CANADA

DEPARTMENT
OF
MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

PAPER 50-2

PRELIMINARY MAP

MATTHEWS LAKE
NORTHWEST TERRITORIES

(MAP AND DESCRIPTIVE NOTES)

By

R. E. Folinsbee and J. C. Moore

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DESCRIPTIVE NOTES FOR MATTHEWS LAKE MAP, N.W.T.

INTRODUCTION

Matthews Lake map-area lies 150 miles northeast of Yellowknife, at the northern limit of trees, a rather sharp line of demarcation between barrens and timbered country. It encompasses the south-central part of a greenstone belt 40 miles long and 1 mile to 4 miles wide. The volcanic rocks outcrop as a prominent northwest-trending ridge rising 200 feet above the level of MacKay and Courageous Lakes. Southwest of the greenstone belt lies the MacKay Lake basin, dotted with granite islands; to the northwest, granitic intrusive rocks outcrop as rolling rounded hills. The eastern part of the map-area is a low, sedimentary plain, featured by two areas of granitic hills that mark the position of intrusive stocks. The southern stock is, in part, girdled with a high ridge of greenstone.

The map-area is 80 miles north of, and 1,000 feet above, the east arm of Great Slave Lake. Timber does not occur in quantities sufficient for development activities, and as the area lies on the Precambrian upland at the headwaters of the main drainage systems, it also lacks attractive, local, hydro-electric power sites. The lakes become sufficiently ice-free to permit pontoon flying some time after June 10 and before July 10; break-up date is quite variable. Prospecting activities are halted by the beginning of freeze-up in mid-September.

GENERAL GEOLOGY

Volcanic Rocks of the Yellowknife Group

The oldest rocks in the area are lava flows of the Yellowknife group (1-3)[1], with minor interbedded sedimentary slates and tuffs (5, 5a).

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[1] Numbers in parentheses are those of map-units on the accompanying geological map.

The basal flows comprise a mixed assemblage of light to dark grey-green weathering volcanic rocks, massive and fragmental, together with interbedded phyllite and mica schist of tuffaceous origin (5a). Although this heterogeneous assemblage, about 2,000 feet thick, is continuous along strike for 14 miles, some members are not. The phyllites and mica schist, in places interlayered with fine-grained flows as well as meta-gabbro, are confined to a distance of 7,000 feet along strike. The andesitic agglomerate (2b) is lenticular, attaining a width of 1,000 feet and an exposed length of 7,000 feet in two localities. It is almost everywhere associated with meta-gabbro (4), and in some instances is so intimately interlayered that it cannot be separated on the scale of mapping.

Pillow lava (1b) and mixed pillow and massive lavas (1c) poured out on the earlier flows and sediments. Altogether these lavas are 4,000 feet thick at Nodinka Narrows and 8,000 feet thick south of Matthews Lake; but they thin abruptly to 2,000 feet in the central and north part of the map-area. The basalts have been altered to dark greenish grey hornblende schists, composed of hornblende and labradorite, with minor quartz, chlorite, and biotite. The percentage of chlorite increases with increasing distance from the volcanic-granite contact.

In the northern part of the map-area, the pillow lavas are replaced by comparable thicknesses of light grey weathering, extrusive, dacitic and rhyolitic rocks (3a), partly agglomeratic (3b). These flows, with a maximum thickness of 6,000 feet, are expressed topographically as the Matthews Lake basin. Along strike to the south they thin very rapidly, and a mile from Matthews Lake the light-coloured zone disappears.

The light weathering lavas have been altered to sericite schists; they display prominent quartz phenocrysts, which in thin section are seen to be typically embayed or corroded. The massive flows are distinguished with difficulty from quartz porphyry intrusions (A); however, the agglomeratic nature of the flows is evident in the outcrops between Matthews and Courageous Lakes. The agglomerate consists of lenses of squeezed and flattened rhyolite and dacite fragments, 1 inch to 6 inches in diameter, in a carbonatized matrix (3m).

The pillowed basalt zone north of Nodinka Narrows grades upwards into a ropy, green weathering, andesitic or dacitic flow, partly fragmental, now altered to a massive, garnetiferous hornblende schist (1e), which is the host rock for important gold-bearing orebodies. The garnetiferous zone is about 400 feet thick; at the south end of Matthews Lake it overlies, and is interlayered with, acidic flows (3), and in turn is overlain by slates and greywackes of the Yellowknife group (5).

