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PRELIMINARY REPORT, GEOLOGY OF COOK - D'AUDHEBOURG AREA, DUPLESSIS COUNTY

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Geology
of
COOK-D'AUDHEBOURG AREA

DUPLESSIS COUNTY

PRELIMINARY REPORT

by

Raymond Davies

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Preliminary Report

on

COOK-D'AUDHEBOURG AREA

Duplessis County

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INTRODUCTION

The Cook-d'Audhebourg map-area lies on the coast of the North Shore of the Gulf of St. Lawrence, about 350 miles east of Sept-Iles. It includes part of Cook and d'Audhebourg townships in Duplessis county. There are no permanent settlements within the area but the villages of Saint-Augustin and La Tabatière lie, respectively, 4 miles north of the eastern half, and 12 miles south of the western half. The area is bounded by longitudes $58^{\circ}30'$ and $59^{\circ}00'$ and latitudes $51^{\circ}00'$ and $51^{\circ}10'$, and covers about 260 square miles. The field work was carried out during the summer of 1963 as a continuation of the Saint-Augustin area (Davies, 1963) which lies adjacent to the eastern half of the northern boundary.

Previous work in the area is limited. De Puyjalon (1899) reported on the minerals of the North Shore, and Longley (1944) described the area between Aguanish and Lobster bay. Hale (1962) did a reconnaissance survey of an area covering 7,000 square miles which includes the present area.

Most of the villages along the coast can be reached either by ship (Clarke Steamship Co., Ltd.) leaving Quebec fortnightly and taking about five days to reach St-Augustin, or by plane (Northern Wings) from Havre-Saint-Pierre or Sept-Iles.

The southeast half of the area is coastal and readily accessible by fishing boat. A freighter canoe may be used in good weather, but should not be depended upon. The northwest half of the area may be reached by canoe via Chevreuil (Deer), Kécarpoui, and Pagachou lakes. Well-cut portages, each less than 1 mile long, connect these lakes with the coast. Portages are also cut from Kécarpoui lake to Trois-Milles lake and Rocky lake. Pagachou lake may also be reached from Saint-Augustin via Pagachou river, but the latter, being tidal, is difficult to traverse at low tide. The above lakes, as well as many smaller ones, are suitable for float planes. Absence of bush, other than in the deeper valleys, would make the area ideal for work involving helicopters.

The area is rugged, being part of a deeply dissected peneplain. Trends of valleys have been determined mainly by faults or fracture zones, and to a lesser degree by differential weathering of the gneisses. The action of the last ice sheet has rounded off the hills and ridges, but has not affected the preglacial topography to any marked degree. Local relief increases from the coast towards the northwest, the maximum being in the order of 500 feet.

There are no major rivers in the area. The northwest corner is drained via Kécarpoui lake which empties into Kécarpoui bay, the northeast via Pagachou lake and Pagachou river, emptying into St-Augustin bay, and a small area in the southwest via Chevreuil lake, which empties into Ha! Ha! bay.

Forested areas are confined to the relatively narrow sheltered valleys, whereas the tops of hills and coastal islands have only a scattered moss-covering over the rock. Because of the abundant exposure, only those outcrops at which geological information was recorded are marked on the map.

GENERAL GEOLOGY

All the consolidated rocks are Precambrian in age except possibly gabbro, diabase, and related dikes, which may be younger. Gneissic rocks of varying composition, together with paragneisses, underlie most of the area. The mineralogy is that of the granulite and upper amphibolite facies. Layers and lens-like bodies of foliated porphyritic granite and granodiorite, as well as larger irregular masses around which the gneisses are folded, occur in the east, and characterize what may be termed the 'eastern zone'. The 'western zone' is characterized by the presence of green pyroxene-plagioclase gneisses. The boundary

Table of Formations

Pleistocene and Recent	Sand, silt, gravel, clay, peat
?	Diabase and related dikes Intrusive Contact Gabbro dikes
Intrusive Contact	
PRECAMBRIAN	Pegmatite, aplites Granodiorite, quartz monzonite, monzonite dikes
	Intrusive Contact
	Meta-gabbro (amphibolites)
	Intrusive Contact
	Interlayered meta-gabbro (amphibolites) Porphyritic granite and granodiorite Fine- and medium- to coarse-grained pink granitic gneisses Green pyroxene-plagioclase gneisses Light gray plagioclase gneiss Sillimanite-biotite-garnet gneiss Calc-silicate rocks Quartzite (+ sillimanite and garnetiferous varieties) Banded, fine-grained, pink and gray gneisses Dark gray, biotite-hornblende gneiss

between the two zones runs just west of Aigle (Eagle) harbor and through Lessard bay to Rocky lake. The gneisses and paragneisses have conformable contacts with each other and with the porphyritic granite and granodiorite. However, the latter is intrusive locally. While many of the meta-gabbros (amphibolites) are interlayered, several are clearly intrusive. Intrusive rocks presumably younger than the regional metamorphism are granodiorite dikes, aplites, pegmatites, and gabbro, diabase, and related dikes.

