CANADA

DEPARTMENT OF MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

GEOLOGICAL SURVEY
PAPER 40-14

QUYTA LAKE AND PARTS OF FISHING LAKE AND PROSPEROUS LAKE AREAS, NORTHWEST TERRITORIES

BY
A. W. Jolliffe

OTTAWA
J. O. PATENAUDE, I.S.O.
PRINTER TO THE KING'S MOST EXCELLENT MAJESTY
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Quyta Lake and Parts of Fishing Lake and Prosperous Lake Areas, Northwest Territories[1]

INTRODUCTION

The area is made up of the Quyta Lake map-area and the northern and southern thirds of Prosperous Lake and Fishing Lake map-areas, respectively. It includes some 450 square miles lying east and west of Yellowknife River between latitudes 62° 40′ and 63° 05′ and longitudes 114° 00′ and 114° 30′. The town of Yellowknife is the chief distributing point for the country about the north arm of Great Slave Lake and lies 30 miles south of the centre of the area. Boats can reach Yellowknife from railhead at Waterways, Alberta, 500 miles south, from about June 15 until October 15; aircraft on floats, from June 1 to October 15, and on skis from December 1 to April 15. All parts of the area are accessible in season by aircraft or canoe. The canoe routes can be used from about the first week in June until October 15. Travel by aircraft in the area is continuous throughout the year except during the break-up and freeze-up periods, which are each from a month to 6 weeks long and occur around May 1 and November 1, respectively.

The region was first traversed by (Sir) John Franklin in 1820. Reconnaissance geological mapping in the district commenced in 1932 and was continued during the field seasons of 1935 to 1938, inclusive.[2] The district received little attention from prospectors until 1933, when the results of the initial geological reconnaissance were published. In that year a gold-bearing vein was found near the northwest corner of Quyta Lake. In consequence of this and the further discoveries around Yellowknife Bay during the period 1934 to 1936 intensive prospecting spread up river from Yellowknife Bay and gold finds northeast and southwest of Clan Lake were staked during 1937. Further discoveries have been made and much staking has been done since that time.

The present report and the preliminary geological maps are based on detailed field work carried on in 1938 by a Geological Survey subparty under A. F. Buckham. Acknowledgment is due also to L. S. Hill, R. E. Folinsbee, and J. D. Macgregor for their capable assistance in the field mapping; and to the engineers and officials of Consolidated Mining and Smelting Company of Canada, Limited; Territories Exploration Company, Limited; Oro Plata Mining Corporation, Limited; and International Mining Corporation for many courtesies extended.

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[1] Preliminary geological maps to illustrate this report were issued as Paper 39-6.

[2] Stockwell, C. H.: Great Slave Lake-Coppermine River Area, Northwest Territories; Geol. Surv., Canada, Sum. Rept. 1932, pt. C, pp. 37-63.

Jolliffe, A. W.: Yellowknife River Area, Northwest Territories; Geol. Surv., Canada, Paper 36-5, 1936.

——— Yellowknife Bay-Prosperous Lake Area, Northwest Territories; Geol. Surv., Canada, Paper 38-21, 1938.

Henderson, J. F.: Beaulieu River Area, Northwest Territories; Geol. Surv., Canada, Paper 38-1, 1938.

——— Beaulieu River, Northwest Territories; Geol. Surv., Canada, Paper 39-1, 1939.

Yellowknife River flows southward through the area and has two main tributaries—one draining Duncan Lake and the other emptying into the north end of Clan Lake. All three streams consist of a series of lake-like expansions joined by relatively short stretches of rapid water and falls. The chief expansions along Yellowknife River proceeding north are Prosperous, Quyta, Sito (Green Tree), Clan, and Rocky Lakes. Between Rocky and Prosperous Lakes, a distance of about 25 miles, there is a total drop of about 250 feet. Almost all of this occurs in fifteen short stretches of rapids and falls, which necessitate a total portaging distance of less than 2 miles.

