

# GEOLOGY OF THE FRANÇOIS GRANITE, SOUTH COAST OF NEWFOUNDLAND

by

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## ABSTRACT

*The François granite is a posttectonic composite granite which has intruded the syn- to late tectonic Burgeo and Gaultois granites, their mylonitic equivalents and Ordovician migmatites. Dikes from the François granite have intruded the late tectonic North Bay Granite, a part of which has been dated at 396 Ma.*

*The Burgeo and Gaultois granites are dominantly coarse grained, K-feldspar porphyritic, variably foliated, biotite granite and granodiorite with extensive areas of younger medium grained biotite ± muscovite granite and granodiorite in the Burgeo granite.*

*The François granite is composed of two overlapping circular lobes which are composite. The northeastern lobe has a well developed concentric arrangement of intrusive units with a less well developed zonation in the southwestern lobe. The outer ring of the northeastern lobe has intruded the outer part of the southwestern lobe.*

*Rock types in each lobe are similar with an early outer zone of coarse grained, porphyritic biotite granite intruded successively by medium to locally coarse grained, porphyritic granite, medium grained porphyritic granite and granodiorite, and fine grained equigranular to quartz-feldspar porphyritic biotite granite which is locally granophyric and miarolitic. This sequence forms the rings in the northeastern lobe but generally forms isolated intrusions in the southwestern lobe. West of La Hune Bay, the southwestern lobe contains an area of syenite?, based on its low quartz and high K-feldspar content.*

*The François granite is distinctly leucocratic with less than 2% biotite and very rarely contains coarse muscovite. The potential for light-ion lithophile element associated mineralization such as tin and uranium is high. Siliceous greisenized granite veins are small but locally abundant. Locally, K-feldspar phenocrysts are completely altered to kaolinite? and the entire intrusion is radiometrically anomalous. Minor uranium-bearing magnetite was located in coarse granite pegmatite near Sugarloaf and late magmatic fluorite is common as a coating on quartz phenocrysts. Molybdenite has been reported to occur in an aplite dike in the northern part of the François granite.*

## INTRODUCTION

### Location and Access

The François granite (informal name) is located on the south coast of Newfoundland, approximately 70 km west of St. Albans (Figure 1). The community of François is served by CN Marine coastal boats from Burgeo and Hermitage. The coast in this area is deeply dissected by steep-sided fiords commonly with talus-covered lower slopes. The interior of the François granite, with some considerable effort, can be reached by foot from the head of these fiords but is best reached by helicopter from St. Albans or Milltown, the closest helicopter bases. The northern part of the François granite was traversed by foot but in the southwestern coastal areas the terrain is extremely rugged and sampling by helicopter was carried out. Most of the François granite is virtually devoid of vegetation, soil or till. Only in a few

gulleys, where there are thin till deposits, does scrub spruce survive.

### Previous Work

Mullins (1958) mapped part of the François granite west of La Hune Bay and described the rock as a porphyritic granite. The François area was mapped on a 1:250,000 scale by Williams (1971) who outlined the massive granitoids and syenite (granite of Mullins, 1958) which now comprise the François granite. Smyth (1979) produced a 1:50,000 scale compilation map of the area with little added detail.

The economic potential of the François granite was clearly indicated by Butler and Davenport (1978) and Davenport and Butler (1981, 1982) using lake sediment geochemical data. These indicated that the François granite contained anomalous U, Mo, F, Pb and W. Further geochemical and geological work by McConnell (1984a,b)

