CANADA

DEPARTMENT OF MINES AND RESOURCES

MINES AND GEOLOGY BRANCH

GEOLOGICAL SURVEY

PAPER 45-8

Preliminary Map

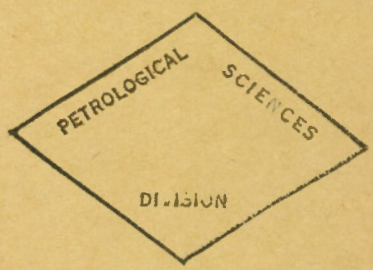
ORFORD

EASTERN TOWNSHIPS, QUEBEC

(Map and Descriptive Notes)

BY

Y. O. Fortier



OTTAWA

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ORFORD MAP-AREA, QUEBEC
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CONTENTS

Illustration

Orford Map-Area, Quebec

SEDIMENTARY ROCKS

Schists (1) with sericite, quartz, chlorite, or graphite, and with local albite metacrysts, are exposed on the western margin of the map-area. They are metamorphosed sedimentary rocks of Palaeozoic or Precambrian age, and are interbedded with some quartzite. Narrow bands of chlorite schists (2) intercalated with the sedimentary rocks are of volcanic origin and comprise bedded tuffs and pillowed lavas.

East of the above strata (1,2), and also in the southeast corner of the area, is a series of greywackes, quartzites, slates, and minor arkoses (3) of Cambrian or Ordovician age. In part these rocks have been sheared to phyllites and schists (6) with development of chlorite and sericite, and in places they contain lenses of coloured slates and quartzites (7).

Iron-stained, dark slates (8), locally quite graphitic, occupy most of the eastern part of the map-area. Bands of these slates are interstratified with the quartzose rocks (3), and some lenses of the latter are found in the slates. Near the western edge of the area of dark slates many exposures carry rock fragments, some of which are derived from older formations; others have resulted from the fragmentation of narrow quartzite beds interstratified with the slates and disrupted by crustal movement. To the northeast, where the rocks are less metamorphosed, the dark slates are interbedded with light grey quartzite, generally in subordinate amount and occurring in 1- to 2-inch beds, and, locally, in strata as much as 3 feet thick. In the southeast corner of the area the slates show greater deformation and alteration; an isograd line of metamorphism marks the appearance of a mica sheen or phyllitic aspect along the cleavage planes, of warping and minute crenulation of the cleavage planes, and of superposition of a secondary cleavage over the earlier one; farther southeast the rocks are phyllites and, locally, schists, and contain abundant stringers of milky quartz. A few bands of conglomerate (9) containing much siliceous volcanic detritus, and associated with tuffaceous grits, are exposed within the dark slates. The only fossils (F) found in the area were obtained from an exposure of dark slates on Castle Brook. The fossils are graptolites of Middle Ordovician age.

Lake Memphremagog and the low area to the north are underlain by a series of Devonian slates (11) with some quartzite and limestone beds. West of Cherry River village a few layers of quartz and quartzite conglomerate (10) lie at the contact of the series with the dark slates (8), and are thought to represent the basal conglomerate of the Devonian system as exposed in the adjoining Mansonville map-area to the south.

VOLCANIC ROCKS

Interlayered with the sedimentary strata (3,6,7,8,11) are rocks of dominantly volcanic origin (4,5). The bulk of these are altered andesites (greenstones) occurring both as small lenses and in areas many thousand feet wide. They include large tracts of massive flows; many bands contain pillowed lavas, some of which are amygdaloidal; and flow breccias, agglomerates, and bedded tuffs are also present. All these types constitute useful stratigraphic horizons. Information on stratigraphic tops, as determined from the attitude of pillows, has helped greatly in interpreting regional structures.

Bedded acidic tuffs and associated cherty slates, rhyolite, and sericite schists (5) occur in narrow bands. In the southeast corner of the map-area bodies of quartz-feldspar porphyry are intrusive into phyllites (8).

INTRUSIVE ROCKS

Ultrabasic rocks (12), including peridotite, dunite, and pyroxenite, are intrusive into the pre-Devonian formations. Most of them are serpentinized, and, locally, further altered to talc or to actinolite schists. Dunite and peridotite occur together without sharp contacts, whereas pyroxenite forms dykes cutting them; in a few exposures fragments of serpentinized dunite, peridotite, and pyroxenite lie in a matrix of serpentine; rare dunite dykes cut the peridotite. These observations suggest that the differentiation of the facies happened both in place and at depth. Some coarse-grained pyroxene-feldspar dykes and dykelets appear as pegmatitic phases cutting the above rocks. Locally the pegmatitic phases pass into medium-grained diorites. Dykes of aplitic granite cut all these types.

