



QUEBEC DEPARTMENT OF NATURAL RESOURCES

MINERAL DEPOSITS SERVICE

Ministère des Richesses Naturelles, Québec  
SERVISE DE LA  
DOCUMENTATION TECHNIQUE

Date: \_\_\_\_\_

No DP 343

Preliminary Report on the

Fitch Bay Area

(Orford County)

by

H.S. de Romer

## INTRODUCTION

The Fitch Bay area lies in the southern part of the Eastern Townships, at about 140 km ESE of Montreal, and 35 km SSW of Sherbrooke. Covering about 180 square kilometers, it is bound by latitudes  $45^{\circ}03'$  and  $45^{\circ}10'$ , and longitudes  $72^{\circ}06'$  and  $72^{\circ}16'$ . Located on the Memphremagog 1/50,000 topographic sheet, the area lies entirely within the Oxford county, and largely within the Stanstead townships; only the northernmost strip falls within the Magog township.

The area consists mostly of arable land suitable for dairy and chicken farming with patches of largely deciduous bush. The main centres of population are Fitch Bay and Georgeville on lake Memphremagog, and Tomifobia in the southeast corner of the area.

Lying in the Appalachian Highlands, the Fitch Bay area is characterized by a gently rolling morphology, except for the Bunker Hill, a prominent northeasterly trending ridge west of Fitch Bay. Relief is moderate, varying from 230 m near Fitch Bay and lake Memphremagog to 485 m at the top of Bunker Hill in the northeast corner of the area.

Extending into the centre of the area, Fitch Bay is probably a fault controlled arm of lake Memphremagog. Lowering lake straddling the northern boundary of the area, Tomifobia River, Bunker Brook and Fitch Creek are the other main water bodies.

Mapping was carried out in the summer of 1975 at a scale of 1/12,000 with the aim to trace the southern extension of the Weedon-

Stoke Mountain volcanic belt. The work is the continuation to the southwest of the mapping carried out by the writer in the lake Massawippi area (1974).

Outcrop density is not uniform; while good exposures are plentiful on Bunker Hill, other large areas, particularly in the south and north-central parts, are practically devoid of outcrop.

#### GENERAL GEOLOGY

The Fitch Bay area lies in the western segment of the Appalachian foldbelt. Its geology consists of a central belt of intensely deformed and moderately metamorphosed metasediments and metapelites with intercalated volcanics and pyroclastics, flanked by less deformed carbonate rocks. Four northeast-trending belts, each differing in lithology and structure, have been established. From NW to SE, they are: 1) the Glenbrooke Group of Upper Silurian age, 2) the Middle Ordovician Magog Group of the St. Victor Synclinorium, 3) the Ascot Formation belonging to the Stoke Mountain Complex of Lower Ordovician to Cambrian age, and 4) the Siluro-Devonian rocks of the St. Francis Group forming part of the Gaspé-Connecticut Valley Synclinorium.

The structural pattern is uniform in that most S-planes dip moderately to steeply to the northwest. Several, large southeasterly trending folds within the Magog and Ascot belts are the dominant structural feature of the area. Polyphase deformation is indicated by several generations of mesostructures. Siluro-Devonian rocks, on the

other hand, are less deformed showing only two generations of minor structures.

Intrusive rocks include gabbro sheets which are associated with basic volcanic rocks of the Ascot Formation. A small, discordant stock of grey granite is probably of Devonian age. Aplites, carbonatized dikes and lamprophyres represent the youngest intrusions, cutting across all the other rocks.

Sand and gravel of fluvioglacial origin is plentiful and some pits are active in the central and western part of the area.

#### ASCOT FORMATION

Rocks of the Ascot Formation underlie a 3-4 km wide belt trending northeastward across the map-area, from Magoon Point on Lake Memphremagog to east of Lovering lake, a distance of 20 km. The formation extends to west of lake Massawippi (de Romer, 1974) and beyond to the Sherbrooke area (St. Julien and Lamarche, 1965).

