CANADA
DEPARTMENT OF MINES AND RESOURCES
MINES AND GEOLOGY BRANCH
BUREAU OF GEOLOGY AND TOPOGRAPHY

LEGEND

PROTEROZOIC (LATE PRECAMBRIAN)

9 — Diabase, gabbro

8 — Granite, pegmatite

ARCHÆAN (EARLY PRECAMBRIAN)

7a, 7b — 7a, biotite granodiorite, granite, and allied rocks; 7b, hornblende granodiorite, granite, and allied rocks; (A, with biotite schist inclusions; B, with hornblende schist inclusions)

YELLOWKNIFE GROUP

5 — Greywacke, slate; minor quartz-mica schist and phyllite

6a, 6b — 6a, nodular quartz-mica schist and hornfels; 6b, mixed rocks; mainly derived from 5. (G, garnet-bearing; S, staurolite-bearing; C, chiastolite-bearing)

4 — Conglomerate, arkose, quartzite, argillite; minor acid lavas and pyroclastic rocks

3 — Altered gabbro and diorite, in part younger than 5 (only the larger bodies mapped)

1a-1b, 1c — 1a, mainly andesite, basalt, dacite; 1b, mainly dacite, rhyolite; 1c, chert, tuff, agglomerate. Minor amounts of 1a, 1b, and 1c interbedded with 4 and 5

2 — Diorite, quartz diorite; derived from 1a

Au — Gold-bearing quartz vein

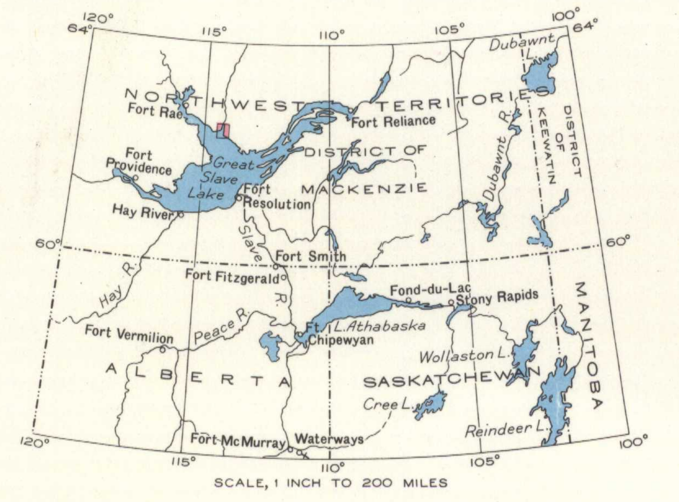
Drift-covered area
Flow contact
Fault
Glacial striæ
Bedding
Bedding (inclined, vertical, overturned, dip unknown)
Bedding (direction of dip known, upper side of bed unknown)

