GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PRELIMINARY SERIES

$31\frac{C}{8}$

LEGEND

ORDOVICIAN

PALAEOZOIC

MIDDLE ORDOVICIAN (BLACK RIVER)

16	GULL RIVER FORMATION: Pamelia beds, light grey to white, microcrystalline to cryptocrystalline dolomitic limestone and limestone; 16a, Rideau beds below Pamelia beds: green shale and sandstone, minor conglomerate and fragmental layers; 16b, Lowville beds (above Pamelia): grey brown, well bedded, fossiliferous limestone

LOWER ORDOVICIAN OR CAMBRIAN

15	POTSDAM OR NEPEAN FORMATION: sandstone, some conglomerate

PRECAMBRIAN

14	Porphyritic and amygdular andesite dykes
13	Diabase dykes
12	Coarse-grained, massive, leucocratic, pink to brownish grey monzonite, syenite, quartz monzonite, granodiorite, and syenodiorite
11	Medium-grained, leucocratic red granite
10	White pegmatite, everywhere associated with marble or lime-silicate rocks; 10a, white granite; 10b, white diorite
9	Gabbro
8	Migmatite: poorly foliated intermixed granitic and metamorphic rocks
7	Pyroxene granulite: fine-grained, leucocratic, generally massive rocks, rich in quartz and feldspar and containing minor diopside
6	Pyroxene gneiss: well foliated diopside-rich gneiss, minor amphibolite
5	Stratiform biotite-quartz-feldspar gneiss with granitic layers, generally contains hypersthene, cordierite, or sillimanite
4	Well-layered garnet-biotite-quartz-feldspar gneiss, containing hypersthene, cordierite, or sillimanite
3	White homogeneous quartzite
2	Interlayered quartzite-marble transition rock, generally finely laminated and associated with lime-silicates
1	Crystalline limestone (marble), siliceous crystalline limestone and skarn, includes fragments of white pegmatite (10); 1a, rusty-weathering, quartz-diopside-feldspar gneiss

Geological boundary (defined, assumed)
Stratiform foliation (parallel to bedding), horizontal, inclined, vertical
Gneissosity (inclined, vertical, dip unknown)
Lineation (inclined, may be combined with other symbols; horizontal)
Mylonite lamination (inclined, vertical)
Minor fold (arrow indicates plunge)
Lineament (from air photographs)
Fault (defined)
Mylonite zone (width indicated)
Anticline
Syncline
Glacial striae
Sand and gravel
Quarry or mineral pit

MINERALS

Galena . . . . . gn	Silica . . . . . . sc
Mica . . . . . . mi	Sphalerite . . . sp
Pyrite . . . . . py	Stone . . . . . . st
Quartz crystals . q	Sand . . . . s

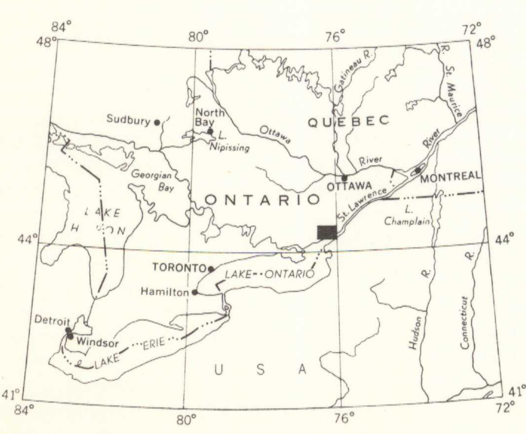
Geology by H. R. Wynne-Edwards, 1961

Cartography by the Geological Survey of Canada, 1962

Main highway
Other roads
Trail
Railway
International boundary
County boundary
Telephone line
Post Office
Cliff
Marsh
Height in feet above mean sea-level . . . 245′

Base-map by the Army Survey Establishment, R. C. E., Department of National Defence,

Approximate magnetic declination, 12° 05′ West, decreasing 0.2′ annually



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MAP 27-1962
GEOLOGY
GANANOQUE
ONTARIO

Scale: One Inch to One Mile = $\frac{1}{63,360}$

Miles 1 ½ 0 1 2 3

DESCRIPTIVE NOTES

The map-area lies astride the Frontenac Axis, a narrow neck of Precambrian rocks (1-14) connecting the Canadian Shield to the Adirondack Mountains of New York State, and separating Palaeozoic strata of the Ottawa - St. Lawrence Lowland to the northeast from similar strata to the southwest (15-16).