In the present area, the Ascot Formation is in fault contact with both, the St. Francis Group to the southeast and the Magog Group adjoining it to the northwest. It is of Cambrian to Lower Ordovician age and can be subdivided into 2 main units: the Bunker Hill, and the Magoon Point units. Each unit again comprises several rock types. Gradational contacts between them, absence of good marker horizons, lack of fossils, and a complex structural pattern resulting from repeated deformation characterize both units. Lenses and outcrop areas

TABLE OF FORMATIONS

Pleistocene		-fluvioglacial sands and gravel
ANGULAR UNCONFORMITY		
Devonian and Post-Devonian		-lamprophyres -carbonatized dikes -aplite -quartz veins -grey granite
ANGULAR UNCONFORMITY		
Siluro - Devonian	St. Francis Group (Gaspé-Connecticut Valley Synclorium)	-dark-grey, limy shale and slate; argillaceous silty limestone -dark-grey, carbonaceous limestone; argillaceous interbeds
	Glenbrooke Group (Gaspé-Connecticut Valley Synclorium)	-beige, felsic tuff -light-grey, limy slates and shales -light-grey, massive, fossiliferous limestone
ANGULAR UNCONFORMITY (?)		
Mid-Ordovician	Magog Group (St. Victor Synclorium)	-beige, felsic tuff -beige, lithic sandstone; black shale -black and grey shale; siltstone, micro conglomerate
ANGULAR UNCONFORMITY		
Lower Ordovician		-gabbro -carbonatized country rock
Cambrian to Lower-Ordovician	Ascot Formation	Magoon Point Unit
		-black shale and slate; microconglomeratic and lithic sandstone -mafic and intermediate tuff -tuffaceous greywacke; minor slate and sandstone -felsic, crystal and lithic tuff -metabasalt and tuff -argillaceous sandstone; black shale
		Bunker Hill Unit
		-tuffaceous greywacke; microconglomerate; minor shale -intermediate and mafic tuff -felsic tuff; minor crystal and lithic tuff -metabasalt; minor intermediate and mafic tuff -black and grey slates; silty and lithic sandstone

of grey slates and felsic tuff, for example, are of such common occurrence in both units, that the writer was, at places, not sure as to where to place them. As a result, the age relationships between the individual rock types are uncertain. In any case, it seems likely that rocks of the Bunker Hill are stratigraphically below, although structurally they overlie the Magoon Point unit.

#### Bunker Hill Unit

Rocks of the Bunker Hill unit occupy the central part of the Ascot belt, being flanked on both sides by rocks of Magoon Point. The dominant rock type in the area is a tuffaceous greywacke with intercalated microconglomerate beds and grey to black shale lenses. The remainder of the Bunker Hill assemblage comprises the following less important rock groups: 1) black and grey slates, silty and lithic sandstone; 2) metabasalt with intermediate and mafic tuff, 3) felsic tuff with minor crystal and lithic varieties, and 4) intermediate and mafic tuff.

The Bunker Hill greywacke is typically a tough and massive looking, grey weathering rock. It is heterogeneous and unsorted, showing the textural and structural features that reflect aqueous deposition of a mixture of detrital and volcanic material. The clearly sedimentary fraction is represented by a medium-grained rock, greenish when fresh, composed of subangular quartz and kaolinized feldspar set in an abundant matrix of sericite and chlorite. Irregular pockets or beds of microconglomerate, consisting chiefly of vitreous quartz

and dull feldspar are characteristic at places. Grain gradation in scour and fill structures or across beds can generally be observed. Zones of microbreccia or lithic sandstone consisting of some quartz, and abundant feldspar and tiny subrounded rock fragments, chiefly grey or black shale, are present. Discontinuous interbeds of grey or black shale further underline the sedimentary character. At places, the greywacke contains, or grades imperceptibly into, layers or streaks, 1 cm to 10 cm wide, of sand-colored kaolinized feldspar representing water-laid tuffaceous deposits. The intimate association and complete gradation between ill-defined streaks of altered tuffaceous material and mixed sandstone beds suggest addition of volcanic components during normal sedimentation. Rapid intermittent aqueous deposition of volcanic material involving little transportation is implied.