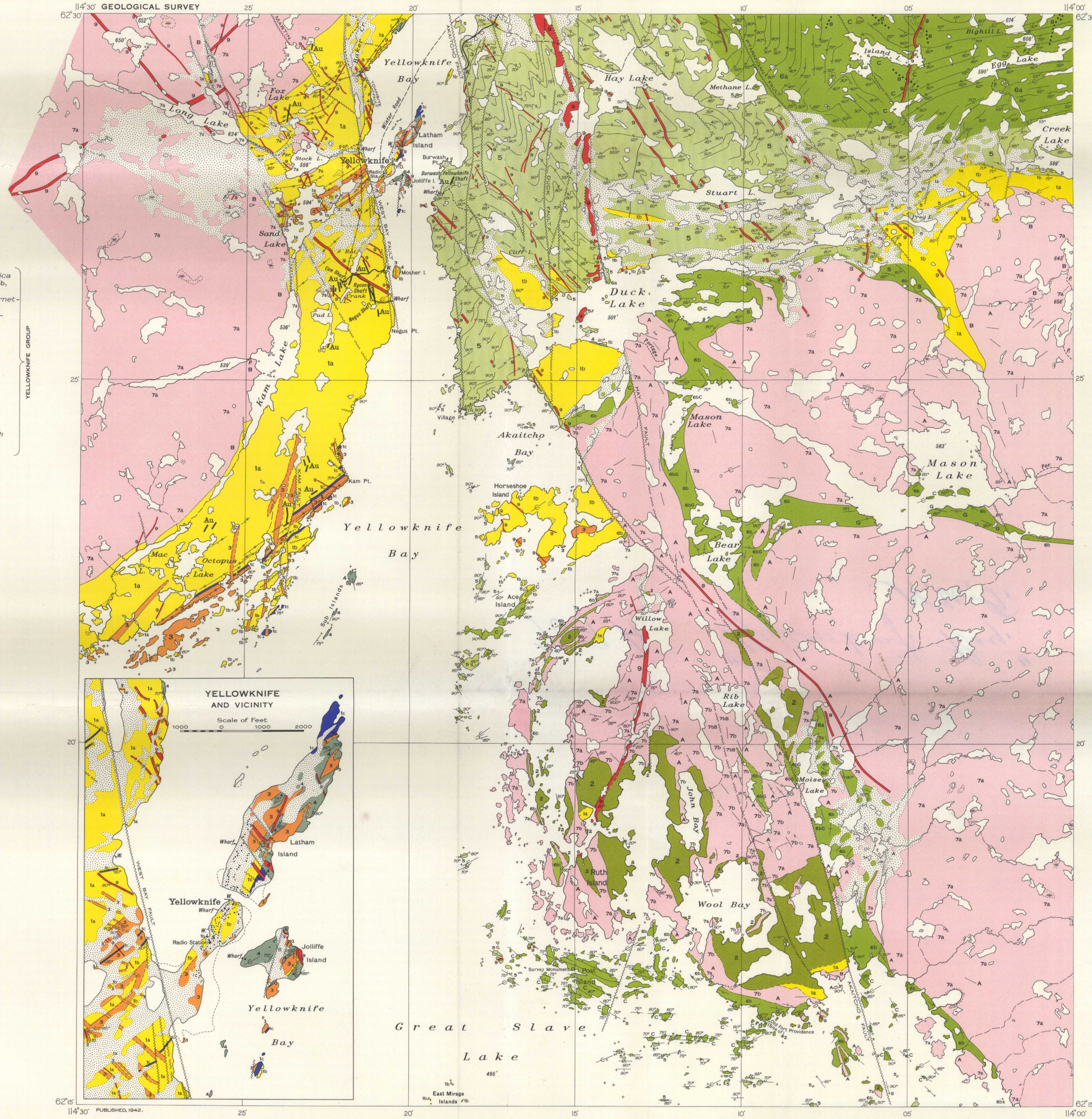
Note:- bedding symbols within areas of 2 and 7 indicate strike and dip of inclusions or of gneissic structures.

Road and buildings
Winter tractor road
Trail or portage
Post Office
Power transmission line
Reserve boundary
Stream (position approximate)
Rapid
Marsh
Reef
Height in feet above Mean sea-level, based on datum of 495 feet, Great Slave Lake .... 563′

Geology by A. W. Jolliffe, 1937, 1938, and 1939.

Base-map compiled by the Topographical Survey, 1938, from aerial photographs taken by the Royal Canadian Air Force, in June, 1937. Cartography by the Drafting and Reproducing Division, 1942.





MAP 709A

YELLOWKNIFE BAY

DISTRICT OF MACKENZIE
NORTHWEST TERRITORIES

Scale, $\frac{1}{63,360}$ or 1 Inch to 1 Mile
Miles

Approximate magnetic declination, 35°45′ East.

DESCRIPTIVE NOTES

Yellowknife may be reached in season by boat or aircraft from Waterways, Alberta, which lies 400 miles south at the northern terminus of the railway from Edmonton.

The area is rugged in detail but few hills rise more than 200 feet above the level of Yellowknife Bay. Bedrock is well exposed throughout most of the map-area. However, even where outcrops are practically continuous, important geological features such as faults, veins, and dykes may be obscured, as they commonly weather to form lineal drift-filled depressions.