Unconsolidated material of Pleistocene and Recent age is widespread, but in minor quantities.

Gneisses

Gneisses of various composition, color, and texture underlie most of the area. Because the rocks are closely banded, many mappable units show considerable range in composition. For clarity, the major map units chosen are (a) fine- and medium- to coarse-grained pink granitic gneisses, (b) green pyroxene-plagioclase gneiss, (c) gray garnetiferous biotite gneiss, (d) dark gray biotite-hornblende gneiss, and (e) mixed gneisses. Light gray plagioclase gneisses and sillimanite-garnet gneisses do not occur as mappable units but are characteristic components of the mixed gneisses. It must be borne in mind that all the gneisses are mixed to some degree, but, in the 'homogeneous' units as mapped, one rock type predominates.

Fine- and medium- to coarse-grained pink granitic gneisses

These are essentially in two types. One is well-foliated, medium grained, and found only in the western zone; the other is fine grained, weakly foliated, and found throughout the area. However, as the two varieties are not easily separated in the western zone, they have been mapped as one unit.

The fine-grained granitic gneiss has an aplitic appearance and low mafic content. The color is distinctly pink on both fresh and weathered surfaces. Essential minerals are potash feldspar and quartz with lesser amounts of plagioclase. Mafics are biotite and hornblende. Small pink garnets are present locally, and opaque iron ores are a common accessory. The rock is usually faintly banded, particularly on fresh surfaces. It is a major constituent of all the mixed zones, occurring as distinct conformable bands with sharp contacts.

The coarser-grained granitic gneiss: Well-foliated, pink, pink to tan weathering granitic gneiss is confined to the western zone in which it constitutes the main part of the granitic gneisses. It is apparently closely associated with the 'green gneiss' with which it is interlayered. It is pink to pinkish gray and medium to coarse grained. Some varieties contain a little greenish feldspar (plagioclase). The most important minerals are quartz, potash feldspar, and plagioclase, with about 5% biotite and/or hornblende. Hornblende is generally present in varieties containing green feldspar. Low mafic, pink varieties are difficult to distinguish from the fine-grained, pink granitic gneiss.

The most characteristic feature is the well-developed foliation, in which the mafic constituents are concentrated as thin folia about 1/4 inch apart between granular layers of quartz and feldspar. There is an incipient augen structure in places. Lineation of mafics and quartz-feldspar aggregates is also well developed.

The contacts with the surrounding rocks are usually conformable and, in many places, there is a subtle gradation into the 'green gneiss'.

Green plagioclase-pyroxene gneiss

Like the well-foliated pink granitic gneiss the green gneiss is confined to the western zone.

Most varieties are medium grained and olive-green to greenish gray, and are composed essentially of green plagioclase with lesser amounts of quartz and potash feldspar. All contain pyroxene with hornblende or biotite or both. The composition is granodioritic to quartz-dioritic.

Foliation is well developed, being similar to that of the well-foliated pink granitic gneiss. Lineation of mafics and quartz-feldspar aggregates on foliation planes is also pronounced.

Weathering is generally deep and only along shorelines was the gneiss recognizable by its green color. Elsewhere it is rusty, dirty brown and generally friable. The deep weathering of this gneiss may lead to its being poorly exposed with respect to interlayered bands of more resistant granitic rocks.

A similar gneiss was found in the St-Augustin area (Davies, 1963) though at the time it was not differentiated from the gray granodioritic gneisses.

Green rock - Île Lecouvré: Similar-looking green rocks occur across the south side of the Île Lecouvré Group. They differ, however, in that they lack a foliation or have only a weak foliation. They are also coarser grained.

Contacts were not observed but they appear to transect the foliation of the gneisses and porphyritic granite.

Gray garnetiferous biotite gneiss

Gray, garnetiferous, medium-grained biotite gneiss occurs as relatively narrow bands in zones of mixed gneisses. It was mapped as a separate unit only in the western zone where it is a characteristic marker horizon. Essential minerals are plagioclase and quartz, with lesser amounts of biotite, garnet, and potash feldspar.