The country appears flat or gently rolling when viewed from the air or from one of the higher hills, but in detail it is broken by many steep-walled valleys and ridges. Local relief is commonly less than 100 feet, but in a few places hills rise several hundred feet above the general level. The most prominent eminences are formed of basic sills and pegmatite stocks. Except along the main river valley bedrock is fairly well exposed, although not to the same extent as in the Yellowknife Bay-Prosperous Lake area immediately south. The most striking topographic feature of the area as seen either from the air or on a map is the pronounced north-south trend to lakes and streams near Yellowknife River Valley, and is in part, at least, due to major faulting along these lineaments.

The area is well wooded, though nowhere densely so. Pike and trout are plentiful in the larger lakes and grayling near rapids and falls along Yellowknife River. Black bears are common and moose less so. Caribou are said to be numerous during the winter months.

GENERAL GEOLOGY

TABLE OF FORMATIONS

Precambrian	Proterozoic? (Late Precambrian)	Diabase, olivine diabase, gabbro	
	Archæan (Early Precambrian)	Granitic intrusives	
		Altered diorite and gabbro; amphibolite	
		Yellowknife group	Greywacke, argillite, slate, impure quartzite, and arkose; nodular quartz-mica schist and hornfels
			Mainly dacite, rhyolite, and breccia; feldspar and quartz-feldspar porphyry
			Mainly andesite, dacite, basalt, tuff; altered basic intrusives

YELLOWKNIFE GROUP

Volcanic Rocks

Three main belts of volcanic rocks occur in the area. Two of these lie west of Yellowknife River and doubtless represent a once continuous lava horizon at least 2 miles thick, now separated by a granite salient southwest of Quyta Lake. The third belt extends irregularly east and northeast from Clan Lake and differs in lithology, and probably in age, from the others.

The two main belts of volcanic rocks west of Yellowknife River and narrower bands in the overlying sediments are chiefly andesite, dacite, and basalt. These weather light to dark green, and in places show pillows, vesicles, quartz-filled amygdules, and other extrusive features. Lenses of chert, tuff, and agglomerate up to tens of feet in thickness are common between flows. The chert shows thin laminations alternately light and dark grey or pink in colour. On the small, northerly projecting point in the southeast corner of Bell Lake a chert lens contains numerous thin bands rich in hematite and might be termed lean iron formation. Most of the tuff bands weather greenish grey to black, are fine-grained, thinly laminated, and in places show slaty cleavage. A banded rock, probably a tuff, lies along the contact between nodular sediments and volcanic rocks southwest of Discovery Lake. This rock shows discontinuous, shadowy bands of light and dark green material from $\frac{1}{8}$ to $\frac{1}{2}$ inch thick, and is studded with reddish brown garnets up to $\frac{1}{2}$ inch across. Most of the rocks styled agglomerate consist of subangular, unsorted, fine-grained, green-weathering blocks up to a foot or more across cemented by smaller fragments of similar material. In some places, as at a locality 3,000 feet northeast of the south end of Discovery Lake, the fragments are more rounded and heterogeneous, the matrix shows rude stratification, and the rock bears some resemblance to conglomerate. Within the andesitic and other flows are a few bands of light-weathering rocks resembling some of the rhyolite and porphyry that lie east of Yellowknife River. Only one of these bands (that immediately southwest of Discovery Lake) is of sufficient extent to differentiate on the map.

Cutting all the above rocks are altered basic dykes and sills, commonly less than 200 feet wide. These are only slightly more coarsely grained, darker, and more homogeneous than the andesite and basalt flows that they cut, and can be distinguished from them only where exposures are exceptionally good. Some of them may represent feeder dykes contemporaneous with overlying flows, whereas others may be related to the later, altered, basic sills that cut the overlying sediments.