The Yellowknife Group is composed, primarily, of lavas, overlain by a series of interbedded sedimentary and volcanic rocks, and succeeded, in turn, by a sedimentary member. The basal assemblage consists of as much as 33,000 feet of lavas with minor bands of pyroclastic rocks and chert. Of this maximum thickness, the lower two-thirds is represented, mainly, by dark green weathering, massive, pillowed, amygdular and spherulitic, intermediate to basic flows (1a) separated by narrow bands of chert (1c). The remainder consists chiefly of lighter-weathering, more acidic, poorly pillowed and massive flows (1b) that, in the western part of the map-area, contain many chert, tuff, and agglomerate bands (1c) and, in the eastern part, include much flow breccia. The overlying series in the western part of the area, is probably from 2,000 to 6,000 feet thick. At its base is a granite-pebble-bearing conglomerate that marks an erosional interval and possibly also a structural discordance, the magnitude of which increases northward into the adjoining Prosperous Lake area. In the eastern part of the map-area the series is from 300 to 2,000 feet thick and a basal conglomerate has been found only on the south shore of Duck Lake; elsewhere the basal lavas of the group pass into the series of interbanded flows and sedimentary rocks without apparent erosional or structural break. The flows are mainly light-coloured, acidic types. The associated sedimentary rocks include numerous tuffaceous bands. The third and youngest member of the Yellowknife Group is made up of a great thickness of interbedded greywacke and slate (5) that, in part (6a, 6b), has been altered by adjacent granitic intrusions. Gradation in grain size from coarse at the bottom to fine at the top of a bed is particularly characteristic of this member, and cross-bedding is common in the coarser clastic rocks of the underlying series.

Many altered basic dykes and sills (3) cut the volcanic rocks of the Yellowknife Group and one or two of similar character were found cutting sedimentary beds. Most of them show diabasic texture and many hold altered feldspar phenocrysts up to several inches long. Many of those cutting lavas are considered to be contemporaneous with overlying flows. In the adjoining Prosperous Lake map-area several such dykes are truncated by the conglomerate member of the Yellowknife Group.

Parts of three large bodies of granitic rocks lie within the map-area. They differ from one another in composition and contact relations and perhaps also in age. The northwestern mass and outlying stocks consist largely of biotite granodiorite (7a). It shows transgressive intrusive contacts with the more basic lavas (1a), and, near some of these contacts, holds numerous hornblendic inclusions (B). Aplitic and granodiorite dykes cut the adjacent lavas and in most places are limited to a zone about half a mile wide bordering the contacts. The southeastern granitic body is likewise intrusive into the rocks of the Yellowknife Group but its contacts are generally concordant. Quartz-feldspar porphyry sills are common in Yellowknife rocks for a distance of about two miles out from the intrusive body. This body may be divided into an eastern part that consists of biotite granodiorite (7a) fairly free of inclusions, and a western part that is made up of either biotite or hornblende granodiorite (7a, 7b), holding numerous sedimentary (A) or volcanic (B) inclusions respectively. Within the western part are more basic phases that approach a quartz diorite or diorite in composition and texture (2) and are considered to be highly altered equivalents of basic lavas. In places the dioritic rocks retain sufficient extrusive characters to allow their being mapped as flows. A third granitic body is represented in the northeastern corner of the map-area by a few pegmatite dykes up to 60 feet wide and half a mile long (8). Besides quartz and feldspars the dykes carry tourmaline, muscovite, and spodumene, and are apophyses of a large body of pegmatitic granite that lies east of Prosperous Lake. This granite is believed to be younger than the granitic rocks of either of the two other large bodies.

Cutting all the above rocks are brown-weathering diabase dykes, up to 350 feet wide (9). They consist of mixtures of basic plagioclase and pyroxene with small amounts of opaque minerals and olivine or quartz. A basic intrusive sheet that lies west of Hay Lake and extends south from Willow Lake is probably of the same age as the diabase dykes. It is 200 to 300 feet thick and dips 5 to 25 degrees easterly. Olivine gabbro forms the lower half of the sheet and grades abruptly upward into quartz gabbro.

No rocks in the map-area are completely unaltered. The more obvious changes are found in rocks of the Yellowknife Group. The basic lavas (1a) have been altered by the introduction or development of albite, chlorite, and alkalic amphiboles, and, near the larger granitic bodies, have recrystallized to form medium-grained amphibolitic rocks. In the relatively acid lavas (1b) the most typical alteration consists of replacement by iron-bearing carbonate. The least altered sedimentary rocks (5) lie farthest from the granitic bodies and consist of fine-grained mixtures of quartz, biotite or chlorite, and a little feldspar. Towards the granite contacts these show recrystallization with coarsening of grain size and the development in certain beds (6a) of nodules or knots that vary from nebulous micaceous clusters to distinct crystals of chiastolite (C), staurolite (S), and garnet (G). The nodules are commonly less than an inch long but may reach a length of eight inches. The matrix surrounding them rarely shows marked foliation and is commonly a slightly schistose quartz-mica hornfels. The width of the nodule-bearing zone around the Prosperous Lake pegmatitic granite (8) is much greater than that surrounding the southeastern granodiorite body (7a, 7b). Near this body the sedimentary rocks are intruded by granodiorite and aplite sills and dykes. Where these intrusions make up between 10 and 50 per cent of the area the rocks are mapped as mixed rocks (6b); where they exceed 50 per cent the rocks are mapped as biotite granodiorite (7a) with biotite schist inclusions (A); where they constitute less than 10 per cent they are disregarded in the mapping.

