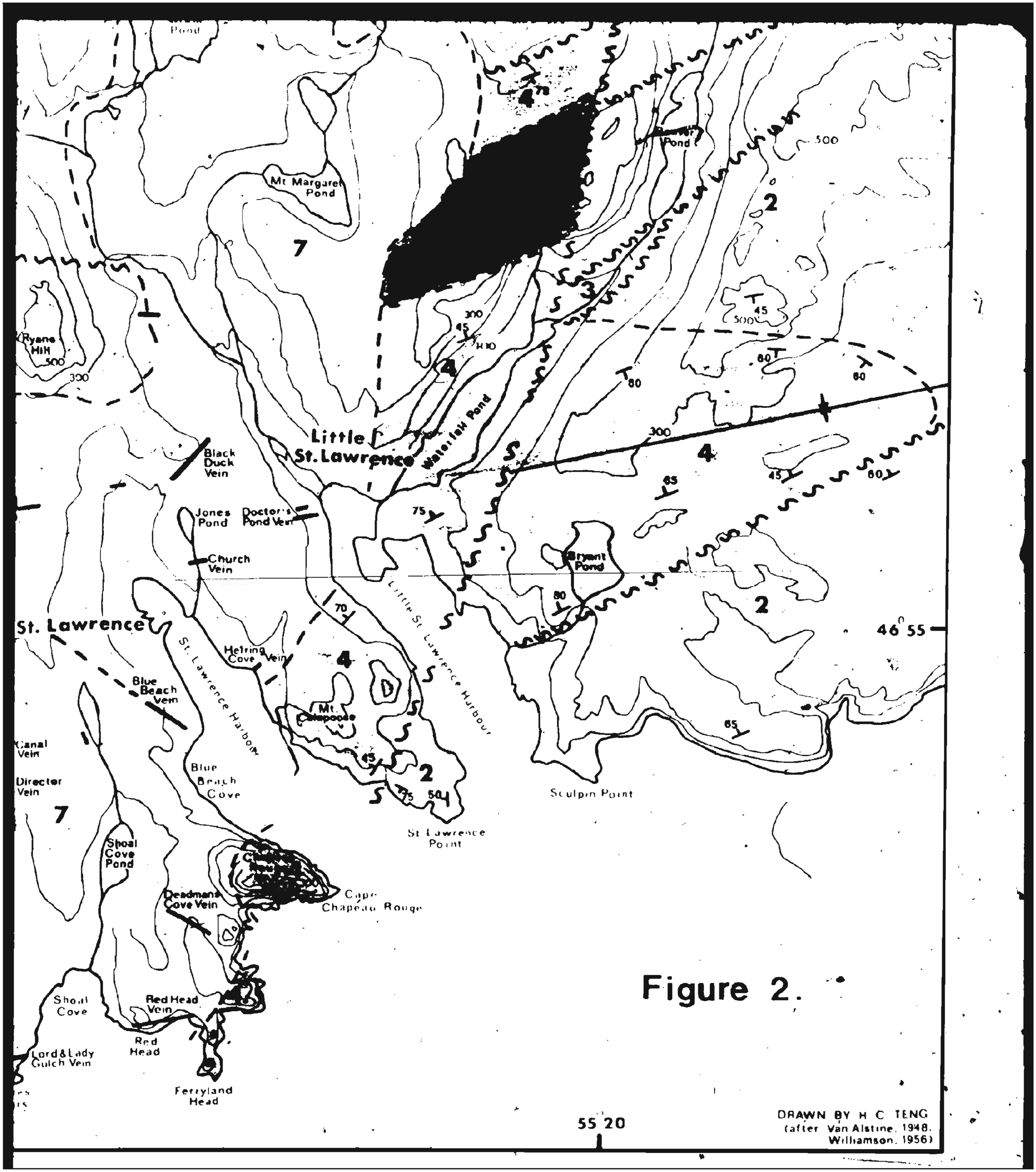
Mt Margaret Pond
Beaver Pond
Ryans Hill
Little St. Lawrence
Waterfall Pond
Black Duck Vein
Jones Pond
Doctor's Pond Vein
Church Vein
Bryant Pond
St. Lawrence
Herring Cove Vein
Blue Beach Vein
St. Lawrence Harbour
Little St. Lawrence Harbour
Mt. Calapoose
Canal Vein
Director Vein
Blue Beach Cove
Sculpin Point
St Lawrence Point
Shoal Cove Pond
Deadmans Cove Vein
Cape Chapeau Rouge
Shoal Cove
Red Head Vein
Red Head
Lord & Lady Gulch Vein
Ferryland Head
46°55
55°20
DRAWN BY H C TENG
(after Van Alstine, 1948, Williamson, 1956)

Figure 2.