CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

MEMOIR 266

GIAUQUE LAKE MAP-AREA, NORTHWEST TERRITORIES

BY

L. P. Tremblay

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1952

Price, 75 cents No. 2506

Discovery Yellowknife Mines Limited in September 1950. The two-story white building to the left is the office and staff quarters. The large tanks to the right are oil tanks. (Page 44.)

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CONTENTS

PAGE
Preface.......... V

CHAPTER I

Introduction.......... 1
General statement.......... 1
Means of access.......... 1
Acknowledgments.......... 2
Previous geological work.......... 2
Physical features.......... 2
Selected bibliography.......... 4

CHAPTER II

General geology.......... 6
General statement.......... 6
Table of formations.......... 6
Volcanic rocks.......... 7
Sedimentary rocks.......... 9
Quartzite and granulitic rocks.......... 9
Greywacke and argillite.......... 11
Nodular schists.......... 14
Chemical composition of the sedimentary rocks.......... 15
Intrusive rocks.......... 20
Diorite.......... 20
Porphyritic rhyolite.......... 21
Muscovite granite.......... 22
Gabbro.......... 22
Pleistocene.......... 23

CHAPTER III

Structural geology.......... 25
General statement.......... 25
Bedding.......... 25
Cleavage.......... 27
Lineation.......... 29
Folds.......... 30
Faults.......... 31
Discovery fault.......... 32
Viking fault.......... 36
Age of the faults.......... 36
Joints.......... 36
Regional relationships.......... 38

CHAPTER IV

Economic geology.......... 39
General statement.......... 39
Characteristics of gold occurrences.......... 39
Quartz veins and stringers.......... 40
Description of properties.......... 43
Discovery Yellowknife Mines Limited.......... 43
History.......... 44
Development.......... 45
Geology.......... 45
Structure.......... 47
Ore zones.......... 48
Viking Yellowknife Gold Mines Limited.......... 53
History.......... 53
Development.......... 53
Geology.......... 56
Structure.......... 56
Ore zones.......... 56

CONTENTS—*Continued*

Economic geology—*Con.*
Description of properties—*Con.*

PAGE

LaSalle Yellowknife Gold Mines Limited 60
Greenlee Mines Limited 62
Typhoon Yellowknife Mines Limited 64
Beauregard Yellowknife Mines Limited 64
Centrix Yellowknife Mines Limited 65
Northland Mines (1940) Limited 66
Circle Yellowknife Mines Limited 66
Oro Yellowknife Gold Mines Limited 67
Wolfpack Yellowknife Mines Limited 68
Goldpac Yellowknife Mines Limited 68

Table I. Chemical analyses of volcanic rocks 9
II. Chemical analyses of sedimentary rocks 16

Index 73

Illustrations

Map 1017A. Giauque Lake, N.W.T. .... In pocket

Plate I. Discovery Yellowknife mine camp .... Frontispiece
II. A. Illustrating effects of frost-thrusting 69
B. A crater-like depression due to frost-thrusting 69
III. A. Interbedded quartzite and granulite 70
B. Bodies of granulite in quartzite 70
IV. A. Interbedded greywacke and argillite 71
B. Vertical section of nodular schist 71
V. A. Joints in sedimentary rocks 72
B. Viking mine 72

Figure 1. Diagram illustrating relation of oxides to silica in sedimentary rocks of Giauque Lake area 18
2. Diagram comparing chemical analyses of sedimentary rocks of Giauque Lake area 19
3. Sketch illustrating channelling in an argillaceous bed 26
4. Sketches illustrating relations of cleavage to bedding 28
5. Sketch-map illustrating structural relations along Discovery fault 33
6. Sketch illustrating gradation of quartzite-granulite band into greywacke and argillite 35
7. Diagram illustrating joint systems, Giauque Lake area 37
8. Diagram illustrating vein pattern, Giauque Lake area 41
9. Plan of underground workings, Discovery mine 46
10. Plan of North vein, Discovery mine 49
11. Plan of West zone area, Discovery mine 51
12. Geological plan of surface workings on Main zone, Viking mine 54
13. Geological plan, 150-foot level, Main zone, Viking mine 55
14. Geological plan, East zone, Viking mine 59
15. Geological plan of main area of surface workings, Greenlee mine 63

