CARLETON UNIVERSITY

DEPARTMENT OF GEOLOGY

GEOLOGICAL PAPER

69 - 1

PRELIMINARY MAP AND NOTES

ARNPRIOR, ONTARIO, CANADA

by

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OTTAWA, CANADA

1969

ABSTRACT

The central and eastern part of the Arnprior map-area is underlain by Ordovician sedimentary rocks of the Ottawa-St. Lawrence lowland, the remainder by Precambrian (Grenville) plutonic and high grade metamorphic rocks of the upper amphibolite or hornblende granulite facies.

The paragneisses consist mainly of interbedded marbles, quartzo-feldspathic gneisses ("granite gneisses") and minor amphibolite, and are divisible into irregular and lenticular units in which superposition could not be determined. They are intruded by granite, granodiorite, syenite, monzonite, and diabase. With the exception of the diabase, all the Precambrian rocks possess a northeasterly-trending, southeasterly-dipping regional foliation. Minor fold axes plunge gently to the northeast.

The Ordovician rocks overlie the Precambrian unconformably. They are flat-lying but locally show gentle supratenuous folds. The Nepean, March, Oxford and Rockcliffe formations wedge out within the map-area and the overlying Ottawa formation appears to have covered the entire area.

The central part of the area is crossed by a graben of Palaeozoic age. Most of the lowland area, was during the Pleistocene, covered by the Champlain Sea.

INTRODUCTION

For about 50 years, from 1910 until her death in 1964, Alice E. Wilson systematically mapped the Palaeozoic rocks of the Ottawa-St. Lawrence lowland. She did not attempt to map the Precambrian rocks and her map of the Ottawa area contains thirty square miles of undivided Precambrian (Wilson 1940).

Dr. Wilson had examined the Palaeozoic rocks of the Arnprior area but had not published her results. Parts of the area had been included in earlier reconnaissance maps, and in detailed descriptions of mineral occurrences (Ells, 1904, Wilson, M.E., 1924). The map-sheets adjoining Arnprior which have been published recently are: Ottawa (A.E. Wilson, 1940), Carleton Place (Reinhardt and Liberty, 1964), Renfrew (Quinn, 1956), and Bristol (Sabourin, 1954). Other local work has been done by Kirwan (1961) and Hogarth (1962). A full compilation is given by MacDonald (1967). The surficial geology has been described by Gadd (1963).

BACKGROUND TO THE PROJECT

The Arnprior map-area is one of the few within reasonable reach of Ottawa for which no complete geological study had been made. In the autumn of 1962, two of us (P.A.H. and J.L.K.) decided that the area could be mapped by students as part of a course in field geology.

The Precambrian was mapped in 1963, 1964, and 1965 by 2nd year students who were assigned specific areas of about five square miles and asked to present a complete record of their traverses together with sketches and samples. Additional traverses were made by Hill and Livingstone. The geology was plotted directly on to air photo overlays on $\frac{1}{2}$ mile/inch and was transferred to a 1 mile/inch base map by means of a Saltzman projector.

Kirwan determined the contacts between the Palaeozoic units by drawing cross-sections on the field map that Alice E. Wilson had graciously given to him, and by finding additional outcrops. Later, K.W. Livingstone, an undergraduate, was invited to co-ordinate the traverses and to compile the Precambrian data. The following account is abstracted from Livingstone (1966).

PHYSIOGRAPHY

The central, and most of the eastern Arnprior area lies within the Ottawa-St. Lawrence lowland. It is rarely higher than 100-feet. Most of it is covered by glacial, lacustrine, silt and clay of the Champlain Sea. Outcrops are rare. A few Pleistocene fluvioglacial gravel deposits exist and have been exploited commercially.

The remainder of the area forms part of the Precambrian exposure known as the Frontenac Axis. It is wooded and swampy with relief reaching 350 feet.

The major rivers drain north into the Ottawa River, which forms the northern boundary to the map-area. Old river terraces and channels found in the northeastern part of the lowland, near Woodlawn and Dunrobin, represent an old branch of the Ottawa River between Morris Island and Shirley Bay (Ells, 1901).

PRECAMBRIAN ROCKS

DISTRIBUTION

The Precambrian rocks are part of the Grenville subprovince. They are confined to the southwestern third of the area and to a belt about three miles wide extending southeast from the Precambrian at Morris Island into the adjoining Ottawa area (Kirwan, 1961). The northern boundary of this belt is suspected to be an angular unconformity; its southern is faulted against Palaeozoic rocks.