Small, lens-like black and grey slates associated with impure siltstones and lithic sandstones interfinger with tuffaceous greywacke. Together with the graded sandstones, they form a genetic part of the eugeosynclinal Bunker Hill assemblage.

Several elongate bodies of metabasalt are present east of the southern tip of Lovering lake. Lying within the greywacke mass, the 1/2-1 km long and 50-80 m wide, discontinuous volcanic flows are probably the surface expression of a single complexly folded sheet. The dark green rock is typically massive, structureless, and fine-grained. Schistose, chlorite-and feldspar-rich zones at the contacts

of the sheets represent mafic to intermediate tuffs, or are marginal alteration products.

Numerous mapeable lenses of felsic tuff, as well as locally occurring crystal and lithic varieties have been distinguished in the greywacke complex. The felsic tuff are massive or foliated bodies a few to several tens of meters in width and traceable over short distances. They are generally beige to cream colored with some, sand- or silt-sized, angular quartz grains embedded in a kaolinized and sericitic matrix.

Numerous stringers or streakers of intermediate and mafic tuff are present in the greywacke complex. Because of their discontinuous nature and small size, not all could be recorded on the map. Several tuffaceous interbeds of considerable persistence and size have been located east of Lovering lake. Structurally significant as a local marker horizon is a 3-km long and 30-50 m wide intermediate tuff layer, about 2 km east of the lake. Occurring at the break of the slope on Bunker Hill, the rock is green, strongly foliated or laminated. At places, it is a chlorite-rich phyllite.

#### Magoon Point Unit

Magoon Point rocks are placed tentatively stratigraphically above the Bunker Hill unit. They form an elongate zone on the periphery of, and virtually surrounding, the Bunker Hill greywacke. Most of the low area around Fitch Bay and the neighbouring hills is underlain by Magoon Point rocks, thus effectively separating the Bunker

Hill rocks into northern and southern segments.

The Magoon Point unit comprises several rock groups, the lithology and structure of which is quite similar to those of the Bunker Hill assemblage. By far the predominant rock types are black shale and slate with minor microconglomeratic and lithic sandstone interbeds. The remainder of the unit is made up of 1) argillaceous sandstone with minor black shale, 2) metabasalt and tuff, 3) felsic, crystal and lithic tuff, 4) tuffaceous greywacke with minor slate and sandstone, and 5) mafic and intermediate tuff.

With the exception of black-slate and argillaceous sandstone, all the rock types listed above have structurally and lithologically similar counterparts in the Bunker Hill unit. The tuffs, metabasalt, greywackes and slates of the Magoon Point unit, for example, could not be differentiated in the field from the Bunker Hill equivalents. Further study will show whether the present division of lithological groups is warranted. The writer suspects that the two main lithologies represented in the Bunker Hill unit may be greywacke, black shale-slate, and metabasalt while the Magoon Point unit may include only the argillaceous sandstone with minor slate.

The black shale-slate belt comprises locally microconglomerate pockets, and, at places, graded sandstone beds. They are similar to the dark Bunker Hill shales and slates, and may indeed be coeval.

The argillaceous sandstone member is exposed at Magoon Point on lake Memphremagog, and in the hilly area north of it. The

dark-grey rock is thick-bedded and medium-grained, consisting of abundant subrounded quartz grains set in a silty and argillaceous matrix. Locally, slaty zones and graded interbeds are present. At places, pockets contain quartz clasts 5 mm in size. Although field data suggest that the argillaceous sandstone is stratigraphically above the Bunker Hill greywacke, its relative age is uncertain and will have to be corroborated by further work. Outcrop areas of similar impure sandstone are found 5 km east of the northern tip of Lovering lake near highway 55, and in the creek crossing highway 50, some 2 km north of the present area. Here, detached blocks of argillaceous sandstone are embedded *pêle-mêle* in a shattered shaley matrix forming a *mélange* assemblage.