Most of the volcanic rocks in the area extending east and northeast from Clan Lake are quite different from those lying west of Yellowknife River. Except for a relatively narrow band of andesite and more basic lavas fringing the southern and eastern margins, most of this area is underlain by feldspar and quartz-feldspar porphyries that appear to be largely acid lavas. These rocks are massive and weather light grey to greenish grey to orange-buff. A fresh fracture is commonly conchoidal, and shows a dense, light-coloured groundmass holding numerous oblong feldspar phenocrysts up to $\frac{1}{4}$ inch long and a few, round, opalescent, quartz "eyes" up to $\frac{1}{8}$ inch across. Many of the porphyries are heterogeneous in that they contain subangular patches a few inches or feet across with more or fewer phenocrysts than areas immediately adjacent. The boundaries of such patches are commonly gradational, but they may also be sharp on one side and shadowy or even invisible on the other. Such rocks pass into typical acid flow breccias. The fragments in these are commonly sharply bounded, angular, and up to a foot across. In places they are slabby and alined parallel to the strike of the breccia lens. Elsewhere they are rounded. Both fragments and matrix resemble the associated massive porphyries.

Sedimentary Rocks

The sedimentary rocks lie chiefly east of Yellowknife River in a north-south belt, which, within the limits of the area mapped, is 30 miles long and up to 12 miles wide. On the maps previously published (Paper 39-6) these rocks are divided into two groups: (1) relatively unaltered sediments; and (2) nodular quartz-mica schist and hornfels. The nodular sediments occur around and near the larger bodies of granite, whereas their relatively unaltered equivalents, the non-nodular sediments, are found commonly at some distance from granite. The nodular zone around the southeastern, muscovite-bearing, pegmatitic granite is much wider than that bordering the western biotite granite or granodiorite. A gradation exists between the two types of sediments, and their mutual boundaries shown on the maps are arbitrary. In places where the contact between nodular and non-nodular sediments appears comparatively sharp, as in the area north of Discovery Lake, it transects the general strike of the bedding.

The relatively unaltered sediments include greywacke, argillite, slate, and impure quartzite and arkose, all commonly interbedded. The finer grained members are in beds from a fraction of an inch to a foot thick, whereas the coarser grained beds may be 10 or more feet in thickness. Crossbedding is rare, but gradation in grain size from coarse at the bottom of a bed to fine at the top is common and is useful in determining the structure and age relations in areas of close folding. The most common rock type is greywacke, which weathers grey to buff to brown, and is made up of variable amounts of quartz, light and dark micas, feldspar, and chlorite. By increase in the amounts of quartz or feldspar present the greywacke approaches a lighter weathering, impure quartzite or arkose, respectively. In the other direction the greywacke grades into finer grained, darker weathering rocks that in many places display excellent cleavage and are argillites or slates.

The nodular quartz-mica schist and hornfels represent the altered equivalents of greywacke, argillite, etc. They are commonly more coarsely grained than the relatively unaltered sediments, presumably due to recrystallization. Their component minerals, which generally can be recognized in a hand specimen, are quartz, micas, and feldspar. In most cases the mica flakes are alined parallel to one another, but in others they show random orientation, and the rocks are, respectively, a quartz-mica schist and a quartz-mica hornfels. The most characteristic feature of the altered sediments is the presence of nodules or knots. These are up to 4 inches long and vary from shadowy, oval-shaped aggregations of micas and quartz slightly more coarsely grained than the rest of the rock, to well-formed, angular phenocrysts or metacrysts of definite minerals that include chiastolite (andalusite), cordierite, and garnet. In general, chiastolite is the most widespread of these metamorphic minerals, cordierite is most common in certain argillitic beds, and garnet is apparently restricted to some sediments immediately adjacent to granite. In the areas mapped as nodular sediments some beds show no nodules, although adjacent beds may contain many. In general, the darker weathering (more argillaceous) beds carry the most nodules.

Structure of the Yellowknife Group

Detailed structural studies were not carried out in the area. Unquestionably complex folding has occurred throughout most of the area underlain by sediments. The intricacy of the folding is reflected in the convolutions in the large, altered, basic sills northwest of Angle Lake and north of Nelson Lake. The outlines of these concordant bodies suggest that the usual strike and dip observations on bedding, even when these are closely spaced and supported by determinations of tops of beds, may not present a true picture of the structure. In the area north of Johnston Lake, where strikes are uniformly northeast and where the beds all dip steeply, opposed tops of beds within short distances across the strike indicate very close folding.