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## LEGEND

### DEVONIAN

#### Francois granite (Units 5 to 15)

- 15 *Pink to red, fine grained, equigranular to slightly porphyritic, massive, biotite aplite dikes.*
- 14 *Pink, fine to medium grained, quartz and potassium feldspar porphyritic, massive, biotite granite.*
- 13 *Buff to gray, medium to medium-coarse grained, plagioclase  $\pm$  potassium feldspar  $\pm$  quartz porphyritic, massive, biotite granite and granodiorite.*
- 12 *Pink, fine to coarse grained, potassium feldspar  $\pm$  quartz porphyritic, massive, biotite granite; 12a – fine grained granite; 12b – coarse grained granite.*
- 11 *Buff, coarse grained, potassium feldspar porphyritic, biotite granite.*
- 10 *Pink to buff, coarse grained, quartz rich, potassium feldspar porphyritic, massive, biotite granite.*
- 9 *Pink, fine to medium grained, quartz-potassium feldspar porphyritic, massive, biotite granite.*
- 8 *Buff to gray, medium to medium-coarse grained, feldspar  $\pm$  quartz porphyritic, massive, biotite granite and granodiorite.*
- 7 *Pink to green, fine to coarse grained, equigranular to feldspar porphyritic, massive, biotite syenite?*
- 6 *Pink, coarse grained, potassium feldspar porphyritic, biotite granite.*
- 5 *Pink, coarse grained, equigranular to slightly potassium feldspar porphyritic, massive, biotite granite; 5a – equigranular granite; 5b – slightly porphyritic granite.*

### DEVONIAN AND OLDER

- 4 *North Bay Granite: Buff, medium grained, equigranular to locally potassium feldspar porphyritic, weakly foliated, biotite  $\pm$  muscovite granite.*
- 3 *Burgeo granite: Undivided, medium to coarse grained, equigranular to potassium feldspar porphyritic, weakly foliated to strongly mylonitized biotite granite and granodiorite.*
- 2 *Gaultois Granite: Pink to gray, medium to coarse grained, mainly potassium feldspar porphyritic, strongly foliated to mylonitic, biotite granite and granodiorite.*

### ORDOVICIAN

- 1 *Undivided metasedimentary and metavolcanic rocks including migmatite and minor mylonitic equivalents.*