Sillimanite-biotite-garnet gneiss

Included in the mixed gneisses at a few places are zones composed of garnetiferous quartzofeldspathic material in which occur easily weathered layers or lenses, a fraction of an inch to 3 inches wide, composed of sillimanite, biotite, and garnet. The sillimanite usually exhibits a prominent lineation.

Light gray plagioclase gneiss

The light gray plagioclase gneiss is fine to medium grained and composed essentially of plagioclase and quartz with varying amounts of potash feldspar. Mafics include biotite and hornblende with pyroxene in low potash feldspar varieties. It is similar in appearance to the fine-grained pink granitic gneiss with which some of it is associated.

Dark gray, biotite-hornblende gneiss

Dark gray, biotite-hornblende gneiss occurs in the eastern zone and is best exposed near Île aux Graines.

It is fine to medium grained and dark gray to pinkish gray, and is composed essentially of plagioclase, biotite, hornblende, and opaque minerals, though the pinkish varieties contain a little potash feldspar. Foliation is well developed.

Mixed gneisses

Various combinations of rock types give rise to the mixed units as mapped. Two of these units are composed essentially of pink granitic gneisses and green pyroxene-plagioclase gneiss, depending on which is dominant. A third unit consists of banded, fine-grained, pink and light gray gneisses. The fourth unit is the most diverse, consisting of three or more main rock types.

Banded, fine-grained, pink and gray gneisses: As well as being a common constituent of the fourth unit mentioned above, they constitute a distinct unit themselves in the western zone. Banding may be on a large or small scale, and gradations in composition occur between the two main components.

The pink bands are essentially the fine-grained granitic gneiss and the gray bands, the light gray plagioclase gneiss.

Mixed gneisses (three or more main components): This unit may include any of the gneisses already mentioned, excluding the green pyroxene-plagioclase gneisses and the well-foliated granitic gneiss, but including the paragneisses and the porphyritic granite and granodiorite. The latter is an important constituent, generally occurring as concordant layers.

Quartzites

Quartzites occur throughout the area, interlayered in the gneisses, and provide characteristic marker horizons. Layers more than 50 feet thick were observed, though generally they are thinner. Several can be traced for more than a mile.

Most are white to gray, and consist of glassy quartz with variable amounts of pink microcline. Many are garnetiferous and occasionally sillimanite and biotite occur in bands from thin folia to 2 inches thick.

Narrow layers tend to be rather massive, whereas the thicker layers show a distinct banding (perhaps bedding).

Calc-silicate Rocks

Calc-silicate rocks were observed only in the eastern half of the area in layers generally less than 20 feet wide. Like the quartzites they serve as characteristic markers.

The rock is banded and of variable composition. The individual bands consist of varying combinations of diopside, scapolite, feldspar, quartz, biotite, and calcite. Sphene is a common accessory. Narrow calcite bands (1-12 inches wide) are present in places.

Porphyritic Granites and Granodiorite

Though these rocks range in composition from granite to granodiorite, they are not easily separated in the field as changes from one to another are generally gradational. However, a few sharp contacts were observed, and in all cases the granite appeared to cut the granodiorite. The granodiorite dominates in the more uniform layers within the gneisses, whereas the lens-like and irregular masses are predominantly granitic. On a regional scale the foliation is concordant with that of the gneisses, whereas locally these rocks may cut the gneisses.

Granite

The granitic varieties are pink, and composed essentially of large potash feldspar phenocrysts in a medium- to coarse-grained matrix of essentially quartz and potash feldspar with plagioclase, biotite, hornblende, and opaque minerals. Foliation is poor and results from the preferred orientation of the feldspar phenocrysts.

Granodiorite

The granodiorites are gray and medium to coarse grained, and are composed essentially of plagioclase and quartz, with potash feldspar, biotite, hornblende, and opaque minerals. Large phenocrysts of gray plagioclase are common but are not so abundant as

the feldspar phenocrysts in the granite. Large augen-like crystals of potash feldspar are common.

Foliation is well developed due to the segregation of mafics and quartz-feldspar aggregates, and the parallel orientation of phenocrysts and augen.

Older Intrusive Rocks

Meta-gabbro (amphibolites)

Scattered across the area are bodies of meta-gabbro varying in width from less than a foot to 700 feet. They are rarely traceable for any great distance. The majority are sill-like bodies conformable with the gneisses, although a few are clearly intrusive. In the north arm of Chevreuil lake a relatively large body of meta-gabbro cuts the gneiss at right angles.