Chagnon, Orford, and Baldface Mountains are underlain by a complex (13,14) of intercutting and intergrading gabbro, diorite, quartz diorite, and granite, all of which are cut by dykes of trap, feldspar porphyry, and granite. Smaller bodies are scattered in the formations lying between the schists (1) and the dark slates (8). All phases of the complex are characterized by hornblende in coarse sieve-texture and by clusters of leucoxene after ilmenite. In some of the more basic phases, cores of diallage are surrounded by hornblende. Chlorite replaces the hornblende in the more altered types. Feldspar is generally thoroughly saussuritized, epidote and chlorite minerals clouding the grains; any discernible plagioclase has the composition of albite. Epidote veinlets are abundant. Quartz, especially in the more acidic facies where it occurs in clusters, is generally milky and coarse; it is surrounded by hornblende and constitutes up to 50 per cent of the rock. Areas where the quartzose and the basic types (14) are present together have been differentiated roughly in the mapping from areas of diorite and gabbro (13) in which no appreciable quartz occurs. The latter types are generally fine- to medium-grained, and have not been mapped separately from associated massive, coarse- to medium-grained, andesitic flows.

Some diorite dykes cut the serpentinized rocks, and, for this reason, the rocks of the Orford-Chagnon-Baldface complex are deduced to be later than the ultrabasic rocks. Other diorite dykes are closely associated with the andesitic lavas and may have been intruded during the period of volcanism, and thus antedate the ultrabasic intrusions.

The conformity of the ultrabasic, basic, and hornblende granite bodies to the regional structure suggests that the country rocks were folded before the intrusion of these igneous rocks. However, brecciation and shearing of the serpentines and local shearing, mylonitization, and development of gneissosity in the hornblende-bearing rocks point to their mechanical deformation. These facts suggest that they were probably intruded between the Taconian and the Acadian orogenies that mark respectively the close of the Ordovician and Devonian periods in the region. None was observed to cut the Devonian strata.

A fresh looking granite with scant biotite is exposed east of Bowker Lake. It is much brecciated, and is probably contemporaneous with the biotite granite that cuts strata of Devonian age near the International Boundary, east of Lake Memphremagog. Other small exposures of brecciated granite occur around Long Pond.

Some lamprophyre dykes and a few composite dykes of alkaline rocks of Monteregian affinity are quite fresh, and are probably the youngest intrusions in the region.

STRUCTURE

The strata in the map-area trend generally east of north and in most places dip steeply. They lie on the limb common to an anticlinorium, on the west, and to a synclinorium, on the east.

In the southern part of the area the Devonian rocks, together with the older strata, have been folded into a syncline. East of Magog, where a uniform cleavage in the slates has not suffered subsequent deformation, the relation of bedding to cleavage has been used to infer the presence of an anticline and a syncline. These folds are overturned to the west. In the northeast part of the area, where the rocks are less metamorphosed and exposures are abundant, folds are observed to be numerous; there are larger tracts of easterly dipping than westerly dipping strata, and, near the east edge of the area, north and south of Orford Centre, exposures of flat-lying beds are up to 300 feet wide. From these observations it seems probable that the area lies on the west limb, and perhaps in the trough, of a synclinorium.

For about half a mile east of Brompton Lake bedded tuffs and associated sediments and iron-stained slates and agglomerates are exposed striking north of east and dipping steeply northward; farther east these rock units swing sharply to the south and are then repeated in the reverse order, striking south and dipping steeply east; the fold plunges northeast. West of the lake bedded tuffs in probable stratigraphic continuity with those exposed to the east are associated with pillowed lavas facing southeast. Consequently, in the structure described above, the beds face each other, and the fold is a syncline with a plunge overturned to the southwest. At East Branch Pond, where the strata face east, and to the east of the pond, the lithologic units present on the west limb of the syncline just described are not exposed. This may be due either to an unconformity, of which no other sign was found, to a fault, or to a steeply plunging anticline east of the syncline. South of Webster Lake rocks are greatly contorted and brecciated; many drag-folds plunge nearly vertically; and, although observations on the attitude of the beds could rarely be obtained, a few suggest curving of the beds around a bend nosing south. A few exposures of agglomerates similar to those found near the nose of the syncline are exposed from north of Little Brompton Lake to the north edge of the map-area. These observations suggest the presence of an anticline east of the syncline, although the possibility of faulting is not excluded. The Z-structure formed by the steeply plunging syncline and anticline is similar to the Sugarloaf-Pevee structure described by Ambrose in the adjoining Mansonville area (Geol. Surv., Canada, Paper 42-1). A small anticline, plunging 60 degrees south, has been outlined in well-bedded dark slates about 4 miles north of Magog.

Bowker Lake, Mud Pond, and the Gulf lie in a depression with some steep cliffs to the west. Coinciding with the depression is a zone of contorted phyllites and schists with some sheared igneous rocks to the east. On each side of the depression the strata have tops to the east; beds on the west side dip steeply east, whereas those on the east side dip vertically or to the west. Schistosity on the west side of Bowker Lake trends slightly east of north, but on the east side it trends northeast. The westernmost exposures of serpentine (12) are strewn along a zone within the depression. The above features are considered as criteria of a fault. Projected southward along the line of westernmost exposures of sheared serpentine and along low ground, the fault joins up in the valley of Missisquoi River with the fault described by Ambrose in the Mansonville area.

Oblique faults displace strata between Bowker Lake and Webster Lake. Numerous small faults are exposed near the axes of the folds in the area east and northeast of St-Elie d'Orford.