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François Granite

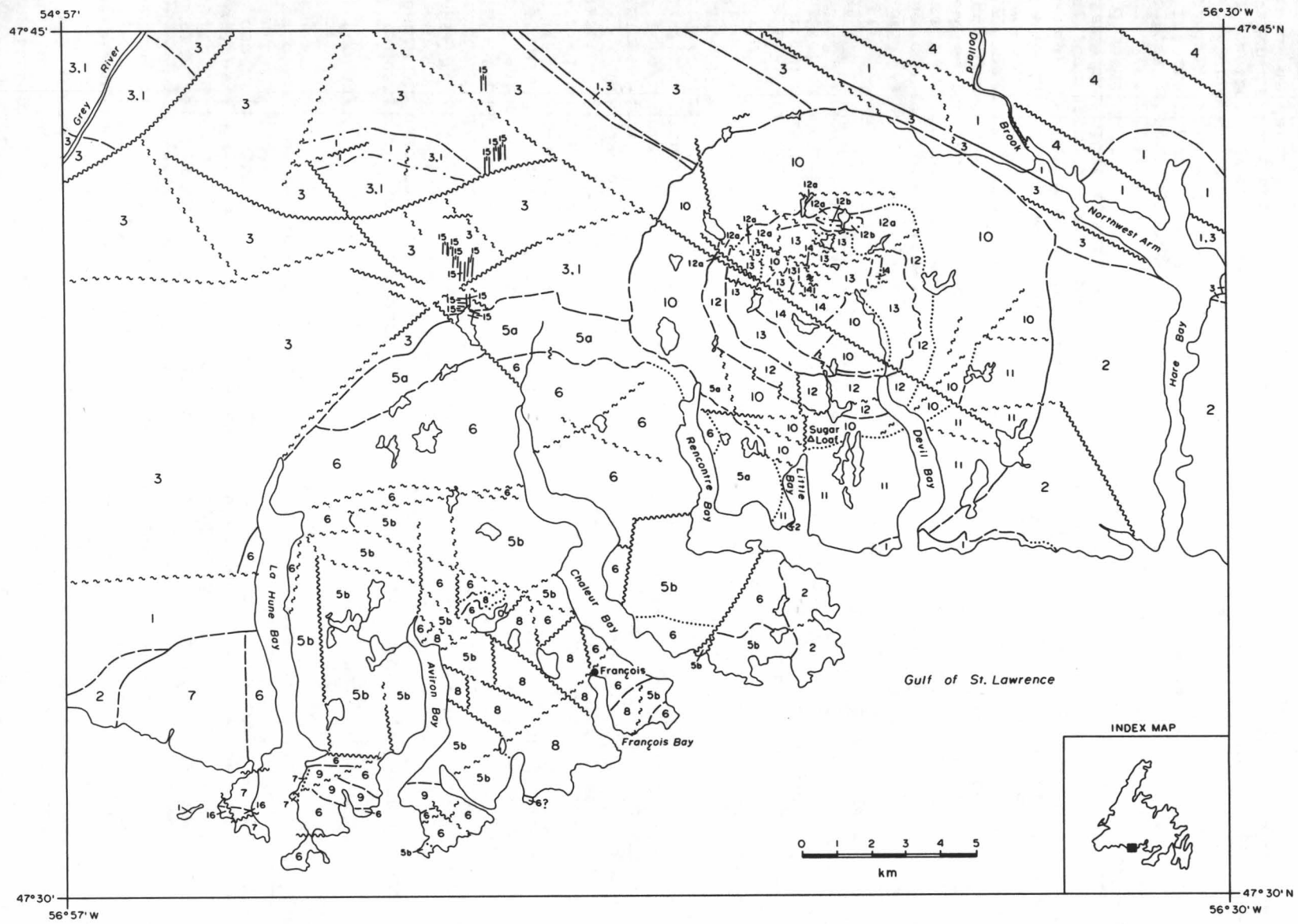


Figure 1: Geological map of the François Granite.

indicated anomalous Sn and the rock geochemistry indicated a highly siliceous, light-ion-lithophile (L.I.L.) element-enriched pluton with several varieties of granite and granodiorite. McConnell (1985) has carried out more detailed stream sediment sampling and prospecting in the northern part of the François granite. Airborne radiometric surveys by the Geological Survey of Canada (1983) indicated that the François granite is anomalously radioactive and that there is a zonal arrangement of the anomalies. The syenite of Williams (1971) contained the highest thorium anomaly and the highest U anomalies occur in the vicinity of Sugarloaf, north of Little Bay (Figure 1).

### Regional Geology

The oldest rocks in the François area are probable Ordovician, strongly deformed and metamorphosed volcanic and sedimentary rocks (Unit 1) exposed along the coast and in the northern Hare Bay area. These rocks have been intruded by the strongly deformed Gaultois Granite (Unit 2), a medium to coarse grained, porphyritic, biotite granite. The Burgeo granite (Unit 3) is mainly a medium to coarse grained, porphyritic, biotite granite which has intruded the Gaultois Granite and is generally much less deformed than the Gaultois Granite. Thus the Burgeo granite is tentatively considered to be younger than the Gaultois Granite. The North Bay Granite (Unit 4) is mainly a medium grained, equigranular to porphyritic, biotite ± muscovite granite which is only weakly deformed. This granite has a preliminary U/Pb age of 396 Ma (see Dickson et al., 1985). More detailed descriptions of the pre-François units are given in Blackwood (1985) and Dickson et al. (1985).

Mylonitization is locally intense along the contact zones between the Ordovician metamorphic rocks, and the Burgeo and Gaultois Granites. The François granite cross cuts these mylonitic rocks and thus is the youngest intrusive unit in the map area. Posttectonic dikes of François granite also intrude the North Bay (Dickson and Delaney, 1984), Burgeo and Gaultois Granites. Contacts between the François granite and the older granitoid units are steeply dipping.

The term François granite (Units 5-14) is an informal name for a variety of massive, pink to gray, medium to coarse grained, porphyritic to equigranular, biotite granitoid phases located in the area between La Hune Bay and Hare Bay. No radiometric age dates are available for the François granite, but the presence of François granite dikes in the weakly deformed North Bay Granite, west of Dolland Brook (Dickson and Delaney, 1984), indi-

cates a maximum age of 396 Ma. The François granite consists of two overlapping circular complexes which trend towards the northeast. In the southwest of the complex, a small area of massive porphyritic syenite is included in the François granite. The two circular bodies which comprise the François granite are referred to as the northeast lobe and the southwest lobe. The northeast lobe is considered to be the younger of the two as one unit in the northeast lobe has intruded a unit of the southwest lobe. The relative age of the units within each lobe is known from intrusive relationships but the relative age between units in different lobes is not known.