The metabasalt and associated tuffs of the Magoon Point unit underlie the hills 1 km northwest of Fitch Bay village, and also immediately west of Fitch Bay proper. The rock is green, massive and fine-grained, and generally exhibits flow structures and pillows. The latter are sheared and deformed, but locally are useful in top and bottom determinations. Several flows are apparent, separated by laminated, and locally graded or phyllitic, mafic and intermediate tuff. At places, the basalt grades into coarse-grained, gabbroic fractions. In fact, gabbro and basalt seem to be genetically associated, i.e. probably penecontemporaneous and of similar origin.

Felsic, crystal and lithic tuffs form large outcrop areas within the black-shale-slate Magoon Point complex. They are un-

distinguishable from felsic tuffs in the Bunker Hill, and in fact may be equivalent.

Discontinuous lenses of tuffaceous greywacke with associated slates and lithic sandstones similar to Bunker Hill rocks are found in the vicinity of Fitch Bay village, and northeast of Molsons Landing.

Mafic and intermediate, chlorite-rich tuffs, some of them distinctly laminated and phyllitic are associated with metabasalt northwest of Fitch Bay village. Future work will indicate whether they should be placed within the Bunker Hill Unit.

#### MAGOG GROUP

The Magog Group of Mid-Ordovician age underlies a north-east trending wedge-like belt at its northern margin, and tapering off at its southern end, where it is cut off by faults near Quinn Bay on lake Memphremagog. The belt is in fault contact with the Glenbrooke Group to the northwest, and with the Ascot Formation to the southeast. Because of lithological and structural similarities, as well as scarcity of outcrops, the contact between Magog and Ascot rocks could not be precisely located. From evidence north of the area, it seems probable that the contact may be an imbricate zone of alternating Magog and Ascot slices.

By far the preponderant rocks of the Magog Group are black and dull shales and slates with occasional lithic or feldspathic

sandstone and felsic tuff interbeds. Some oligomictic micro-conglomeratic beds show good grain gradation.

A 300-500 meter wide northeast-trending zone of beige, thick-bedded lithic and feldspathic sandstones and interbedded black slates is located west of Lovering Lake. Most of the clasts in the coarse, graded fractions are black shales or shale. At places, the feldspar content exceeds 20 percent.

Thin and discontinuous lenses and interbeds of beige, felsic tuff were observed here and there. They are in field appearance identical to felsic pyroclastics found in the Ascot Formation.

#### GLENBROOKE GROUP

Rocks of the Glenbrooke Group of Siluro-Devonian age are exposed in a northeast-trending 2 km-wide belt on the eastern bank of Lake Memphremagog. A fault separates the belt from Magog rocks to the east. It extends along the lake to south of Molsons Landing, where the Glenbrooke rocks are in fault contact with Ascot shales and slates.

Only three rock types are represented: 1) belts, 300 and 1000 m wide, of light-grey, massive to bedded, fossiliferous limestone. Bedding is not obvious in massive varieties; recrystallized remnants of colonial corals are found locally. 2) light-grey, limey shales and slates forming a 500-700 m wide central zone bound by the fossiliferous limestones above. 3) thin lenses of beige, felsic tuff within fossiliferous limestone northeast of Quinn Bay and south of Molsons Landing.

No age relationships between the above units could be obtained.

Of considerable interest are two occurrences of fossiliferous limestone outside the Glenbrooke belt. Grey, massive limestone is exposed in a creek bed 4 km west of Fitch Bay village. Sandwiched at the contact between Ascot and Magog belts, the limestone marks the fault separating the two belts. It probably represents a thrust slice of Glenbrooke.

Another anomalous outcrop area of Glenbrooke fossiliferous rocks occurs on the mainland north of Whitstone Island, in the southwestern part of the area. Here, several limestone outcrops and 3 small, abandoned quarries are found in an area of approximately 1 square kilometer. Contacts were not located, although Ascot shales and phyllitic slates were found nearby. A small patch of St. Francis rocks adjoins the Glenbrooke outcrop area to the south. The grey limestones are gritty, steeply dipping, and veined with coarse calcite. At several locations scattered crinoid discs were found. Obviously more work will have to be done to understand the contact relations between the Glenbrooke and adjoining rocks. For the present, the writer believes that this enclave represents an erosional outlier or thrust slice of Siluro-Devonian rocks.