Formations throughout the map-area display a cleavage. Between Orford Mountain and a mile west of Lake Magog this cleavage strikes uniformly east of north, and generally dips steeply to the east. North of Lake Magog the cleavage changes attitude in passing from quartzite into slate or back into quartzite; viewed in vertical section normal to its trend, it describes sinuous curves and apparently has been deformed by the sliding of one bed over another. Westward from Orford Mountain the deformation of the cleavage increases to the point where, in the schists (1), it is dragged into numerous folds and a closely spaced secondary cleavage is superposed on it along the axial planes of minute crenulations; secondary minerals like actinolite, which grew along the earlier cleavage, were bent around the minute crenulae and fractured by the superposed secondary cleavage, whereas albite metacrysts carry inclusions drawn into minute crenulae. The same phenomena may be observed, but to a lesser degree, in the area east of Lake Magog. It is doubtful if the relations of bedding to cleavage can be used to deduce stratigraphic tops where the cleavage has undergone deformation.

Both structure and relative competency of the country rocks have influenced the localization of the great majority of intrusions of igneous rocks. Intrusions are limited almost exclusively to a central zone of relatively brittle rocks (3,4) flanked on both sides by relatively plastic rocks (1,8). Sills are plentiful, and the larger intrusive masses reflect roughly the regional structural trend. The best example of structural control of intrusive rocks is found around the Z-fold east of Brompton Lake and along the Missisquoi Valley-Bowker Lake fault.

ECONOMIC GEOLOGY

Chromite occurs as an accessory mineral in the serpentinized ultrabasic rocks. Concentrations of the mineral in "banded disseminations" or in massive lenses occur in the different serpentine bodies throughout the area. Concentration is greatest in a zone that is roughly parallel to, and near the east contact of, the large body of serpentine between Brompton and Webster Lakes. Chromite was mined from this zone during both the last and the present wars. Other, small concentrations of chromite are exposed in relatively fresh dunite east of Mud Pond, in serpentine near the north arm of Stukely Lake, and also west of Trousers Lake.

Tiny veinlets of asbestos are common in serpentine, but sizable veins are comparatively rare. Showings were observed in the serpentine mass east of Brompton Lake; the best of these are along a shear zone near the northeast shore of Little Brompton Lake. A sizable pit in asbestos-bearing serpentine lies on the east shore of Long Pond; another pit lies a third of a mile northwest of Trousers Lake.

Impure talc occurs in narrow zones of shearing within the serpentine masses or at their edges. One such showing lies between the serpentine and the greenstone lavas at the Ives mine south of Eastman.

A nickeliferous deposit was operated in the last century between Webster and Brompton Lakes. The deposit lies in a vein of calcite at the contact of serpentine and quartzose tuffs, and the ore consists of millerite, diopside, and uvarovite with cores of chromite. Some diopside and uvarovite with chromite occur at the contact of serpentine with red slates a third of a mile north of Little Brompton Lake.

The Ives and Huntington copper mines, ½ mile and 3 miles respectively south of Eastman, have been worked and explored at intervals since 1866. The ore consists of chalcopyrite and pyrrhotite filling shears in east dipping greenstone lavas near their contact with a serpentine sill to the west. At the Ives mine a band of talc separates the serpentine from the greenstone. Other occurrences of chalcopyrite lie in the greenstone north of O'Malley Pond, in narrow shear zones in serpentine southwest of St-Denis de Brompton, and at the contact of serpentine and pegmatitic diorite in a narrow shear zone half a mile northwest of Fraser Lake. Logan reported on some chalcopyrite showings at the foot of Carbuncle Hill, west of Brompton Lake.

In the southeast corner of the map-area sulphides are associated with numerous, small, milky quartz veins in quartz-feldspar porphyry. Disseminated sulphides replace narrow bands of sericite schists, which are probably meta-rhyolite flows; these are too small to be shown on the map. The siliceous rocks are similar to the host rocks in which occur the copper-pyrite or lead-zinc-silver deposits at Suffield, Eustis, Albert, Ascot, etc., a few miles east of the Orford area.

A small lens of hematite lies at the contact of greenstone flow breccia and slates, a few feet south of the highway, 4 miles west of Magog. Another such small lens lies a mile east of Long Pond at the east contact of banded greenstone schists and greywackes.

Red marble has been mined from a small quarry at the contact of actinolitized serpentine and brecciated granite between Bowker Lake and Chain Ponds.

The dark slates are generally highly fissile, breaking into small scales, and, consequently, would be of little use as roofing material. Green, purple, and red slates near Orford Lake and northwest of Fraser Lake are more massive and break in larger slabs; they might be useful as decorative roofing material. Granite and serpentine are either too brecciated or are traversed by too many irregular fractures to have any strength as building material. A band of fine-grained, massive, dark grey rhyolite, exposed on the highway half a mile west of Orford Lake, might include material suitable for roofing granules.

Many small gravel pits are scattered throughout the area. They are mostly in poorly stratified fluvioglacial deposits; the material varies from fine sand to boulders a foot in diameter; sorting is poor; stratification is irregular, fine to coarse, and lenticular, with frequent crossbedding. The product is used mostly as road metal.