### FRANÇOIS GRANITE

#### Contact Relationships within the François granite

Contact relationships between each of the units indicate the sequence of intrusion. Unit 6 postdates subunit 5a as Unit 6 becomes finer grained adjacent to the contact and xenoliths of probable subunit 5a were found in Unit 6 within a hundred metres of the contact. Unit 7 postdates Unit 6 along a gradational contact (Blackwood, 1985). Unit 6 and subunit 5b are everywhere in fault contact. Unit 8 postdates subunit 5b with sharp intrusive contacts between finer grained Unit 8 adjacent to coarser grained Unit 5b. In one area the contact dips at 40° to 45° towards the north. The contact relationship between Unit 9 and Unit 6 is not known. Dikes of Unit 9 were found in all units except Unit 7. Thus Unit 9 is probably the youngest unit in the western lobe.

Unit 10 of the northeast lobe clearly postdates subunit 5a of the western lobe. This is indicated by a consistent zone, tens of metres wide, of fine grained, porphyritic granite which becomes coarser grained away from the contact with subunit 5a. The relationship between Unit 10 and Unit 11 is uncertain and may be transitional. The contact between Unit 10 and Unit 12 is often irregular and a sill-like intrusion of Unit 12 is indicated in some localities in the northern portions of the northeast lobe, by vertical textural variations in Unit 12. Unit 13 is a sill-like intrusion into Units 10 and 12, with sharp contacts dipping 40° south in the southern portion of the northeast lobe and 40° to 50° southwest in the southwestern portion of the northeast lobe. Thin, fine grained (chilled), biotite-rich margins occur within Unit 13 at the contacts with Units 10 and 12. Thin veins of Unit 13 intrude Units 10 and 12. Unit 14 probably postdates Unit 13 since fine grained, equigranular aplite dikes, similar to the main body of Unit 14, have intruded Unit 13.

**Detailed description of the François granite (Units 5-15)****a. Southwest lobe - Units 5 to 9**

Unit 5 is composed of pink, coarse grained, equigranular to slightly potassium feldspar porphyritic, massive, biotite granite, and has been divided into subunit 5a, which forms the northern arcuate margin of the southwestern lobe, and subunit 5b which forms the central part of the lobe. Subunit 5a is in sharp contact with the Burgeo granite and contains locally abundant xenoliths of migmatite and foliated granite close to the contact. The subunit is a homogeneous hypidiomorphic granular granite with approximately 1 to 2% biotite. Steeply dipping, medium grained, equigranular granite dikes have intruded subunit 5a. The dikes are commonly over 50 m in length and 1 m wide. Thin quartz veins are associated with easterly and northerly trending minor shear zones.

Subunit 5b is tentatively correlated with subunit 5a as both have a similar matrix texture, grain size and mineralogy. However, subunit 5b is generally porphyritic with up to 10%, 1-3 cm long, potassium feldspar phenocrysts. Biotite forms 1% of the rock. The subunit is cut by thin shear zones which contain small barren quartz veins. In a few areas, very thin veins of dark coloured material is probably greisenized granite.

Unit 6 is composed of pink, coarse grained, potassium feldspar porphyritic, biotite granite and forms a discontinuous circular zone, which separates subunits 5a and 5b, and forms most of the remaining parts of the outer ring of the southwest lobe. The marginal zones of Unit 6 are generally finer grained than the rest of the unit. Potassium feldspar phenocrysts are 1 to 3 cm in length and comprise 10 to 20% of the rock. The matrix contains varying proportions of potassium feldspar and plagioclase with 1 to 2% biotite. Small, dark, irregularly shaped, metadiorite (?) xenoliths, occur locally.