#### ST. FRANCIS GROUP

Siluro-Devonian rocks of the St. Francis Group are exposed south-east of Fitch Bay and Bunker Brook, occupying the southeast

corner of the area. With the exception of extensive outcrop areas on the shore of Fitch Bay south of Whetstone Island, along and in the vicinity of Tomifobia River, and around Amy Corners, only sporadic outcrops are exposed in the 70 square kilometer area. A major northeast-trending fault running along Fitch Bay and Bunker Brook marks the western contact of the St. Francis Group with rocks of the Ascot Formation.

Both lithologically and structurally, the St. Francis rocks are very monotonous. In spite of intensive search, only two broad rock groups could be distinguished, mainly because of lack of outcrop and because the compositional differences are too slight to note on a map of this scale.

Most of the area is underlain by grey to blueish-grey carbonaceous limestones with silty argillaceous limestone interbeds. Dark-grey when fresh, the rock is generally evenly laminated. Locally, zones of dark-grey limy slates are characteristic, such as east of Whetstone Island.

A 1-2 km-wide, northeast trending belt of dark-grey limy shale and slate with argillaceous and silty limestone interbeds has been distinguished in the southeast part of the area. No structural or age relationships with enclosing limestone areas north and south of it could be obtained.

Three fossil occurrences were found in the St. Francis impure limestones. On a small road-cut east of Whetstone Island, a

1 meter-wide zone of recrystallized crinoid discs is observed. The other locations showing pockets of crinoids occur 3 km and 2.5 km north-northeast and northeast of Tomifobia, respectively.

The significance of the enclave of St. Francis rocks inside Ascot terrain north-northwest of Whetstone Island is still unknown. The dark-grey, laminated and tightly folded impure limestones are also in contact with silty and fossiliferous Glenbrooke limestones. Although a fault contact is postulated, an interfingering relationship is not excluded and would have to be corroborated later.

#### INTRUSIVE ROCKS

There are few intrusive rocks in the area. In decreasing order of abundance, they are: grey granite with associated aplites, gabbro, carbonatized dikes, and lamprophyres. Included here are also patches of carbonatized zones and quartz veins.

A nearly round stock of grey granite occupies a 3/4 square kilometer area north of Magoon Point. It is in discordant contact with argillaceous sandstones, as well as shales and slates of the Ascot Formation. The granite is an unaltered, coarse-grained, biotite-bearing variety of hypidiomorphic-granular texture. Its contact trace is regular and smooth with short and massive offshoots penetrating the argillaceous sandstone. The chill zone as shown up by microgranitic texture is 20-30 cm wide, while the alteration zone of

hornfels is only about 10-20 cm wide. Considering the striking compositional and textural similarity with the large granite mass around Graniteville some 2.5 km south of the area, it is likely that the granite stock is a post-kinematic intrusion related to the Acadian orogeny.

North and northeast-striking aplites, a few meters across, intrude brecciated contact zones on Long Island, northwest of Magoon Point.

Gabbro sheets are associated with the basalts and mafic tuffs of the Ascot Formation. Most are concentrated in the hilly area west of Fitch Bay. As mentioned above, the irregular distribution pattern of coarse fractions within the basalt mass suggests a genetic and probably coeval relationship between the basic rocks.

A yellow-weathering, 20 m-wide carbonatized dike, striking southeast was observed on Whetstone Island, cutting across basalt and black Ascot shaly slates.

Two small patches of carbonatized rock were found within Ascot shales and slates 0.7 and 1.3 km east of Fitch Bay village, respectively. The rock is red-brown on the weathered surface, and grey-blue when fresh. North of the area, similar iron-magnesium-carbonate zones are almost everywhere associated with ultramafic intrusions. It is probable that the carbonatized rock is an alteration of small ultrabasic bodies not far below surface.

Several basic lamprophyres are observed in shore outcrops of Glenbrooke limestone, north of Georgeville. They are 20 to 50 cm wide, steeply dipping, and their northwest-southeast trend is controlled by the regionally prevailing joint direction.