Several meta-gabbro sills (4) are intrusive into the basal part of the volcanic series. The largest is a mass of amphibolite 2,400 feet thick and 2 miles long. Coarse hornblende crystals, with cleavage surfaces as much as $\frac{3}{8}$ inch in diameter, characterize this rock type; in thin section it is seen to consist of 65 per cent hornblende, 25 per cent labradorite feldspar in well-defined phenocrysts, and chlorite. In addition to the main zone of meta-gabbro sills at the base of the volcanic series, there are, within the zone of pillowed and massive flows, bodies of either very coarse, massive lava or of intrusive sills, altered to meta-gabbro. The porphyritic meta-gabbro (4a) represents an unusual type of sill containing abundant rounded feldspar phenocrysts, up to 6 inches in diameter, comprising as much as 60 per cent of the rock mass.

Sedimentary Rocks of the Yellowknife Group

Sedimentation, interrupted by the outpouring of pillowed and dacitic flows, recommenced during the final phases of volcanic activity. The main sedimentary assemblage (5) has at its base a series of argillites, interlayered with light grey weathering rhyolite and dacite flows and tuffs (3d). There is no evidence of a time break or unconformity between the period of vulcanism and that of sedimentation.

The older sedimentary strata appear to have been thin bedded and argillaceous, whereas the younger beds of the series are more massive, thicker, and arenaceous.

The sedimentary rocks have been profoundly altered by dynamic and thermal metamorphism; the least altered beds, far from granitic contacts, are light to dark grey weathering slates and greywackes, in places showing tops by grain gradation and crossbedding. Towards Nodinka Narrows, the slates and greywackes become increasingly metamorphosed, altering to quartz-mica schists, and developing nodules of the alumino-silicate minerals cordierite and andalusite. The cordierite occurs as oval to cigar-shaped nodules $\frac{1}{2}$ inch in diameter, the andalusite as square prisms of chiastolite.

Granodiorite and Diorite Intrusions

Metamorphism of the sedimentary and volcanic rocks of the Yellowknife group was brought about by the intrusion of diorites (7) and granodiorites (8).

The diorites (7) occur as small stocks intrusive into Yellowknife sedimentary rocks, and, northwest of the volcanic belt, as larger masses apparently grading into granodiorite (8). A dark greenish grey rock, the biotite-hornblende-quartz diorite (7c), consists of 30 per cent andesine, 20 to 30 per cent each of hornblende

and biotite, 10 per cent quartz, and more than the normal amount of accessory titanite and apatite. Biotite-hornblende-quartz diorite grades into hornblende-quartz diorite (7a) and hornblende diorite (7b). Small, titaniferous amphibolite dykes, of variable width and lens-like habit, were observed cutting the sedimentary rocks; they may be related to these diorite intrusions. The hornblende diorite bodies in the northwest part of the map-area may include some recrystallized flows and sills (1, 2, 4).

The granodiorite (8) is a light grey to cream and pink weathering, medium- to coarse-grained, granitic rock. It intrudes all rocks of the Yellowknife group, and appears to be younger than the dioritic intrusions (7). The rock consists of about 30 per cent quartz, 40 per cent plagioclase feldspar, mostly oligoclase, about 15 per cent microcline, 15 per cent biotite, and minor hornblende. It is cut by aplite dykes (A).

In addition to the normal granodiorite, there are small bodies of gneissic granodiorite (8a), hornblende-biotite granodiorite (8b), and granodiorite (8c) with hornblendic inclusions derived from intruded volcanic rocks.

Porphyry Intrusions

The genesis of the porphyry intrusions (A) is as yet uncertain. The porphyry bodies are irregular; many are elongated normal to the strike of the volcanic and sedimentary rocks. They occur in greatest concentration in the basalt flows (1) underlying the rhyolite and dacite flows (3) of the Matthews Lake part of the map-area. Two possible genetic interpretations can be made; either these dacitic porphyry intrusions may be feeder dykes to the dacite and rhyolite flows that overlie the basic volcanic rocks in which they are concentrated, or they may be much younger than the rhyolite and dacite flows, and related to the granodiorite intrusions of the area.