Unit 7 is composed of pink to green, fine to medium grained, equigranular to feldspar porphyritic, massive, biotite granite and medium to coarse grained, feldspar porphyritic, biotite syenite(?). The coarser grained component of this unit locally contains less than 10% quartz and thus has been termed a syenite, e.g. Williams (1971). Mullins (1958) records that in some areas the finer grained component contains up to 30% fine grained quartz in the matrix. Blackwood (1985) reports that the contact between Units 6 and 7 is gradational. Unit 7 contains 2 to 3 cm long potassium feldspar phenocrysts which form 2 to 20% of the rock and pale

green plagioclase phenocrysts, about 1 cm in length are less abundant than the potassium feldspar. Biotite forms 2 to 5% of the rock. Aplite dikes up to 60 cm wide cut Unit 7 in a few places.

Unit 8 is composed of buff to gray, medium to medium-coarse grained, feldspar ± quartz porphyritic, massive, biotite granite and granodiorite. This distinctly more mafic unit is characterized by its generally darker colour and the presence of both plagioclase and potassium feldspar phenocrysts. The phenocrysts are 1 to 3 cm in length and form 10 to 20% of the rock. The matrix contains mainly plagioclase with smaller amounts of quartz and potassium feldspar and approximately 2 to 5% biotite.

Unit 9 is composed of pink, fine to medium grained, quartz - potassium feldspar porphyritic, massive, biotite granite. This unit forms small intrusions and dikes in the southwestern part of the southwest lobe. The granite is generally resistant to weathering and commonly has retained a glacial polish, perhaps as a result of a high quartz content. Potassium feldspar phenocrysts comprise 5 to 15% of the rock and are 5 to 20 mm in length. Quartz phenocrysts are commonly 5-7 mm in diameter and form 2 to 10% of the rock. The matrix contains 1-2 mm crystals of quartz, plagioclase and potassium feldspar with 1 to 3% biotite. Mirolitic cavities are common in this unit particularly near the margins and indicate that the unit was emplaced at a high structural level. Swarms of 10 to 50 cm wide quartz veins are common and cover areas of 3 to 5 m<sup>2</sup>.

**b. Northeast lobe - Units 10 to 14**

Unit 10 is composed of pink to buff, coarse grained, quartz rich, potassium feldspar porphyritic, massive, biotite granite and forms most of the outer ring of the northeast lobe. In the central part of the lobe, similar granite is tentatively correlated with Unit 10. Within a few metres of the contact of Unit 10 with the country rocks, the granite becomes finer grained. Xenoliths of migmatite and foliated granite are common near the margin. Potassium feldspar phenocrysts, 2 to 3 cm in length, make up 5 to 20% of the rock. The matrix consists of quartz, plagioclase, and potassium feldspar, with 1 to 2% biotite. The finer grained varieties of Unit 10 are locally granophyric.

Steeply dipping aplite dikes, 20 to 50 cm wide, and aplite sills are common in the northern part of Unit 10. The dikes appear to have a radial arrangement about the center of the northeastern lobe. The dikes commonly contain a central zone of pegmatite and one sill was found to contain alternating layers of pegmatite and aplite.

Unit 11 is a buff, coarse grained, potassium feldspar porphyritic, biotite granite and forms an arcuate belt along the southeastern margin of the northeast lobe outside of Unit 10. This unit is distinguished in the field from Unit 10 by the buff colour, and higher proportion of plagioclase. Radioactivity is also higher in Unit 11 (see section on mineralization). Unit 11 contains about 10 to 20% potassium feldspar phenocrysts which are 1 to 2 cm in length. The matrix contains about 25% plagioclase with quartz and potassium feldspar and 1 to 3% biotite.

Unit 12 is composed of pink, fine to coarse grained, potassium feldspar ± quartz porphyritic, massive, biotite granite and forms a complete ring in the northeastern lobe. Mappable textural variants of Unit 12 are termed subunits 12a, a fine grained granite, and 12b a coarse grained granite. In general, Unit 12 is highly variable with common changes in grain size, texture, and proportions of quartz and feldspar phenocrysts. Quartz and potassium feldspar phenocrysts are conspicuous in this unit. Quartz is generally dark gray to brown, subhedral, and 5 to 7 mm in diameter. The potassium feldspar phenocrysts are 1 to 2 cm in length and are locally highly altered to brown kaolinitic aggregates. The matrix of the granite is fine to coarse grained with minor plagioclase and less than 1% biotite.