The age relations between the volcanic rocks and sediments in the southwestern part of the area are obscured by faulting. The area around Discovery Lake presents one of the most complete sequences across the main lava-sediment contact known in the Yellowknife region. The succession there, from southwest to northeast (neglecting the altered basic sills), is as follows:

	Thickness Feet
Main lava body	
Garnetiferous tuff	0–50
Sediments	1,800
Lavas with intercalated sediments	100–1,000
Sediments	450
Lavas	100–500
Main body of sediments	

The contact of the main lava body and garnetiferous tuff with the first band of sediments may be complicated by strike faulting. All the other contacts are conformable and appear unsheared. At a number of places grain gradations within the sediments indicate that the tops of beds face northeast, and thus that the main body of flows underlies the interbedded flows and sediments and that these in turn underlie the main mass of sediments, or at least that part of it occurring west of the Yellowknife fault zone. None of the coarsely fragmental bands associated with the flows or interbedded flows and sediments, whether they be agglomerate, conglomerate, or breccia, seems extensive enough to imply any long erosional period or major time break within this sequence.

The structures in the area of predominantly acid volcanic rocks east of Clan Lake and their age relations with the surrounding sediments were not determined. In those places where the contact was seen it appeared conformable. The acid lavas generally resemble those found around Duck Lake in the Yellowknife Bay area, which are known to occur within the main body of sediments some distance stratigraphically above the main lava-sediment contact.

ALTERED DIORITE AND GABBRO; AMPHIBOLITE

Most of the altered basic intrusives occur as sills in the sediments. Some are as much as 1,000 feet thick, but in places such thicknesses may be due to duplication by folding. These intrusives weather dark green, are medium- to coarse-grained, and, in places, are foliated. They consist chiefly of variable proportions of hornblende, chlorite, and altered plagioclase, and range from diorite to gabbro or amphibolite. Minor modifications of both sills and enclosing country rock are displayed along some contacts. In places quartzite beds near a sill contain radiating sheaves of amphibole a fraction of an inch long, and small blocks of sediments included in a sill are bordered by amphibole crystals. Nebulous patches rich in biotite within a sill may represent more thoroughly incorporated sedimentary material.

GRANITIC INTRUSIVES

Granites and allied rocks occur in two main areas: (1) in a continuous north-south belt forming the western third of the area; and (2) in a number of disconnected intrusive bodies of various sizes and shapes in the southeastern part of the area.

The western granite is part of a large mass that extends 30 to 40 miles west. Throughout much of the area a major fault or faults mark its eastern contact; elsewhere it is definitely intrusive into the bordering rocks. Most of it is medium- to coarse-grained, homogeneous granite or granodiorite with pink, buff, or white feldspar, glassy quartz, and minor amounts of dark and light micas and chlorite. Within the areas mapped as granite west of Greyling and Quyta Lakes and near the contact with lavas, mixed rocks occur in areas up to 5 miles long and 1 mile wide. In part these consist of lavas cut by a network of granitic dykes. Both dykes and the intervening strips of volcanic rocks are up to 100 feet wide. In other areas, blocks of lava are enclosed in large masses of granite. The blocks show random orientation, are commonly subangular, and evince little or no assimilation by the enclosing granite. The volcanic rocks in each case are more or less recrystallized and contain numerous, chalky white, feldspar laths up to ¼ inch long. The granitic rocks have biotite as their principal dark constituent. Another rock type resembles the quartz diorite and diorite southeast of Yellowknife Bay, and is considered to represent a hybrid or composite rock formed by contamination of the intrusive by absorbed or replaced volcanic inclusions. This type is rather variable, but is commonly porphyritic with white to buff feldspar phenocrysts up to an inch long in a fine- to medium-grained groundmass consisting of about equal amounts of feldspar and hornblende with a little quartz. A common non-porphyritic phase weathers dark red, is medium to coarse grained, and consists of reddish feldspar with somewhat smaller amounts of chloritized hornblende.