The porphyry intrusions are medium grey, light grey weathering, slightly schistose rocks, consisting of phenocrysts of quartz and feldspar in a fine-grained groundmass of quartz, feldspar, biotite, and sericite. The quartz phenocrysts, as in the rhyolites and dacites (3), are corroded and embayed. The feldspar is principally altered andesine, with subordinate fresh microcline, indicating that the porphyry should be classified as dacite. As the granite contact is approached, the phenocrysts in the porphyry bodies increase in size and form a larger percentage of the rock. At one point along the contact with granodiorite the porphyry apparently grades into porphyritic biotite granodiorite (8). However, as the acidic lava zone is approached, the porphyry bodies take on the appearance of this lava, and are indistinguishable from it microscopically. Furthermore, they appear to be concentrated in such a position as to suggest that they are feeder pipes to the lava flows. In this interpretation, the increase in size of phenocrysts towards the granite contact could be interpreted as more complete crystallization with increasing depth. On the other hand, similar porphyry intrusions in the nodular sedimentary rocks near MacKay Lake are undoubtedly related to the nearby granodiorites, and the writers believe that the porphyry bodies in the volcanic rocks are also, most probably, related to these intrusions (8).

Proterozoic Diabase and Gabbro Dykes

Pale, reddish brown weathering diabase and gabbro dykes (9) are the youngest consolidated rocks in the map-area, and are probably of Proterozoic age. Their texture is ophitic; the fresh surface is greenish grey; and the rock consists of 50 per cent labradorite and 40 per cent pyroxene, with varietal quartz, accessory magnetite and apatite, and minor amounts of secondary chlorite, hornblende, leucoxene, epidote, and sericite.

Three distinct sets of dykes are represented. One set

strikes north 20 to 30 degrees west, and includes five dykes ranging in width from 50 to 160 feet. Two dykes of this set, in the volcanic rocks, can be traced the length of the map-area. Dykes in the sedimentary rocks are more irregular in width and strike, apparently split, and are displaced or change strike abruptly along minor east-west cross-faults.

The second dyke set, represented in the map-area by two large dykes, one 250 and the other 160 feet wide, strikes north 80 degrees east. These dykes were used as markers in calculating horizontal displacement by north-trending strike-faults that occur in the map-area.

A third dyke set, striking north to north 20 degrees east, has two representatives, one of which is cut by a dyke trending north-northwest. Age relations of the set of dykes striking north 80 degrees east to the other two sets were not established.

Glacial Deposits

Glacial and glacio-fluvial deposits cover 75 to 90 per cent of the bedrock in the map-area. Drift on the volcanic ridges and granitic hills is not as thick as on the sedimentary plain, and percentage outcrop in these areas is higher than in areas underlain by sedimentary rocks. Glacial striae indicate a generally westerly movement of the ice-sheet; confirming this, a trunk esker ridge extends westerly across the northern part of the area, and has northwest-trending eskers, diverted by the greenstone ridge, diverging from it.

Drumlins or drift ridges are elongated parallel with the glacial striae and with the esker ridges. They cover considerable parts of the sedimentary plain with a thick mantle of drift, though in other parts the drift mantle is thin, and frost-heaved outcrops of greywacke and slate project through the ground moraine.

The trunk esker in Courageous Lake has been modified by post-glacial lake wave action; spits, bars, and hooks are prominent features in the northwest part of the map-area.

STRUCTURAL GEOLOGY

Structure within the Yellowknife volcanic rocks (1-3) is homoclinal. The flows strike north to north 30 degrees west and dip from 70 degrees east to vertically; the rather abrupt change in their strike occurs south of Matthews Lake. Pillow structures indicate in all instances that the volcanic rocks face easterly and underlie the main sedimentary series (5).

Structures within the sedimentary series are more complex; determinations of attitude were made by observations of grain gradation within greywacke beds. Generalized strikes and dips are shown on the map by trend lines, which, however, do not represent individual beds. The sedimentary rocks are seen to conform to the contact with the more competent volcanic rocks on the west; they are intruded conformably by diorite (7) and granodiorite (8) bodies on the eastern edge of the map-area.

