GEOLOGY OF THE GATINEAU STRIP: CHELSEA, QUEBEC

By D.D. Hogarth
University of Ottawa

This report and accompanying map summarizes our knowledge of the geology in this region. It is designed for local residents, the inquisitive laypersons, not the scientific specialists. It should be regarded as a preliminary and generalized report of the solid rocks in place, many of which lie below Recent (geologically speaking) clays, sands and gravels of the southern Gatineau Valley. It is concerned with *Precambrian* formations extending through the middle-to-late era of primitive life (*Proterozoic*). With the exception of a few small outcrops of irrefutably *igneous* rocks, they are all *metamorphic*. Sedimentary rocks are rare: only in Headley Brook, about 2 km south of Chelsea Road, and outside of our map-area, is unmetamorphosed *Cambro-Ordovician* (Nepean) sandstone exposed, and there as a very small outcrop. For fossiliferous (*Ottawa*) limestone we must go another 3 km, traverse the ridge of the Gatineau Park, to the Mountain Road below.

Except for the southernmost end of the map - area (west of Rt 105), previous geological research has involved reconnaissance only (summarized in guidebooks for field trips pertaining to International Geological Congresses of 1913 and 1972, and reported by the Quebec *Ministère des Richesses naturelles* in 1977). The present report and map is based on fieldwork conducted during the summer of 2000 and parts of summers 1998 and 1999.

The map-area includes the strip of land between the Gatineau River to Rt 5 (see map). Route 5, the "autoroute", is a natural boundary, as it lies on, or is very close to, a topographic divide: waters on the east drain directly into the Gatineau, those on the west drain into Meech Creek (north end of the autoroute), or into Chelsea Brook (near the southern map boundary). This "height of land" peaks about 150 m above the River. It generally, separates minnow-rich creeks on the west from fish-free creeks on the east.

Rock types with sedimentary ancestry

The region can be trisected in terms of meta-sedimentary rock: the northwestern part characterized by dark green, granular, layered *gneiss* (coloured by *diopside*), the middle (southeast of the Kirk's Ferry fault

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system) characterized by hard, white-to-brown *quartzite* with interlayered black-to-grey biotite gneiss, and the southeast characterized by soft white-to-grey *marble*. Compared with other rock types, marble is water soluble and the resulting high porosity can provide good aquifers and reservoirs, but the water is inclined to be "hard", and extra large pore spaces and channels may lead to poor filtration. The overall rock assemblage suggests sedimentary ancestors of a shallow, marine, platform type, though quartzite, locally containing considerable residual feldspar, may reflect surficial and desert conditions.

Magnesium-bearing carbonates in the marble reacted with silica in the gneiss or quartzite to produce a diopside-rich *skarn*, a favourable host for mica and phosphate deposits. The reactions were enhanced by the presence of water and fluorine in the system. Note, one pattern is used for both marble and skarn. This pattern represents mostly marble southeast of Hellard Point, mostly skarn to the west.

Rocks with igneous ancestry

Hard, pink-to-orange or yellow *meta-syenite* and black-to-dark green *meta-diorite* are common northwest of the Kirks Ferry Faults. They are part of the *Wakefield Complex* and part of a large metamorphosed igneous body, the *Wakefield Batholith*, which crops out for 110 square miles (70,000 acres), mainly to the west. In our region, the syenite contains considerable quartz and is transitional to granite. It is distinctly foliated and could be termed gneiss. However, in common with less-metamorphosed variants in Gatineau Park, it contains large grains of pink feldspar set in a finer grained groundmass. The coarse grains are thought to represent early precipitates from a melt *(phenocrysts)*. Accessible syenite exposures can be viewed at and around the Larrimac golf course. Meta-diorite (with grey feldspar) is associated with metasyenite and, in some places (Like Binks' Peninsula), is transitional into it. Good exposures are available near the northwest end of the autoroute.

Two rocks, probably contemporaneous with regional metamorphism, should be mentioned: *quartz monzonite* and *granite pegmatite*. Quartz monzonite is a hard, granular grey rock, here showing neither foliation nor igneous texture. It can be traced, as a single body, from Old Chelsea 3 km to near the Gatineau River.

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All rocks noted to this point, whether meta-sedimentary, meta-igneous or igneous, are transected by hard pink, coarse-grained (commonly with crystal > 1 cm across) granitic rock, known as granite pegmatite. Only a few of the larger occurrences are plotted on the map. An approachable example is at the extreme northwest end of the autoroute.

Of all rocks with igneous parentage, only the *basic* (dark coloured, magnesian) *dykes* retain an irrefutable, microscopic igneous texture, but these dykes are all small (< 1 m thick). They belong to three types: 1) black, very hard, calcic *diabase* (only one, poorly exposed, example known in the map-area, near Chelsea Rd), 2) black-to-grey, hard sodic (e.g. south of Burt's Point), and 3) brownish black, softer, but equally tough, potassic (e.g. dykes along the autoroute).