Several spectacular white quartz veins from 1 to 2 m thick fill vertical, northeasterly striking fractures in black Magog slaty shales 5 km west of Fitch Bay village. It is probable that their emplacement is related to the fracture zone separating Magog and Ascot belts.

Another quartz vein, about 3 m wide and traced for almost one kilometer, was located in the St. Francis slaty, argillaceous limestones east of Whetstone Island. Small, erratically distributed concentrations of calcite crystals fill the vugs between the coarsely crystalline material. Here too, the fracture is probably related to the fault zone several 100 meters farther west.

#### STRUCTURAL GEOLOGY

The structural picture of the area is complex as a result of polyphase deformation. An involved pattern of rock distribution characterizes the area underlain by the Ascot Formation; bits and pieces of tuff or basalt that originally were part of the same horizon are now dotting the country side as a result of repeated deformation. The structural inventory, in particular several foliations and lineations, is another indication of a complex structural history.

A diligent search was made for sedimentary structures, graded bedding in particular.

With the exception of few local occurrences, the regional structural grain is northeast, with beds and secondary foliations dipping moderately to steeply northwest. Although all four belts show evidence of repeated folding, the type and intensity of deformation varies from belt to belt.

#### Ascot Formation

The Ascot Formation is characterized by several major, inclined folds the axial traces of which follow the trend of the belt. Practically all foliations strike northeast, dipping moderately or steeply northwest. Three or possibly four lineations suggest that large, early recumbent and isoclinal folds have been repeatedly deformed. The 1st and, in particular, 2nd generation structures are most penetrating features controlling rock pattern, folding style and ground morphology. While the  $L_1$ -lineations trend northeast,  $L_2$  has a general NNE direction. The effects of the 3rd deformation, although everywhere evident, did not influence the structural pattern to a large degree.  $S_3$  and  $L_3$  as well as  $F_3$ -fold patterns are the most consistent structural features in the Ascot rocks.  $S_3$ -foliation dips gently northwest, while  $L_3$  generally plunges gently northeast. The most prevalent  $F_3$ -drag folds in the Ascot rocks are sinistral, looking north. At several localities, such as on a road cut 2 km northeast of Fitch Bay village, kink bands and folds in

graded feldspathic greywackes show up  $S_4$  and  $L_4$ , the latest and least developed mesostructures. The faint  $S_4$  foliation trends northwest and is parallel to the prevalent direction of joints in the area.

The most important structure of the Ascot Formation is the Bunker Hill antiform, the axial line of which was traced from north of Whetstone Island to Fitch Bay village and along the crest of Bunker Hill to west of Massawippi lake and North Hatley, beyond the present area. Primary and secondary structures within the greywacke complex of the Ascot have established with certainty that the fold, at least in the part northeast of Fitch Bay village, is an  $F_2$ -antiform plunging steeply northeast. The core of the antiform is occupied by younger rocks. Argillaceous sandstones exposed near Magoon Point seem to be in the core of the antiform and would therefore be stratigraphically above the greywacke. At the latitude of Lovering lake, it is fairly certain that the shales and slates of the Bunker Brook valley stratigraphically underlie the Bunker Hill greywacke. At the present stage, it seems probable that the Bunker Hill antiform folds a large, recumbent and isoclinal  $F_1$ -anticline, the nose of which is west of the above hill. In this interpretation, the core of the anticline would be occupied by black shales and slates, followed by necessarily younger tuffaceous greywacke and argillaceous sandstone. More conclusive top determinations in the argillaceous sandstones of Magoon Point should be of critical

importance in testing the validity of the stratigraphic order proposed above.

### Magog Group

Structurally, the Magog belt is controlled by a broad, southeasterly overturned, gently plunging synclinal fold. Plunge reversals to northeast and southwest are frequent.

Primary structures, in particular grain gradation, cross-bedding and flow or load casts, are common in Magog lithic and feldspathic sandstones. Exceptionally good outcrops are found 2.7 km west of Lovering lake and on an island, 1.7 km north of the area. Here, flow casts and refraction cleavage, as well as transverse joints, clearly indicate a gently, southwesterly plunging synclinal axis to the west.