The granitic bodies in the southeastern part of the area are quite different from the western granite in both mineral composition and mode of occurrence, and possibly also in age. Most of the smaller bodies are pegmatite and consist of a variably coarse-grained mixture of pink to white feldspar, glassy quartz, muscovite, and black tourmaline. The quartz commonly occurs in graphic intergrowth with tourmaline, less so with feldspar or muscovite. Spodumene, beryl, lazulite, tantalite, arsenopyrite, molybdenite, and native copper have been identified in similar pegmatites in adjoining areas. These smaller bodies occur as dykes, sills, and irregular masses of varying size and shape, and they intrude the nodular sediments in a most complex fashion. Possibly half of them are concordant and their irregular outlines may in part be due to the rather shallow dips and varying strikes of the enclosing sediments. In some places pegmatite dykes form rectilinear patterns apparently unrelated to bedding, suggesting that they have been intruded along joint systems.

The larger masses of granite in the southeastern part of the area are mainly white to red weathering and medium grained. They are composed of about 60 per cent feldspar, 30 per cent quartz, 10 per cent micas (chiefly muscovite), and, in places, tourmaline needles and tiny specks of an unknown blue-green mineral. In many places this medium-grained granite is cut sharply by or grades into coarse-grained, pegmatitic phases composed of the same minerals. Some of the larger bodies contain much included sedimentary material. Irregular quartz lenses fringed by a fine- to medium-grained selvedge of tourmaline, quartz, and mica, are common in the nodular sediments around the southeastern granite bodies. Many such lenses carry mauve-coloured andalusite crystals up to 6 inches long.

DIABASE, OLIVINE DIABASE, GABBRO

Late basic dykes are widespread in the area, but are most common in the southern part, where one dyke attains a maximum width of 400 feet. They are the youngest known rocks of the area. The dykes weather rusty to dark brown, are fresh, homogeneous, and massive except near later faults. Their finer grained border facies have an ophitic texture. The dykes consist of about equal proportions of plagioclase and pyroxene with relatively small amounts of either olivine or quartz.

FAULTS

Faults are numerous throughout the area, but probably the greatest displacements occurred within a zone less than a mile wide that extends due north along Yellowknife River to a short distance north of Clan Lake. Beyond this point the zone cannot be traced due to the absence of horizon markers and the lack of any distinct topographic expression of the faulting. Within the zone the rocks are sheared almost beyond recognition, and what are mapped as single faults represent shearing that, in places, is more than 1,000 feet wide. This fault zone strikes north and most of the other large faults of the area strike between north and northwest. They follow straight or broadly sinuous courses regardless of topography, hence their dips are probably steep. In any fault where the horizontal displacement could be measured, the rocks to the east moved relatively northwards for distances up to 2 miles. That is, they show a left-hand horizontal offset. The directions and amounts of the vertical components are unknown, but from the fact that a section from west to east across the area shows successively younger formations, possibly the eastern sides of the faults were downthrown. A few small faults striking about northeast, such as that through the south end of Neck Lake, show a right-hand offset—that is, the rocks on the northwest side have moved relatively northeasterly.

The larger faults offset the late diabase dykes, and thus are late Precambrian in age or even younger. Following the movements some comb and cherty quartz with specular hematite and sulphides was deposited in some of the shear zones along and near the major faults.

ECONOMIC GEOLOGY

Much of the country along Yellowknife River in the area has been staked, but surface development work has been done on only a few of the claim groups, and underground work is limited to a single showing on the Mon group.