Mineral deposits

The Gatineau region is famous for its amber mica *(phlogopite)* deposits, formerly in demand as a component of electrical generators. Peak production was in the early part of the last century. It was later replaced in the electric industry by white mica (*muscovite)* and synthetic products, and has no market value today. The main mica mines were east of the Gatineau yet, on this side, some of the phlogopite crystals were very large: a crystal from Gleneagle Peninsula measured 17.6 cm diameter, and a crystal from the Cascades mine, immediately north of the map-area, was reported to be "5 × 7 feet" (1.5 × 2.1 m)!

Less well known is *apatite*, from 1877 mined as a source of phosphate for the fertilizer industry. From 1891 to 1895 new producers in Florida depressed the market and tolled the death knell for Canadian apatite. Apatite commonly occurs in the same deposits as phlogopite (e.g. the Haycock mines on Gleneagle Peninsula), but they may occur separately. Thus, some veins were worked for apatite only (e.g. the Irish Mine on Sherrin Point), but some were worked mica alone (e.g. the Swamp Mine near the south end of Musie Fault).

An interesting rock is exposed in low rock cuts along each leg of the divided autoroute, about 2 1/4 km above the Scott Road overpass. On first impression, it appears to be white marble, but this rock is hard and contains little calcite, an essential ingredient of marble. In fact, the rock is mainly made up of quartz and diopside, and closely resembles the Minnes

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deposit near Wakefield, tested for ceramic-grade diopside by Bishop Fibertek, 15 years ago. Of course, our deposit is far too small for economic potential, but it has considerable academic interest. How is an iron-free skarn deposit generated?

Jasper (near Scott Rd) has been know to lapidaries from at least as far back as 1884. Brownish yellow and brick red, it takes a good polish and produces a handsome stone. However, a word of warning to over-enthousiastic collectors: most occurrences are badly overgrown or filled in due to property development or safety considerations. Furthermore, nearly all are on **private property and permission must be obtained for access and removal of material.** Those wishing to collect from highway cuts should park on the shoulder, well off the road. Beware of traffic and make your stop, one of short duration!

Structure

Planar minerals (like micas) tend to be aligned parallel to the axial planes of folds and, with the exception of apices of a few folds in quartzite, these foliations parallel layering in the rock. Most outcrops show north-northeast to northeast trending layers (measured on a horizontal surface) and are inclined (with respect to the horizontal) steeply eastward. The two flanks of folds are roughly parallel *(isoclinal)* and the folds are tight. The crests and troughs of folds trend northeasterly and dip at gentle angles (commonly 15 to 25°) in this direction, with respect to the horizontal. Applying this model, the upright "u-fold" below the Glen Eagle Peninsula is trough-shaped or *synclinal*, but the inverted "u-fold" to the west is dome-shaped or *anticlinal.*

These folds were formed at depth and there is no evidence that the tight folding with short periodicity had a surface expression in the Proterozoic. The popular impression that these folded rocks represent the stumps of former mountains, may very well be a myth.

Faults occur everywhere in the area, but have little displacement, one side with respect to the other. One fault (the Willson) can be traced continuously SSW to Meech Creek, where it produces an abrupt drop at the ruins of "Carbide" Willson's phosphate mill, near the outlet of Meech Lake. Another (the Chelsea) can be traced 15 km across country: WSW to the Meech Lake Road and ENE into Templeton Township. Faults can provide

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a welcome water course, but just as easily, they can steal the water. There is no evidence of recent movement along the fractures, but flat fractures near the top of large rock cuts on the autoroute, may be the result of "popups" after excavation.

Some faults, with their fractured borders, have been eroded into linear depressions. Thus the Chelsea Fault Channel provided access to Leda clay, culminating in the disastrous landslide of May 8, 1973, which removed portions of the autoroute, Route 105 and the C.P.R. track.

Age and conditions of metamorphism

The age of sedimentary protoliths can be correlated with similar metasedimentary rocks in the Frontenac terrane (south of Ottawa) as 1400 million years (m.y.). Peak metamorphism appears to have taken place 1100 m.y. ago, which pinpoints the time of intrusion of syenite-diorite-quartz monzonite-granite. The potassic dykes have been dated at 1000 m.y., the diabase at 590 m.y. The last, a *Neoproterozoic* intrusion, is the most recent igneous rock of the area. In contrast, the post-Pleistocene Champlain Sea, representing an invasion of marine waters after recession of the glaciers, dates from 11,500 to 9,500 years ago.

Temperatures of metamorphism ranged from 600 to 700°C at pressures equivalent to 22 to 25 km of rock burial. A convenient mechanism to attain such extreme conditions and, at the same time, explain the peculiar mix of mantle and crustal constituents in the rocks, is by thrusting a segment of the Earth's crust downwards. This is the theory of plate tectonics, and it has been evoked (many times) to explain various geological phenomena.

This has gone on too long. Like Sir Robert Boyle, in his *Origine and Virtues of Gems* (1672), "I have written a long essay because I had not the leisure to write me a short one".

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