PARAGNEISS

Map units (1) to (4) consist of interlayered paragneisses. Their superposition could not be determined.

Marble (1)

Marble forms 25 percent of the Precambrian rock. The marble is white or grey, layered, coarse to medium-grained and usually contains thin intercalations high in graphite and phlogopite. The layering is up to 6 inches thick and is generally lenticular. Locally, talc and tremolite and discontinuous layers of quartzite and pyroxenite or diopsidic marble are interbedded in the marble.

Near Arnprior, the marble is finer-grained and dark grey from contained graphite. It is part of the Bristol Series, as defined by M. E. Wilson (1924), and considered by him to be younger than the Grenville.

In the migmatite zone (1d), the marble contains porphyroblasts of pink calcite $\frac{1}{2}$ - 1 inch diameter. The plutonic fraction of this zone is composed of dykes and pods of white granite (7) and minor granodiorite (6).

Mafic Gneiss and Schist (2)

Intercalated biotite and hornblende schists and gneisses, interlayered with marble, form a synform south of Pakenham. Unit (2) is composed of several sub-units tens of feet thick, compositionally and texturally distinct, but each internally relatively homogeneous with layering a few inches thick. The biotite-rich rocks are gneissic and locally may contain 15 to 20 percent porphyroblasts of red garnet up to pea size. The amphibolitic rocks are locally coarse-grained. The unit includes minor, pink granitic gneiss.

Granitic Gneiss (3) and (4)

Red granitic gneiss (3a) forms most of the outcrops north of Carp. In general, it is thinly-layered with intercalated and subordinate mafic gneiss and schist. The layering is usually only a few inches thick.

Near Carp, south of the monzonite (10), unit (3b) contains green, coarse-grained, diopside-pyroxenite horizons up to ten feet thick and, in the southermost part, scattered, irregular and rounded blebs of pyroxenite a few inches across and pockets of coarse pink marble, rarely more than ten feet across. Subunit (3b) interfingers with calcium-poor granitic gneiss.

The rocks between the syenite (9) and monzonite (10) north of Carp are feldspathic quartzite and quartzo-feldspathic gneiss (3c). These quartz-rich rocks are fine-grained and usually reddish-grey. They grade imperceptibly, both parallel and perpendicular to strike, into normal medium-grained, red granitic gneiss (3a) without any change in structure.

Granitic unit (4) is lithologically similar to unit (3) but is composed of nearly equal amounts of mafic rock and granitic gneiss. Black amphibolite up to 50 feet thick alternates with pink granite,

granitic gneiss and mafic gneisses and schists. The amphibolite is medium-grained and foliated, with predominant hornblende and minor biotite and quartz.

PLUTONIC ROCKS

Syenite Gneiss (5)

This unit, restricted to a single body near Carp, is grey to pinkish grey, or red. It is uniformly gneissic with only minor foot-scale layering. Northeast of Carp, the rock is medium to coarse-grained and is slightly porphyritic. The dominant gneissosity however masks much of the original texture. The unit is thought to be an orthogneiss because of its regular and uniform gneissosity, its relict phenocrysts (?) and its lack of the distinct, contrasting layers to be found in the paragneisses.

A linear, topographic depression trends northeast through the unit. Toward it, the rock becomes more gneissic and changes progressively through an augen gneiss, into a fine-grained, sugary-textured syenite gneiss. This depression possibly represents a Precambrian fault zone.

Grey and White Granodiorite and Granite (6) and (7)

These rocks crop out near Kinburn, near the centre of the map-area. The grey granodiorite (6) is texturally heterogeneous. It is a fine to medium-grained, rock composed of quartz, potassic feldspar, plagioclase and biotite. Locally it is well-layered (relict bedding ?) with bands a few inches thick, in places with megacrysts, possibly phenocrysts, of white feldspar up to a half-inch diameter. A white coarse-grained marble about 2 feet thick is found in one granodiorite outcrop parallel to the layering and can be traced for a few hundred feet. Xenoliths of mafic gneiss have gradational contacts and appear to have been incompletely assimilated by the granodiorite. The heterogeneous texture, the layering, and the continuous marble horizon mentioned above, suggest that the granodiorite may represent granitized sedimentary rocks.

Map unit (7) is a massive, coarse, locally pegmatitic, white granite associated with the granodiorite (6). Dykes and pods

of white granite intrude the eastern margin of the granodiorite. The white granite also forms east-dipping sills up to 50 feet thick in thinly-layered rusty-weathering biotite gneisses and schists (2). The xenoliths at the bottom of the lowermost sill differ from those in the granodiorite in that their contacts are sharp.