The Mon group of thirty-five claims was staked by G. Moberly and L. Nelson in September 1937 on behalf of Consolidated Mining and Smelting Company of Canada, Limited. These claims lie around and to the northwest of Discovery Lake, about 30 miles north of Yellowknife. Gold has been found in half a dozen or more quartz veins on this property. The main showing is in a steeply plunging drag-fold at the contact of altered basic sills and flows with sediments (chert, tuff, greywacke, and cordierite hornfels). The contact strikes north 30 degrees west, with sediments on the northeast and basic igneous rocks on the southwest. The beds and contact dip moderately to steeply to the southwest and are probably overturned. An S-shaped quartz lens about 20 feet wide and 50 feet long lies in the drag-fold. Quartz veins up to 3 feet wide extend along and near the contact for at least 40 feet southeast, and at least 250 feet northwest, from the lens. The quartz in the lens and veins is glassy and in places contains much hornblende or chlorite or both minerals arranged in vertically elongated foils or pencils up to several inches long, which are parallel to a similar structure in the adjacent basic igneous rocks. Metallic minerals make up less than 5 per cent of the vein matter and include pyrrhotite, arsenopyrite, pyrite, chalcopyrite, galena, sphalerite, a little native copper, and, in places, considerable visible gold. During the summer of 1938 a vertical prospect shaft located 50 feet southeast of the lens was put down and 160 feet of lateral work was done at a depth of about 60 feet. This limited underground investigation encountered only a few quartz stringers carrying low gold values.

Adjoining the Mon group on the south are the Lil and Lilex groups, totalling eighteen claims, on which surface work was done in 1938 by Oro Plata Mining Corporation, Limited. This work disclosed a number of gold occurrences, several of which are in shears in altered gabbroic sills. Native silver was panned from a 6-inch quartz vein cutting gabbro.

In a block extending northeast for 15 miles from Clan Lake six groups, totalling two hundred and thirty-two claims, were staked in 1937 on behalf of Territories Exploration, Limited. Many gold-bearing quartz veins, six of which show visible gold, were found on these claims. According to the company's geologists, those veins carrying visible gold have only minor amounts of other metallic minerals, whereas those in which no visible gold was seen, but from which gold could be panned, contain considerable arsenopyrite, pyrite, pyrrhotite, chalcopyrite, galena, sphalerite, stibnite, and unidentified, soft, grey, metallic minerals. The quartz in both types of veins varies from light bluish grey to dark grey, contains small amounts of ferruginous carbonate, and in general resembles the quartz found in other veins carrying neither visible gold nor gold values. One glassy white quartz vein, 4 inches wide and carrying several gold nuggets from the size of a matchhead down, was found in a joint in a diorite sill.

The numerous discoveries within the past few years of gold-bearing veins throughout a region of about 12,000 square miles around Yellowknife Bay have indicated that the volcanic and sedimentary rocks of the Yellowknife group are the most favourable in which to prospect for such deposits. The discoveries in the present map-areas further indicate that the altered diorite and gabbro sills that cut the Yellowknife group rocks are likewise favourable. The map-areas are underlain by similar rocks and lie within the same belt of late major faulting as does the Yellowknife Bay area to the south. Also they contain a wide belt of nodular and non-nodular sediments similar to that lying 30 miles east, which includes the gold deposits around Gordon, McDonald, Murray, Pensive, and Thompson Lakes. By analogy with these two areas, prospectors searching for gold in the area should examine carefully: (1) quartz veins along sheared zones in volcanic rocks that are approximately parallel to and not far distant from a late major fault; and (2) quartz bodies within structures in sediments that are controlled by folding (saddle reefs, bedded veins, lenses along drag-folds or along the shattered crests of folds, etc.). By analogy with the Ptarmigan (Lily-Jack) and Thompson Lake gold-quartz-tourmaline veins (Prosperous Lake and Beaulieu River map-areas, respectively), prospectors should seek for such veins just within the outer margin of the nodular sediments surrounding the southeastern muscovite granite in the area. In general, throughout the whole of the Yellowknife-Beaulieu region, past experience has shown that gold values in most deposits are limited to the quartz, and that the character and appearance of this quartz and the presence or absence of sulphide minerals bear only slight relation to the gold content.

The pegmatite dykes, sills, and stocks in the southeastern part of the area carry tourmaline, spodumene, and andalusite. Similar pegmatites in the areas adjoining to the east and south have been found to contain beryl, lazulite, lepidolite, tantalite, arsenopyrite, molybdenite, native copper, and other minerals as yet unidentified. A number of chips taken 3 miles south of Alexie Lake from several pegmatites containing a little molybdenite and arsenopyrite showed traces of gold, silver, and tin on assay.