Units 1-7 are metamorphosed sedimentary rocks typical of large parts of the Grenville province. Crystalline limestone (1) is dominantly coarse-grained marble containing small amounts of diopside, serpentine, quartz, feldspar, scapolite, apatite, and tourmaline. Small masses of white pegmatite and diopside skarn, as well as contorted and broken layers of pyritic, rusty-weathering, quartz-diopside feldspar gneiss (1a), are distributed throughout the marble and are included in this unit. North of Gananoque Lake, and west of Gananoque, the marble becomes highly serpentinous and siliceous, marking a gradual transition from marble to quartzite. These transitional rocks are mapped as unit 2. Where best developed, this unit consists of thin, alternating layers of marble, quartzite, and calc-silicates, but large masses of each of these, as well as white pegmatite, are present. The white pegmatite (10) west of Gananoque and just south of Highway 401 is a part of this unit where feldspathic rocks predominate.

Quartzite (3) is a hard, white, massive rock, which forms prominent ridges. In many places it displays undisturbed bedding marked by disseminated magnetite and specularite. Units 4 and 5 are layered gneisses that consist predominantly of quartz, oligoclase, microcline perthite, and biotite. Layers containing garnet form persistent marker horizons and have been mapped separately (4). Cordierite, hypersthene, sillimanite, magnetite, and green spinel are common in these rocks, typically forming small, elliptical lenses or pods about an inch long. Pyroxene gneiss (6) is a foliated green rock consisting essentially of quartz, diopside, and oligoclase, with minor sphene, and scapolite, perthite, and grossularite in some varieties. The granulite of unit 7 is similar in mineralogy to unit 6, but is more leucocratic, finer grained, and either massive, or only poorly layered. Migmatite (8) forms an envelope of varying thickness around large bodies of syenite and granite, and consists of units 5, 6, and 7 intermixed with granitic rocks.

The gabbro (9) around Horseshoe and Traverse Lakes is a brown- to black-weathering rock consisting mainly of andesine, altered pyroxene, and biotite. That northwest of South Lake is less altered, contains less biotite, and generally displays ophitic texture. The small associated mass south of Seeley's Bay has a fine-grained margin, presumably the result of rapid cooling, and the presence of wollastonite in the marble nearby may be a contact-metamorphic effect. The gabbro grades into syenite (12), and their relative ages were not established with certainty. Both are cut by quartz-perthite-tourmaline dykelets, and by diabase (13).

White pegmatite (10) and granite (10a) occur within marble (1) and have the same composition as the pink granitic material in the gneisses. Their white colour is due to the reduction of ferric iron, normally responsible for the pink colour of the feldspars, by carbon dioxide emanating from marble, so that these white rocks are an unfailing indicator of the presence of carbonate, and units 1 and 10 may be grouped together for stratigraphic correlation purposes. The white pegmatite and white granite bodies are generally small in size, and contain the mafic minerals present in the adjacent crystalline limestone. White diorite (10b) contains olive-green hornblende and subhedral, zoned andesine feldspar.

The medium-grained granite of unit 11 is uniform in appearance and composition over wide areas. Grey, yellowish, and white phases are locally developed, but otherwise the rock is an attractive rose red. The granite is potash-rich and consists of an equigranular mosaic of quartz, microcline, albite, and biotite. Perthite is not developed.

Coarse-grained syenite and related rocks (12) occur in four large bodies. Of these, the syenite south of Perth Road village, the syenite that extends from Kingston Mills northeast to South Lake, and the syenite that extends from Gananoque to the east edge of the map-area, are similar in composition and appearance. Each of these is characterized by a pink, leucocratic outer rim, and a dark grey, more dioritic core. The rocks consist essentially of an inequigranular interlocking mosaic of perthite and oligoclase. Quartz is locally present in amounts up to 15 per cent. The varietal minerals typically include biotite, clinopyroxene altered to hornblende or to a chlorite-carbonate intergrowth, sphene, magnetite, apatite, and zircon. The similar mass north of Battersea village differs from the others in containing 20 to 40 per cent quartz. At two localities east of the map-area the syenite contains inclusions of fine-grained pink granite lithologically identical with unit 11, which indicates that the coarse-grained syenite of unit 12 is the younger rock.