PREFACE

Giauque Lake map-area occupies about 50 square miles of the Canadian Shield some 50 miles northeast of Yellowknife. It has been actively prospected for gold in recent years, and to the end of 1951 the one productive property has, in its 2 years of operation, produced gold to the value of roughly $1,250,000. The area is underlain mainly by Archæan sedimentary formations, but includes some associated volcanic and younger intrusive rocks. Over relatively large areas the sedimentary strata have been metamorphosed to nodular schists, and the formations as a whole have been steeply and intricately folded and subjected to considerable dislocation.

The present report deals at some length with the lithology and complicated structural features of the rocks of this area, and with their relation to its mineral deposits. The several properties and prospects are described, and these and other geological features have been illustrated by a series of figures and by a few photographs. The report itself is accompanied by a detailed coloured geological map of the area on a scale of 1 inch to 2,000 feet.

GEORGE HANSON,
Chief Geologist, Geological Survey of Canada

OTTAWA, December 5, 1951

Giauque Lake Map-Area, Northwest Territories

CHAPTER I

INTRODUCTION

GENERAL STATEMENT

Giauque Lake map-area lies some 50 miles north 15 degrees east of Yellowknife and occupies an area of about 50 square miles between latitudes 63°03′ and 63°15′ and longitudes 113°46′ and 114°09′. The geological map of the area (in pocket) is in one sheet: its northeastern half covers an area about 7 miles long and 4·5 miles wide situated almost entirely in the southwestern corner of Carp Lakes map-area (11)[1], whereas its southwestern half covers an area about 8 miles long and 2·5 miles wide that lies almost entirely in the southeastern corner of Wecho River map-area (19). The Discovery shaft, located at about the centre of the northeast half of the area, is at a flight distance of 52 miles from Yellowknife; and the Viking shaft, which is in the southern half of the area, is 44 miles from the same town.

Although gold had been found at several places in Carp Lakes and Wecho River map-areas before 1944, the Giauque Lake area was not known as a potential gold-bearing area before the autumn of that year, when gold was first reported from it, and since then has passed through a boom period, which ended in early 1948, to a period of production, which commenced in January 1950. During the boom years, from late 1944 to early 1948, much work, including prospecting, mapping, trenching, and drilling, was done in the area by several mining companies, and one property, that of Discovery Yellowknife Mines Limited, emerged as an interesting prospect and was finally brought into production in January 1950. The area was mapped in considerable detail by the writer during the summers of 1948, 1949, and 1950, with the hope that the information obtained might prove useful in correlating the various gold discoveries, in assisting development operations, and in the search for new occurrences. The mapping was done on air photographs enlarged to the scale of 1 inch to 750 feet.

MEANS OF ACCESS

The Giauque Lake area is best reached by plane from Yellowknife. There are, however, two possible canoe routes from Yellowknife, but both require at least a dozen portages. Both routes follow Yellowknife River from Yellowknife Bay as far as Quyta Lake, from where one route proceeds via Angle, Short Point, Neck, Duncan, Wagenitz, and Thistlethwaite Lakes to reach the northern part of the area on Giauque Lake, and the other continues through Sito, Clan, and Johnston Lakes to the southern part of the area. A winter road, suitable for tractor or truck, gives access

[1] Numbers in parentheses are those of references listed in Bibliography at end of this chapter.

to the area during the winter months, and is used to carry most of the heavy freight to the area. It follows Yellowknife River to Clan Lake, and thence passes via Johnston, Goodwin, and Morris Lakes to Giauque Lake and represents a trip of about 67 miles from Yellowknife to the Discovery shaft.