The rock is dark greenish black and medium grained, and consists essentially of greenish black to black hornblende, and gray-white to gray or greenish gray plagioclase. Light brown pyroxene occurs in some of the larger bodies. Biotite is usually a minor constituent, but in some cases it is fairly abundant, giving rise to a well-developed foliation or schistosity. Magnetite, ilmenite and, in some cases, pyrite are common accessories.

Weathering is generally deep with the rock becoming a dark rusty color and rather friable. The weathered surface is a mottled black and dirty white, but from a distance appears black. The susceptibility to weathering explains why it is difficult to trace these bodies over any great distance, and also why many of them occupy valleys.

Foliation, banding, and lineation of the conformable bodies parallel those of the surrounding gneisses. Foliation and banding in the Chevreuil Lake body are parallel to the intrusive contacts.

Younger Intrusive Rocks

Granodiorite, quartz monzonite, monzonite dikes

Exposed in the coastal part of the area, is a group of dikes and sills of quartz monzonitic, monzonitic, and granodioritic composition. They are not nearly so abundant as near St-Augustin bay (Davies, 1963), and become fewer towards the west. Their width varies from a few feet to 150 feet. Contacts are sharp and there is a suggestion of an east-west trend.

Though the dikes differ slightly in composition, grain size, and development of foliation, they all have a similar mineralogy. Plagioclase, potash feldspar, and quartz constitute 2/3 to 3/4 of the rock, with hornblende, biotite, and iron ores constituting the remainder. Disseminated pyrite is common. The dikes are gray, greenish gray or pinkish gray, and medium to fine grained. Some varieties contain phenocrysts of feldspar and biotite.

Most of the dikes have a faint to good foliation parallel to the contacts.

Age relationships were established with greater confidence than in the St-Augustin area. One dike cuts a meta-gabbro in Kécarpoui bay, and a diabase dike cuts another in the Grande-Rigolet.

Pegmatites and aplites

Pegmatites and aplites are widespread and are probably of more than one age. They occur both parallel to the foliation of the gneisses and as crosscutting dikes. The pegmatites, in addition to quartz and feldspar, commonly contain biotite, hornblende and magnetite.

Gabbro dikes

Three coarse-grained gabbro dikes occur in the area. One, passing through Tucker cove, is the southern extension of the dike crossing the St-Augustin area (Davies, 1963). Another is exposed on the islands south of Kécarpoui bay, and the third, just west of Aigle harbor. The last-mentioned dike is the only one with both contacts exposed, and is approximately 200 feet wide.

Though variation in composition is common, the typical rock is greenish gray and composed essentially of plagioclase and pyroxene, and has a decussate texture.

All three dikes are vertical and strike 5°-15° east of north.

Diabase and related dikes

Fine-grained dikes of variable composition, and seldom more than 15 feet wide, are widely distributed. They are particularly abundant around Ha! Ha! bay, and in the neighborhood of the gabbro dikes. They cut the latter and are the youngest intrusive rocks in the area. The dominant trend is north and dips are steep.

Most are gray to greenish black or black diabases, but pink to brown varieties are common. Many are porphyritic with phenocrysts of feldspar 1/2 to 1 inch long and 1/8 to 1/4 inch wide.

All are well jointed and more easily weathered than the country rock.

PLEISTOCENE AND RECENT

Deposits of glacial origin are represented by unsorted gravel and sand in shallow depressions, and by erratic boulders on tops of hills. Sand and gravel, exposed in valleys and on marine beaches, is also of glacial origin but has been reworked.

Gray clay is found in sheltered coves and bays along the coast. It is seldom exposed much above the high-water level and is believed to have been deposited during marine submergence. At several localities around Kécarpoui bay and the east side of Ha! Ha! bay it contains a variety of marine shells.

Evidence of glacial erosion is abundant, particularly along the coast where rock surfaces, only very recently exposed by marine emergence, show beautifully striated glacial pavements, friction cracks, fluting, grooves, and potholes. Hills have been rounded off and plucking is evident on their south and southeast slopes.

Movement of the ice was generally to the southeast. In places, deep striae parallel to the regional trend have superimposed upon them a second set of finer striae controlled by local topography.

Most of the coarse unconsolidated material can be matched with local rock types. However, pebbles and boulders of siltstone and fossiliferous limestone are common, and, in the western half of the area, boulders of coarse-grained anorthosite are probably derived from the body to the northeast described by Hale (1962).