Late diabase dykes (13) cut all these Precambrian rocks. With few exceptions, they trend north-northwest, and are concentrated in a swarm between Gananoque and South Lake. They are believed to occupy tension fractures along the culmination of the Frontenac Axis. Younger fine-grained andesite dykes (14), in many places containing large phenocrysts of andesine, are chilled against diabase, have a consistent northeast trend, and are not found on the west side of the Axis.

Pure quartz sandstone (15) unconformably overlies the Precambrian rocks (1-14) on an erosion surface similar in topography to that of the present day. The deep weathering of this ancient landscape is preserved in many places beneath the sandstone. Numerous outliers show that the sandstone once covered the Frontenac Axis. Conglomerate lenses are locally present at the base and within the formation, which is otherwise a white to red silica sandstone composed of well-rounded quartz grains cemented by hematite, quartz, or calcite. Sandstone of this lithology underlies a large area in northern New York State and southern Ontario, on both sides of the Frontenac Axis. It was termed 'Potsdam' in St. Lawrence County, New York in 1838, and this name was later applied over its whole extent, the formation being assigned to the Upper Cambrian. East of the Frontenac Axis in Ontario, where the sandstone is overlain conformably by sandy dolomite of the Beekmantown and thus may be Lower Ordovician in age, it was redefined as the Nepean by Wilson[1].

Limestone of Black River age (Gull River Formation of Okulitch[2]) (16) directly overlies both the Potsdam Sandstone and the Precambrian rocks in Gananoque map-area on the west side of the Axis, showing that the relationship between the two sedimentary units (15, 16) is disconformable. Occurring at the base of the limestone where it overlies Precambrian rocks, is a conformable green clastic unit, designated the Rideau beds (16a) by Kindle[3], with its type locality in the railway-cut at Kingston Mills. Its maximum known thickness is 30 feet. On the south shore of Loughborough Lake, a mile east of Battersea, these beds rest on Potsdam Sandstone, but this is the only locality where this was observed. Apart from a capping of brownish limestone (Lowville beds, 16b) just north of Kingston, the rest of the Ordovician strata in the map-area consists of the Pamelia beds (16), with a total thickness of approximately 110 feet. These are the thickly bedded, dove-grey dolomitic limestones used in many of the older buildings in Kingston.

The structure of the Precambrian rocks is similar to that in Westport map-area immediately to the north[4], except that the plunge of the fold axes is shallow and changes in short distances from southwest to northeast. Northeast of the crest of the Frontenac Axis, in Westport map-area, the folds plunge northeast at an average of 35 degrees. In Gananoque map-area, on the crest of the Axis or southwest of it, the folds most commonly plunge gently southwest. This difference must be due to the uplift of the Frontenac Axis itself.

Apart from the rocks in the northwestern corner of the area, which are in true granulite facies, the grade of metamorphism of units 1-7 is probably intermediate between amphibolite and granulite facies, but does not fit into the present metamorphic facies classification. It is characterized especially by abundant cordierite, the assemblage cordierite + garnet, the predominance of diopside over hornblende, and the local appearance of hypersthene in the gneisses. Similar rocks are found in Westport map-area[4].

Numerous sand and gravel pits are in operation, as are quarries for crushed limestone aggregate in the Ordovician rocks (16). These rocks, as well as granite (11), syenite (12), and sandstone (15) have all been quarried for building- and paving-stone in the past, but the only dimension stone being produced at present is striped sandstone from quarries east of Joyceville. The Potsdam Sandstone is also a potential source of silica sand. No other economic deposits were being worked in 1961.

[1] Wilson, A. E.: Geology of the Ottawa - St. Lawrence Lowland, Ontario, and Quebec; Geol. Surv., Canada, Mem. 241 (1946).
[2] Okulitch, V. J.: The Ordovician Section at Coboconk, Ontario; Trans. Roy. Can. Inst., No. 48, pt. 2, pp. 319-339 (1939).
[3] Baker, M. B.: The Geology of Kingston and Vicinity, Appendix 1 "The Ordovician Limestones of the Kingston Area" by E. M. Kindle; Ont. Bur. Mines Ann. Rept., vol. 25, pt. 3 (1916).
[4] Wynne-Edwards, H. R.: Westport Map-area, Ontario; Geol. Surv., Canada, Map 28-1959, with descriptive notes (1959).

MAP 27-1962
GANANOQUE
ONTARIO
$31\frac{C}{8}$