The area itself cannot be traversed by canoe, for though lakes are numerous, they are small, unconnected, and far apart. The largest, Giauque Lake, provides access to the northeastern part. Much of the area is traversed at 400-foot intervals by cut lines, which were probably made use of by the mining companies for mapping purposes, and which greatly facilitated the work of the writer's parties.

ACKNOWLEDGMENTS

Much assistance was given by officials of the various mining companies, and acknowledgment is extended to all of them, and especially to Norman W. Byrne, consulting engineer for several of the companies, who supplied plans of the various properties; to Tom Anderson, manager of Discovery Yellowknife Mines Limited, for courtesy and information on the Discovery mine; and to M. Piloski, geologist for the same company in 1948 and in 1950. The writer was ably assisted in the field by C. K. Bell, G. Rancourt, and K. F. Pallett in 1948; by T. O. H. Patrick, D. A. Lowrie, O. J. Keskinen, and D. E. MacDougall in 1949; and by S. J. Melihercsik, R. V. Oja, and W. H. Thompson in 1950.

PREVIOUS GEOLOGICAL WORK

Stockwell (16) in 1932 conducted a reconnaissance survey from Great Slave Lake via Yellowknife River to Coppermine River, Northwest Territories, during the course of which he passed within a few miles of the southwestern tip of the Giauque Lake area. In 1936, Jolliffe (5) compiled the results of early geological mapping in the vicinity of Yellowknife River, and, by interpolation, included all of Giauque Lake area within a belt of sedimentary formations. In 1948, Miller (11) mapped the southern half of Carp Lakes area on a scale of 1 inch to 4 miles, including the northeastern part of the Giauque Lake area. The east half of the Wecho River area, mapped by Yardley (19) in 1948 for publication on 1 inch to 4 miles, includes the southwestern part of the Giauque Lake area, which is held to be underlain entirely by sedimentary rocks. Short references to the geology of the area are made by N. W. Byrne in two papers (2, 3) on Discovery Yellowknife Mines Limited. In October 1950, Quinn (15) presented a more complete account of the geology of the area. In his report the rock types are described in some detail, a general idea of the structure is presented, and a detailed account of the mineralogy of the gold occurrences is given. Preliminary maps and a report (17, 18) by the writer have been issued in advance of this memoir.

PHYSICAL FEATURES

Giauque Lake map-area displays most of the physiographic features characteristic of the Canadian Shield. Viewed from the air, the area appears almost flat and featureless, but seen in detail it is rugged. Relief is nowhere pronounced, but in several places, such as west of Narrow Lake, north of Piloski Lake, and north of the Viking camp, it reaches an elevation of about 150 feet above nearby lakes. Near the Discovery shaft and on the west shore of Giauque Lake, the relief is at least 170 feet, a maximum for the map-area. Areas of volcanic rocks and quartzite and granulites normally stand well above adjacent areas of other formations and constitute some of the highest points of the map-area. Commonly, too, strata at the nose of a major fold or drag-fold stand above adjacent beds, due to a thickening of the siliceous greywacke and its relatively great resistance to erosion. North of the Viking camp, some of the rocks have been intensely indurated along the contacts of large gabbro dykes; such rocks are relatively resistant to erosion and underlie a few hills.

The average elevation of Giauque Lake map-area is about 900 feet above sea-level, or about 400 feet above the level of Great Slave Lake, which has a mean elevation of 495 feet. Giauque Lake is probably the lowest part of the map-area, its elevation as determined with an aneroid barometer being roughly 825 feet. Morris Lake is about 850 feet above sea-level; Shona Lake, about 870 feet; and Piloski Lake, probably the highest in the area, about 900 feet.