In detail, the sedimentary rocks have been deformed into a series of steeply plunging, isoclinal folds, the limbs of which dip steeply, in most cases vertically, with axial planes of the folds paralleling the volcanic and granodiorite contacts.

The major faults and shears strike north to northwest, nearly parallel with the sedimentary-volcanic contact. This direction of weakness has persisted through much of Precambrian time, and was utilized for the emplacement of gold-bearing quartz veins, probably about the time of the granitic intrusions (8); parallel fractures were later occupied by the northwesterly trending diabase and gabbro dykes (9), and still later movement displaced the set of dykes striking north 80 degrees east.

The total, left-hand, post-diabase displacement across the Matthews Lake map-area, as measured on the dykes striking north 80 degrees east, cannot be accurately determined because of the lack of outcrop and the possibility that the dykes in some places merely utilized former, northerly trending fractures to shift to the left. The possitle horizontal displacement, as indicated by shifts of the northern, easterly trending dyke in nine faults across the map-area, is 4,400 feet. Left-hand displacement on the southern dyke is not easily determinable - the displacement at the sedimentary-volcanic contact is apparently 1,500 feet, but other left-hand shifts along the dyke may well exist. A possible post-diabase cross-fault trending northeast passes through the south end of Matthews Lake. Both diabase dykes and the contact between the acidic and basic volcanic rocks indicate a left-hand displacement of about 1,200 feet.

Fault and shear zones in the slates and greywackes are marked by zones of brecciated, crumpled, and sericitized greywacke, with associated quartz lenses. The shears may be 15 to 20 feet wide, and are separated by beds of massive greywacke and slate.

Shear zones in the volcanic rocks are not well exposed, and generally occupy valleys. From the appearance in small outcrops and from float, they are commonly mineralized with pyrite and minor chalcopyrite, are silicified, and weather to produce a rusty gossan.

ECONOMIC GEOLOGY

The principal mineral occurrences in the area are gold-bearing quartz veins and gold-sulphide replacement deposits, found along the sedimentary-volcanic contact.

Occurrences in the central Matthews Lake area lie on the property of Salmita Northwest Mines Limited; those at the south end of Matthews Lake, on property of Bulldog Yellowknife Gold Mines Limited;

and the southernmost showing is on the property of the Jacomat Syndicate.

The two southerly showings (on the Bulldog and Jacomat properties) are in ropy and fragmental lavas, which in places have been altered to garnetiferous hornblende schist (1e). The gold occurs in sheared lava that has been silicified, tourmalinized, and impregnated with arsenopyrite. Gold values are highest in the silicified parts of the zone; visible gold in quartz was observed; and the ore is reported to be free milling. Scheelite is a minor accessory mineral in the quartz lenses. Surface gossan from the southerly showing on the Bulldog property assayed 1 ounce in gold a ton; drilling indicates somewhat lower values in the massive sulphide ore. The sulphide orebody on the Bulldog property occurs at the flexure point where trends change from north to north 30 degrees west.

The northerly showing on the Bulldog property, and all showings on the Salmita property, consist of gold-bearing quartz veins, which lie along the sheared contact between ropy fragmental lava (1e) and slate (5). Short vein sections (ore shoots) contain visible gold, and a little arsenopyrite, galena, tourmaline, and scheelite. The richest of the ore shoots assayed 8 to 10 ounces of gold a ton across a width of 1 foot along 30 feet of quartz vein. The ore minerals appear to be concentrated on the hanging-wall portion of the contact vein, which dips steeply east.

Gold is reported from several shear zones in the sedimentary rocks lying to the east of the volcanic contact; quartz veins mineralized with pyrite and arsenopyrite were observed at these points, though no visible gold was seen.

In the basal volcanic rocks, a persistent north-trending gossan zone is mineralized with fine pyrite and minor chalcopyrite.

Low assays in copper and gold were obtained at several places along this altered and sheared zone. In this zone, a body of altered feldspar porphyry, 3 feet square, assayed 5 per cent copper and 0.1 ounce of gold a ton. Two 1-inch veinlets of quartz, containing 3 to 5 per cent molybdenite, were discovered in the basal volcanic rocks near the granite contact.