The structural geology of the map-area is complex. Such elucidation as has been possible is due to the excellent exposures and to the remarkable preservation of certain extrusive and sedimentary features within the Yellowknife Group rocks whereby the original tops of the steeply-dipping and overturned flows and sedimentary beds may be determined. These features include shapes of pillows, breccia-massive flow contact relations, grain gradation in flows, and, in sedimentary beds, grain gradation, cross-bedding, and scour. By the use of such evidence more than 4,000 top determinations were made within the map-area. Considered broadly, the bulk of Yellowknife Group rocks lie in a northeasterly-plunging syncline bordered on either limb by younger granodiorite intrusions and greatly modified by later folding and faulting. The present course of the synclinal axis lies up Yellowknife Bay from just north of West Mirage Islands to Burwash Point on the eastern mainland. The syncline is assymetric. The northwest limb consists of a simple homoclinal succession that dips and faces southeast throughout except for local reversals near Yellowknife townsite and Burwash Point. The southeast limb is overturned; is in part folded into a subsidiary anticline; and is further complicated by cross folding. The axis of the anticline passes through three areas of volcanic rocks that border the southeastern granodiorite and that are now separated by faulting and cross folding. On Horseshoe Island the anticline plunges to the southwest; south of Duck Lake the plunge is to the east; and north of Preg Lake the continuation of the same structure plunges westerly again. These alternations in direction of plunge are considered to be the result of cross folding at nearly right angles to the original anticlinal axis. The cross folding is further expressed in numerous northwesterly-trending minor folds that lie east from Yellowknife Bay to Methane Lake. The fact that many of these minor folds have an overturned plunge is thought to reflect the original overturning in the southeastern limb of the earlier-formed syncline. Presumably, the northeasterly direction of folding is related to the emplacement of either the northwestern or southwestern granodiorite bodies or both. On the other hand, the cross folding is tangential to and probably connected with the intrusion of the Prosperous Lake pegmatitic granite.

The faults of the Yellowknife Bay map-area rank with the largest known steeply-dipping dislocations of the earth's crust. The area lies at the intersection of two fault systems. One extends at least 50 miles north up Yellowknife River Valley. The other trends north-northwest for about 70 miles and probably continues an equal distance farther in this direction to join with faults in the Indin (Wray) Lake gold area. Within the Yellowknife Bay area most of the faults strike between northwest and north and all have steep to vertical dips. The movements along them have been largely or wholly horizontal and in each case the east side has been shifted relatively northward. Displacements on individual faults range up to five miles, and across a width of 10 miles the total horizontal offset produced by faulting is about 11 miles. The faults branch and join as indicated on the map. Where two or more faults join to form a single fault the sum of the offsets on the branches is about equal to the offset on the main fault. Thus, four miles north of the map-area the West Bay fault (offset 3½ miles) is joined by the northerly extension of the Akaitcho fault (offset 1½ miles) to form a single fault showing an offset of about five miles. The faults are marked by intensely sheared rock from an inch to more than 100 feet wide. The width bears little relation to the amount of displacement and may vary greatly along a single fault. It is greatest where a fault changes strike. Many of the large faults appear on certain outcrops as little more than cracks, particularly where the wall rocks are sedimentary. Such cracks are commonly bordered by an inch or two of rusty weathering cherty mylonite holding numerous tiny pyrite crystals. The West Bay fault, two miles north of Yellowknife, is marked by strong shearing more than 100 feet wide. One and one-half miles farther north (in the Prosperous Lake map-area) the same fault follows a drift-filled trench a foot wide that crosses relatively unsheared rocks. Three miles beyond this point the fault holds a quartz vein and stockwork up to 180 feet wide. The pattern and general features of the major faults are duplicated in innumerable minor shears, even where the offset may be measured in inches. For these and other reasons many of the shears are considered to be related in age and origin to the major faults. Some, however, undoubtedly represent earlier-formed fractures reopened during the period of faulting. The movements on the major faults were largely or wholly subsequent to the intrusions of diabase and gabbro of Proterozoic age.