The topography of the map-area is controlled mainly by the structure of the underlying rocks. Rock ridges generally trend parallel with the trend of the bedrock formations, which is about northeasterly. In many places where the formations have been folded the ridges swing with the formations around the noses of the folds. Glaciation has modified the topography resulting from the bedrock structure, but its main effects have been to accentuate it by deepening the valleys between rock ridges and by smoothing and rounding the tops and flanks of these ridges. Some valleys transect the rock ridges and are continuous for long distances; they commonly occupy fault zones. In places, some of the material left by the glacier has obscured the bedrock structure and effected some modification of the topography, as for example south of the Discovery shaft and east of Narrow Lake, where a large esker traverses the area in a southwesterly direction and occupies much of that part of it.

Drainage in general is poorly established, water flowing from lake to lake by seepage through swampy ground or in narrow, shallow, and irregular streams that are dry most of the season. Swampy ground is common in areas of esker or till, which form drainage barriers. Eventually all drainage reaches Yellowknife River, some of it via Giauque and Thistlethwaite Lakes, but much of it directly via minor creeks and small lakes.

North and northwest of Giauque Lake, about 30 per cent of the surface of the area is rock outcrop, and in the vicinity of the property of Discovery Yellowknife Mines Limited as much as 55 per cent. In the area southwest of Giauque Lake, however, and in the vicinity of Lucky Lake, as little as 15 per cent of the bedrock may be exposed. Southwest of the Morris Lake fault and at some places around Piloski Lake, bedrock exposures occupy between 25 and 45 per cent of the surface.

Giauque Lake area is, on the whole, thickly timbered, and much of the rock outcrop is covered with a heavy growth of lichens. Near Shona Lake, however, part of the area was burned over a few years ago and some of the best rock exposures are found there. The timber, in general, is small, but a few large trees, mainly jack pine and rare spruce, can be seen in the valleys and on the sand or gravel ridges, especially on the less exposed southeasterly slopes. A good stand of jack pine, some of it 22 inches in diameter at the base, occupies the sand plain southwest of the Viking shaft. As a result of mining operations, the large trees, particularly in the north part of the area, are becoming increasingly scarce.

Frost-thrusting (20) is a common and striking physiographic feature of the area, and is especially effective in the rocks of this area, probably because they are strongly jointed. The thrusted blocks can be of almost any size (*See* Plate II A) up to more than 1,000 feet long by 100 feet wide, and commonly are more abundant and the process, in consequence, more spectacular near the low-ground areas, particularly where drainage is poor. In the low areas themselves, thrusted blocks can be encountered, but frost-thrusting commonly occurs where the overburden is only a matter of a few inches thick. As most of the map-area is underlain by sedimentary formations, no adequate comparison can be drawn between the effects of frost-thrusting on sedimentary rocks and on those of volcanic origin, but the different types of sedimentary rocks were observed to react differently. Areas of finely bedded sedimentary rocks, such as interbedded argillite, argillaceous greywacke, and siliceous greywacke, show the effects of frost action by breaking along the bedding planes and forming slab-like blocks that have been pushed regularly to irregularly upward and that in many places have, for lack of support, tilted at various angles over the adjacent ground. The more massive beds or areas of greywacke commonly break along the joint planes, which may either parallel the bedding or trend at right angles to it; in their case, the final result is a chaotic assemblage of blocks of different sizes. In some places, however, the arrangement of those irregular blocks gives rise to crater-like depressions (*See* Plate II B), apparently formed in areas of very low relief from a force raising the blocks up and sideways uniformly all around. The bottom limit of the thrusted blocks commonly is an almost flat-lying joint plane. Many of the openings or irregular crevices left by the thrusted blocks are the best natural wells of the area, commonly containing cool, clear water.

Many of the thrusted blocks carry surface erratics and gravel, which appear to represent glacial drift left during the last advance of the ice while the blocks were still in place. As the upper surface of the thrusted blocks is the only glaciated surface, the frost-thrusting movements must post-date the last retreat of the ice in this region.