Red Granodiorite and Granite (8)

The major part of this unit is immediately southwest of Pakenham where several conformable intrusions form a syntectonic plutonic complex extending southward to near Clayton (c.f. Reinhardt and Liberty, 1964). The complex consists of a large central stock, 9 miles long and $2\frac{1}{2}$ miles wide, separated by paragneisses from small linear and ellipsoidal stocks around its periphery. The major axes of these stocks are parallel to the strike of the paragneisses. The unit possesses a pronounced marginal foliation that is absent in the central parts of the intrusions.

In hand specimen the rock is seriate and medium-grained and only rarely porphyritic. It is composed of mosaic-textured microcline and plagioclase with minor biotite. A foliation, particularly well developed near the margins of the stock, is defined by a parallelism of the biotite.

Small bodies of red granite are exposed $2\frac{1}{2}$ miles east of Fitzroy Station.

Red Syenite (9)

Unit 9 consists of two bodies of red syenite, the first, south of Pakenham, is of indeterminate shape, because of the paucity of outcrop. The second, north of Carp is elliptical and conformable, with well-developed marginal foliation and a central, locally porphyritic zone. It is locally interbanded with mafic gneiss. Generally the texture is granoblastic with medium-grained microline, plagioclase, scattered coarser embayed microperthite and minor pyroxene, hornblende, and biotite.

The body north of Carp is similar in size and shape to the monzonite bodies, but typically is pink and poor in oxide minerals.

Monzonite (10)

Two small stocks of monzonite intrude granitic paragneisses one and a half miles and three miles north-northwest of Carp. The larger, more northerly stock is subcircular with an outcrop diameter of 8000 feet. The smaller stock has a maximum dimension of 8000 feet and is terminated to the south by the Hazeldean fault. The stocks are well delineated by positive aeromagnetic anomalies (Canada, Geol. Survey 1947). The southern stock, as interpreted from the aeromagnetic data and the outcrop pattern, appears to be lens-shaped, two and a half miles long and 4500 feet across. A third buried stock is suggested by an anomaly immediately west of the northern stock.

The monzonite is a dark-grey, medium to coarse-grained rock which locally exhibits regular planar (primary?) layers an inch to a foot-scale, resulting from small variations in texture and composition. It is composed of feldspar, clinopyroxene, sphene, apatite, ilmenite, and magnetite. The feldspar is mostly perthite and antiperthite but microcline, orthoclase and plagioclase (oligoclase or sodic andesine) are also present. Locally, tabular phenocrysts of perthitic feldspar, up to a centimetre diameter, are oriented parallel to the layering.

The monzonite becomes syenitic at the margins with a contact zone of red, quartz-bearing, syenite which, in places, may be as much as 100 feet wide. Discordant pods of grey pegmatitic syenite, with abundant sphene and crystals of feldspar up to two inches long, are present near the contacts. In the country rock at the contacts, migmatite is locally developed. The migmatitic zone on the eastern border of the northern stock is from 75 to 100 feet wide.

The stocks were regionally metamorphosed after emplacement with a partial recrystallization and an impressment on the monzonite, of the regional foliation.

Diabase (11)

Diabase dykes in the map area strike east-west. The largest is in the granite-granodiorite pluton southwest of Carp. It is about 3000 feet long and from a foot to 25 feet wide. The dyke in

the granodiorite southeast of Galetta crops out for several hundred feet and is 15 to 20 feet wide. Elsewhere the diabase forms small dykes and pods.

Granite Pegmatite

Bodies of granite pegmatite are not shown on the map because of their small size and ubiquitousness. The pegmatite, composed of quartz and pink feldspar, is irregularly distributed and forms blebs, veinlets, dykes and pods up to tens of feet across. In the monzonite, granite pegmatite is confined to the marginal zone.

METAMORPHISM

A regional metamorphism in the uppermost almandine-amphibolite or hornblende granulite facies is indicated by the lack of muscovite, the presence of perthitic feldspars with hydrous mafic minerals and by the widespread migmatization.

PALAEOZOIC ROCKS

The Palaeozoic rocks in the Arnprior map-area occupy the northwestern part of the Ottawa-St. Lawrence basin and are divided into two belts by the Precambrian inlier which extends southeast from Morris Island.