Unit 13 is composed of buff to gray, medium to medium-coarse grained, plagioclase ± potassium feldspar ± quartz porphyritic, massive biotite granite and granodiorite. This distinctive gray to buff unit is similar to Unit 8 of the western lobe. Contacts are generally sharp and dip approximately 40°S, just north of Sugarloaf.

Unit 13 consists of 10 to 15% plagioclase phenocrysts, approximately 1 cm in length. Potassium feldspar phenocrysts 1 to 2 cm in length occur mainly in the coarser varieties of this unit and may comprise up to 10% of the rock. Phenocrysts of coarse subhedral to anhedral quartz also occur locally and comprise 5% of these rocks. The matrix consists of plagioclase, potassium feldspar, quartz, and 2 to 4% biotite. The proportion of potassium feldspar in the matrix is greater in the coarser varieties of this unit.

Unit 13 has been intruded by steeply dipping, northerly trending aplite dikes, 20-30 cm wide, in the northern portion of the eastern lobe. In one area, northerly trending, 2-4 cm wide greisen veins were observed adjacent to the contact with Unit 14.

Unit 14 is composed of pink, fine to medium grained, quartz and potassium feldspar porphyritic, massive, biotite granite and forms the core of the northeastern lobe. This unit is similar to Unit 12. In Unit 14, quartz phenocrysts are generally black to dark gray, anhedral to subhedral and 0.5 to 0.75 cm in diameter. Potassium feldspar phenocrysts are 1 to 2 cm in length. Combined phenocrysts comprise 10-25% of the rock. The matrix consists of fine to medium grained pink to red potassium feldspar, quartz ± plagioclase and less than 1% biotite.

In the eastern part of this unit the granite grades into a pink, coarse grained, potassium feldspar porphyritic, biotite granite which is tentatively included in Unit 10.

Unit 15 is composed of pink to red, fine grained, equigranular to slightly porphyritic, massive, biotite aplite dikes. To the northwest of the François granite, numerous thick red aplite dikes have intruded the Burgeo granite. The aplite dikes have a consistent northerly trend and are discontinuously exposed for up to 6 km from the edge of the François granite. The dikes range from 5 to 25 m in width and have exposed lengths of over 400 m. Contacts with the country rock are sharp and straight. Near the contact with the François granite, some of the dikes are medium to coarse grained and probably related to Unit 5a of the François granite.

The aplite contains 2 to 5% phenocrysts of feldspar, 2 to 3 mm in length. Biotite occurs as 1 to 2 mm flakes and forms 1% of the mode.

#### STRUCTURE

The northeastern lobe of the François granite is characterized by major ring structures. The outer margin of the lobe (Units 10 and 11) is 2-4 km wide with a diameter of 11-12 km and has been intruded by an irregular-shaped sill of Unit 12, a 0.5 to 1.25 km wide ring with a 6-7 km diameter. Unit 13 is generally 1-2 km wide but narrows to a true thickness of 60 m (horizontal width of 85 m x sine 45°) at the head of Devil Bay. The unit has a diameter of 4.5 to 5.5 km and has a 45° southward-dipping contact with Unit 12 in the southern and southwestern areas but the attitude of the contact in the north is unknown. The core of the lobe is elliptical and is occupied by Unit 14 in the west which grades into Unit 10 in the east. The elliptical core is 2 km by 4.5 km and at its western margin overlaps Unit 13 in possible lacolith fashion.

The southwestern lobe is not as obviously a ring structure as the north-eastern lobe. Unit 5a and Unit 6 form an outer margin in most places. If the lobe was extended into the ocean to complete its circular shape then the youngest units would occur in the center.