Gold-bearing veins were first reported from Yellowknife Bay area in 1898. Forty years later the Con-Rycon property entered production and thereby became the first producing gold mine in the Northwest Territories. This and the Negus mine up until the end of 1940 had produced 75,733 and 36,394 ounces of gold respectively. The deepest working levels at that time were at 500 and 300 feet. Many other gold prospects have been found in the area and a wide variety of other minerals of possible importance are known to occur. Prospecting and development work have been confined to the gold occurrences, some of which are described below.

The gold-bearing veins at the Con-Rycon and Negus mines lie in well-defined shears that are marked by bands of chloritic schist and that cut pillowed and massive andesites (1a). The shears trend a few degrees west or east of north and show the same sort of branching pattern and offsets as exhibited on a larger scale by the major fault system. They dip 45 to 85 degrees west and lie about parallel to and, in some cases, along the borders of altered diorite and gabbro dykes (3) that cross the lavas. Many of the shears can be followed for upwards of 1,000 feet. They are commonly less than 10 feet wide but in places are more than 100 feet wide. The shears hold veins and lenses composed of a very fine-grained mixture of quartz and ferruginous carbonate; this material is veined and partly replaced by milky to dark grey quartz that in places is drusy. These bodies vary greatly in size and many merge into the enclosing chloritic schist without any sharp boundary. In places they occupy almost the entire width of a shear; elsewhere, along the same shear, they may be lacking. Most of them are less than three feet wide although some exceed 30 feet. They are commonly continuous for hundreds of feet. Parts of the veins carry sufficient gold to constitute ore. On the 250-foot level of C4 vein (Con property, between Crank and Rat Lakes) 1,200 feet of drifting exposed 648 feet of ore in six shoots averaging 5½ feet wide and containing 1.3 ounces gold to the ton. One shoot is 287 feet long; its width is from one to 13 feet, and averages 3.8 feet; and it contains 1.58 ounces gold to the ton. Another shoot is 100 feet long, averages 17 feet wide, and contains one ounce of gold to the ton. The change from vein matter below ore grade to ore is commonly not accompanied by any obvious change in either gangue or metallic minerals although visible gold is most common in relatively pure quartz. Most of the shoots occur where the wall-rocks are massive unpillowed lavas, a connexion first observed by geologists of the Con mine. More than 25 primary metallic minerals have been identified in the ores but commonly form only one or two per cent of the vein matter. They include gold, electrum, pyrite, arsenopyrite, sphalerite, galena, and chalcopyrite; a number of grey-coloured lead, copper, and iron sulpharsenides and sulphantimonides (some of which carry small amounts of tin); and tellurides.

The age and origin of the Con, Rycon, and Negus, gold-bearing veins are obscure. They occur in shears that may be related to the major faults none of which are known to be older than the late diabase dykes (9). One gold-bearing vein 500 feet north of Pud Lake lies in a shear that offsets such a dyke but the offset may be due to post-ore shearing that has occurred along some of the veins. On the 500-foot level of C4 vein a late diabase dyke appears to be chilled against gold-bearing quartz. On the Ptarmigan property, in the adjoining Prosperous Lake map-area, gold-bearing quartz-tourmaline veins cutting nodular sediments are considered to be related to the Prosperous Lake granite, much of which carries tourmaline.

On the Rich claims of Burwash Yellowknife Mines, Limited, (2,000 feet south of Burwash Point), a quartz lens 25 feet long and up to 27 inches wide, containing 13.6 ounces gold to the ton, occurs in a small shear cutting greywacke and slate (5). The shear lies one-quarter mile west of and parallel to a major fault. The quartz is milky to dark grey and contains carbonate minerals, feldspar, and less than one per cent of arsenopyrite, pyrite, gold, marcasite, chalcopyrite, galena, and pyrrhotite. Most gold is in quartz, some is in carbonate, and a very little occurs in chloritic gouge bordering the quartz.