THE FORMATIONS

The Nepean Formation (12) consists of thin-bedded, flaggy, quartz sandstone. Near the base of the unit there are quartz-pebble conglomerates. Primary shallow water structures -- cross-bedding, ripple marks, mudcracks -- are common. The buff and white colored sandstones are used as a building and decorative stone.

In the upper units the sandstone is usually grey and where interbedded with dolomite, forms the transitional March Formation (13). The Oxford Formation (13) consists of beds of brown silty dolomite, up to three feet thick, with shaly partings.

The Rockcliffe Formation (14) rarely crops out in the map-area and only as small exposures. It consists of green shale and siltstone with lenses of impure coarse-grained quartz arenite.

The Ottawa Formation (15) is composed predominantly of grey, fossiliferous or bioclastic, fine to medium-grained limestone with dark grey and black shaly partings. The rock used to be used as a building stone. The bridge over the Mississippi river at Pakenham, reputedly the only North American five-span stone bridge built on the Roman keystone principle, is made of Ottawa limestone obtained from a local quarry. Today the rock is quarried only for crushed stone.

RELATIONSHIP TO THE BASEMENT

Many Palaeozoic units thin or pinch out in the area. The Oxford Formation near Arnprior and at Morris Island directly overlies the Precambrian. The Nepean sandstone is thus confined to areas south and east of these localities. The Rockcliffe Formation does not extend west of the Arnprior area (c.f. Quinn, 1956) and therefore must pinch out immediately west of Arnprior. The Ottawa Formation directly overlies the Oxford Formation at Pakenham. The Oxford Formation is much thinner in the map-area than to the south and east. The March is of doubtful validity as a formational unit in the map-area because of its extreme thinning.

STRUCTURE

FOLDS

Small tight folds with wavelengths of a few inches to a few feet are present in the paragneisses. Plunge is usually difficult to measure; trend and sense of plunge is however shown where possible. In general the minor folds plunge northwards at angles of up to 20 degrees.

Larger folds also exist. In the extreme northern part of unit (1e) amphibolite, biotite schist, marble and interbanded mafic and granitic gneisses dip outward at 30 degrees from a small granite stock (8). Folds along the contact between marble (1) and granite gneiss (4) near the Carp River north of Kinburn, plunge

northwards. Farther north of Kinburn, open, upright folds in granite gneiss (4) with wavelengths 50 - 100 feet plunge gently northeastwards.

The largest recognizable fold in the area is the overturned synform south of Pakenham in alternating marble (1) and mafic and granitic gneiss (2). The plunge is to the northeast. There is no evidence that this fold continues below the Palaeozoics into the Precambrian north of Carp.

Poles to foliation in the Pakenham synform show, when plotted on an equal-area net, a considerable dispersal of points with an indicated angle of plunge between 20 to 30 degrees northeast.

Poles to foliation for the Precambrian rocks north of Carp also indicate northeasterly trending folds overturned to vertical, but with steeper plunges -- usually 50 - 70 degrees -- to the northeast. The steepness may be related to the presence of the monzonite stocks (10).

The Palaeozoic rocks are flat-lying or gently dipping. Where draped over irregularities in the Precambrian basement, they show in places, open supratenuous folding.

FAULTS

No major faults of Precambrian age were mapped. Long east-west lineaments in the granite or granodiorite west of Pakenham show up as swamp-filled depressions. No strike-slip movement is evident; any movement appears to have been normal, minor, and pre-Palaeozoic as there is no deformation in the adjoining Palaeozoic rocks. The lineaments indicate zones of closely-spaced joints.

North of Carp, the northeast-trending lineament in the syenite gneiss (5) is suspected to be a fault, for the gneiss along it, is cataclastically deformed and contains small inclusions of unrelated rock.

Two major, normal faults transect the Palaeozoics to form an east-west graben. The western end of the northern fault -- the Hazeldean fault -- terminates in the Madawaska River southwest of

Arnprior whereas the southern fault extends to Pakenham (Ells, 1904). The throw of both faults varies along the strike.

The northward-facing scarp a mile north of Pakenham and the southward-facing scarp along Glen Creek, two miles south of Pakenham, could not be confirmed, as postulated by Kay (1942), to be the easterly continuations, respectively, of the Pakenham and Shamrock faults.

ACKNOWLEDGEMENTS

We are indebted to the late Alice E. Wilson for her encouragement and support in the early stages of this work; to John M. Moore for his field and editorial assistance; to the 36 students whose names are listed below for obtaining much of the information incorporated herein, and; to Anna Carlman for minor corrections made to the map in 1969.

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