STRUCTURAL GEOLOGY

Foliation

The area consists of alternating layers of varying composition and texture. All these rocks are foliated and the foliation is generally concordant with the large-scale layering.

Lineations

Lineations are displayed by most of the rock types, particularly those rich in mafic minerals. Plunges are roughly to the north or south at angles varying with the dip and strike of the foliation.

Folds

Folds are complex, as shown by the field mapping and a study of aerial photographs. Two sets of minor folds are present. One parallels the lineations and the other is at approximately right angles to it. All are open folds with a wave-length to amplitude ratio of approximately 10:1. Minor drag-folds were observed at a few localities, with axes parallel to the lineations.

Joints

Joints are well developed throughout the area. The majority strike parallel to prominent linears and are generally

steeply dipping. More variable are joints parallel or subparallel to the foliation.

Faults and shear zones

Three sets of linear valleys or drowned valleys, representing faults or fracture zones, result in a prominent feature of the area.

The most prominent set strikes parallel to the coast and includes Pagachou river and lake, Petit-Rigolet, and Grande-Rigolet. Evidence of faulting is shown by the displacement of folds and characteristic marker horizons, and also by abundant shearing of the rocks along the linears.

The second set strikes a little east of north. The most prominent of these is occupied by Kécarpoui lake, and mapping indicates the displacement of geological units. At its southern extremity on the shore of Ha! Ha! bay a small breccia zone offers further evidence of faulting. Belonging to the same set is the linear occupied by the gabbro dike which passes through Tucker cove and Fournier passage.

The third, and least prominent, set strikes east-west. Shearing and evidence of displacement were found in one of these linears extending eastward from the mouth of Kécarpoui lake to just north of Argile (Clay) cove.

A number of minor faults and shear zones were observed along the well-exposed coastal shorelines.

ECONOMIC GEOLOGY

Sulfides

Disseminated grains of pyrite occur in most rock types. However, sulfide concentrations were observed only in the meta-gabbros at the following localities.

Argile cove: Cutting the meta-gabbro at the bottom of the cove is a zoned quartz vein. It is exposed on the shore for a length of 65 feet and varies in width from 2 to 4 feet, the widest part being to the south. The quartz is rich in pyrite, and, at the southern end, is a core of coarse-grained

massive pyrrhotite up to 2 feet wide and 25 feet long. The latter contains a little pyrite and narrow veinlets of chalcopyrite. Two channel samples across the massive sulfide core gave the following assay results:-

- 1) 0.25% copper, 0.10% nickel, 0.015 ounce of silver a ton;
- 2) 6.30% copper, 0.08% nickel.

A grab sample assayed 0.56% copper, 0.01% nickel, 0.04 ounce of silver a ton. A sample of pyrite-rich meta-gabbro at the contact assayed 0.10% copper, 0.15% zinc and 0.015 ounce of silver a ton.

North side of Quarry bay: Small hornblende veins 1/2 to 2 inches wide with, in places, lens-like cores of quartz occur in a meta-gabbro over a strike length of 20 feet and a thickness of 3 feet. Pyrite and chalcopyrite are associated with the hornblende. Three grab samples assayed:-

	Copper %	Nickel %	Zinc %	Lead %	Silver oz./ton	Gold oz./ton
1)	0.01	-	0.02	-	0.010	-
2)	0.15	0.01	0.02	0.01	0.016	0.002
3)	0.02	0.01	-	-	0.013	0.002

West side of Quarry bay: Near the eastern contact of a meta-gabbro is a heavily-stained zone 1 foot to 3 feet wide, extremely rich in pyrite.

Four grab samples assayed as follows:-

	Copper %	Nickel %	Zinc %	Lead %	Silver oz./ton	Gold oz./ton
1)	0.01	0.01	-	-	0.052	-
2)	0.02	0.01	-	0.01	0.040	-
3)	0.02	0.01	0.05	0.01	0.030	Trace
4)	0.02	0.01	-	-	0.071	0.002

West of Aigle harbor: Two small pyrite veins about 18 inches long and 1/2 to 1 inch wide were noted in a strongly iron-stained zone in gneisses adjacent to a meta-gabbro.

Black Sands

Black sands derived from the weathering of the large meta-gabbro body occur in Chevreuil lake.

Pegmatites

Magnetite occurs in many small pegmatites. On Wakeham island a 15- to 25-foot-wide pegmatite contained a little fluorite and pyrite.

Sand and gravel

No important deposits of sand or gravel occur in the area. However, small quantities may be obtained from beaches along the coast.

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