Both lobes of the François granite are crosscut by faults. In most cases displacement is difficult to determine. A major northwest trending fault bisects the eastern lobe. Along this fault, the granite is brecciated and in some localities 1-10 m wide zones of 1-5 cm wide quartz veins are parallel to the fault. Displacement at the steeply dipping contact of the eastern lobe with the country rock is less than 200 m indicating a minimal strike slip component. North of this fault, the rings of the northeastern lobe have been offset by numerous faults but the ring structure is still apparent. The southwestern lobe is extensively faulted which may confuse identification of any rings in this lobe.

#### MINERALIZATION

Lake sediment surveys conducted by Butler and Davenport (1978) and Davenport and Butler (1981, 1982) indicated that the François granite contains anomalous W, Mo, Pb and F concentrations in the northeastern lobe and the southern part of the southwestern lobe. A follow-up stream sediment geochemical survey conducted by McConnell (1984a,b), produced very high Pb and U values as well as moderately high values for Sn, Zn and F, mainly in the vicinity of

Sugarloaf. No significant mineralization was found in the François granite and these anomalies may be partly the result of over-all large-ion-lithophile enrichment in this highly siliceous granite.

Minor magnetite, probably containing uranium, occurs in pegmatite patches near Sugarloaf. One minor occurrence of possible topaz was located about 4 km north of Little Bay. McConnell (1984a,b) discovered topaz in a scree slope 1 km west of Devil Bay and trace molybdenite in an aplite dike near the northern contact between the François granite and the Burgeo granite. Fluorite occurs in the François granite as a coating on quartz crystals. This was most common in the fine grained version of Unit 12 where fine grained fluorite coats the quartz phenocrysts. This indicates a late magmatic origin for the fluorite and a system enriched in fluorine.

Airborne radiometric surveys by the Geological Survey of Canada (1983a) show the François granite to be enriched in U and Th. The radiometric anomalies were also able to pick out the concentric zones observed in the field. A hand-held GIS-4 Gamma Ray Spectrometer indicated lower anomalous radiometric values than expected but discerned relative differences between units and between the two lobes (Table 1).

#### SUMMARY AND CONCLUSIONS

The François granite is a Devonian, posttectonic, composite intrusion comprised of two overlapping ring complexes, each

**Table 1:** Mean Gamma Radiation for each unit of the François granite. Values obtained using a Scintrex GIS-4 gamma ray spectrometer and reported in counts per second (c.p.s.).

##### a. Western Lobe

	Total Counts	K+Th+U	Th+U	Th
Unit 5a	150	6	3	1
5b	260	8	4	2
6	190	7	3	1
7	315	11	6	1
8	190	7	4	2
9	250	9	5	2

##### b. Eastern Lobe

	Total Counts	K+Th+U	Th+U	Th
Unit 10	290	10	6	2
11	330	12	6	3
12	300	10	6	2
Units 12a,12b	310	11	6	2
13	200	7	5	1
14	310	11	6	2

approximately 12 to 15 km in diameter. The pluton has a northeasterly trend and part of the northeastern ring complex has intruded the southwestern ring complex. The sequence of intrusion in both complexes is similar with early coarse biotite granite intruded by medium grained granodiorite and subsequently by fine to medium grained granite. A small area of syenite at the southwest end of the complex is considered to be part of the François granite. Locally developed miarolitic cavities indicate that the François granite is a high level intrusion.

The ring structure is best developed in the northeastern part of the François granite where four distinctive rings have developed. Airborne radiometric surveys highlight these rings and also indicate that the entire François granite is three to five times more radioactive than the surrounding rocks. Highly radioactive magnetite was found in a few pegmatites north of Little Bay. The source of the Pb, Mo, Sn and W anomalies (Butler and Davenport, 1978; 1980; McConnell, 1984) is not apparent. Thin greisen veins are developed locally. Fluorite forms coatings on quartz crystals in a few places in the granite indicating a late magmatic origin for the fluorite and a system enriched in fluorine.

The François granite along with the other granites in the area have been geochemically sampled using a 2 km x 2 km grid system. Geologically complex areas were more intensively sampled. These samples will be analysed for major elements and trace elements including Sn, W, U, Mo, Li and Be. Samples have been collected for age dating.

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