Only two generations of mesostructures are apparent in Magog rocks. It may be tentatively deduced that the earliest cleavage in Magog is coeval with  $S_2$  in Ascot. It is, moreover, fairly certain that the second cleavage, which is a crenulation plane, corresponds to the regionally developed  $S_3$ - prevalent in a large part of the Eastern Townships. The synclinal fold mentioned above is probably a  $F_2$ -fold, since  $S_2$  is its axial plane cleavage. The  $S_3$  crenulation cleavage cuts across it.

It was noted that what seemed to be Magog shales and slates in the contact zone with the Ascot Formation, showed structural and metamorphic characteristics similar to those found in Ascot rocks.

There are indications that the Magog-Ascot contact may be a belt of thrusting rocks, that is, an imbricate zone of Ascot and Magog rocks.

#### Glenbrooke Group

Too few outcrops of Glenbrooke limestone have been visited, and data are insufficient to interpret them structurally. Because of their massiveness, only a faint cleavage is developed, and even bedding is not everywhere apparent. Both S-planes dip moderately to steeply northwest.

#### St. Francis Group

Although the area underlain by St. Francis rocks is large, only very few significant structural data are available. Because of the monotonous lithology and lack of outcrops, no major fold axes have been located.

Only two generations of secondary structures have been observed. Tight, similar type folds, coeval with Ascot  $F_2$ -folds, are of common occurrence. Their  $S_2$ -axial plane cleavage is clearly refolded by broader  $F_3$ -flexures, which are overturned to the southeast.

Some of the best examples of refolded folds are on the east bank of Fitch Bay, east of Whetstone Island. Here, tight,  $F_2$ -folds in laminated, and, at places slaty and silty limestones plunge  $45^\circ$  northeast. They are clearly deformed by small and open  $F_3$ -folds, the axial planes of which ( $S_3$ ) dip  $50^\circ$  northwest, and with axes

nearly parallel to  $L_2$ . Some kink bands of 130/50°S attitude are also present.

Another place where refolded folds are well exhibited is located in the Tomifobia rapids, 150 m south of that town's main road intersection. Tight, recumbent  $F_2$ -folds in buff-colored and grey-blue, laminated limestone are deformed into open, inclined folds, the axial plane of which ( $S_3$ ) dips 35° northwest. While  $F_2$ -axes plunge moderately, some 20°-30° northeast,  $F_3$ -axes have a gentle northerly direction.

Although the general pattern of deformation of St. Francis rocks is known, further work, perhaps in an area of greater outcrop density, would be necessary to gain more information about age relationships of structures between tectonic belts.

#### Joints and Faults

Joints are common, particularly in the Ascot basalt and Glenbrooke limestones. A prevalent set strikes 120° to 140° controlling the emplacement of lamprophyres.

Although there is nowhere evidence in the area of movement or displacement, the boundaries between the major belts are fault contacts. Certainly the Fitch Bay - Bunker Brook valley is the site of a regionally important fault that extends for tens of kilometers. Similarly, the contact between Magog and Ascot belts may be a zone of imbricate thrusting. More work will have to be done on a regional scale before the nature of the fractures can be properly evaluated.

### PLEISTOCENE

Although a blanket of glacial material covers some extensive areas, such as southeast of Fitch Bay, only few actual fluvioglacial deposits are concentrated anywhere. Some sand and gravel pits have been located south and west of Lovering lake, and 2.5 km southeast of Georgeville; they are actively exploited for local needs.

Glacial striae showing a 125° to 165° ice movement have been observed at several places.

### ECONOMIC GEOLOGY

Although the area is in a geologically favourable location, particularly as regards prospecting for copper minerals, and in spite of a diligent search for economically worthwhile mineralization, no significant finds were made. Since the lithology and structure of the Ascot belt in the present area are very similar to the geologic picture along strike farther northeast, where copper occurrences have been located and exploited, it is suggested that particular attention be paid to the volcanic ridge running parallel to Fitch Bay. The presence of a major fault in the vicinity further adds to the favourable geological and structural situation.

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