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CHAPTER II

GENERAL GEOLOGY

GENERAL STATEMENT

All the consolidated rocks of the Giauque Lake area are of Precambrian age. They consist almost entirely of sedimentary formations that are finely to coarsely interbedded and vary in composition from an argillite and argillaceous greywacke to siliceous greywacke and small amounts of quartzite and granulites. Interbanded with these sedimentary rocks are a few small lenses of basic to intermediate volcanic rocks, which in places show pillowed and fragmental structures. All these rocks have been subjected to several periods of deformation and now are intensely folded and faulted. They are considered to be part of the Yellowknife group and, following the usage established by Jolliffe (6, 7) for similar types of rocks in the Yellowknife and Prosperous Lake areas, and later by Lord (9), Henderson (4), and others, they probably represent the upper part of the Yellowknife group and, consequently, Archæan time. In part, the sedimentary formations have been intensely metamorphosed, and a wide zone of nodular quartz-feldspar-mica schist has been mapped in the northeastern part of the map-area. Intrusive into the sedimentary rocks are small amounts of diorite, porphyritic rhyolite, and gabbro, which occur either as sills or irregular masses, probably intruded before or during deformation, and as late dykes cutting all the rocks and structures. The gabbro dykes and possibly the muscovite granite are the only rocks of the area of Proterozoic age.

TABLE OF FORMATIONS

Age	Lithology
Cenozoic	Morainal material; sand, gravel, clay
	Great unconformity
Proterozoic	**Gabbro; quartz gabbro; diabasic in part**
	Intrusive contact
Proterozoic or (?) Archæan	Muscovite granite; quartz veins and stringers
Archæan or (?) Proterozoic	Porphyritic rhyolite (intrusive) Diorite; minor amphibolite dykes

Age	Lithology
	Intrusive contact
	Yellowknife group
Archæan	Nodular quartz-feldspar-mica schists and hornfels
	Siliceous greywacke, argillite, and argillaceous greywacke (intimately mixed)
	Argillite; slate; argillaceous greywacke; minor siliceous greywacke and graphite schist
	Siliceous greywacke; minor argillite, slate, and argillaceous greywacke
	Quartzite; granulitic rocks; minor greywacke and argillite
	Hornblende-feldspar gneisses; amphibolite; volcanic breccia; agglomerate; dacite; minor basalt and andesite

VOLCANIC ROCKS

Volcanic rocks of the Giauque Lake area are all basic to intermediate in composition and occur in very small amounts intercalated with the sedimentary rocks. They are considered as part, probably the upper part, of the Yellowknife group, which, as established elsewhere in the Northwest Territories, consists predominantly of sedimentary rocks.

Seven bodies of volcanic rocks have been recognized in the Giauque Lake area. One of them, of small extent and Z-shaped, outcrops near the central part of the northeastern boundary of the map-area. It was probably originally a lenticular body, approximately 2,000 feet long and 300 feet wide, that has since been drag-folded into its present position. Five other bodies outcrop within a relatively small area that extends southwesterly from the Discovery shaft to the northeast end of Narrow Lake, and could be considered as parts of a single stratigraphic zone as they lie near each other and the same anticlinal axis. All five are lenticular bodies. Two of them, representing most of the volcanic rocks of the area, as they are each about 4,000 feet long and 500 to 700 feet wide, have been joined tentatively on the map, on the view that they are probably parts of one body. The other three bodies of this group of five are small masses, in general less than 100 feet wide and a few thousand feet long. The seventh and southernmost body of volcanic rocks of the map-area is a lenticular mass about 2,500 feet long and 80 to 250 feet wide, that outcrops in a northeasterly direction at a distance of some 800 feet northwest of the Viking camp. Results from drilling indicate that all these bodies of volcanic rocks probably narrow with depth.

The volcanic rocks of Giauque Lake area are fine to coarse grained, and weather reddish brown to brownish green and dark green. Fresh surfaces are dark green to greenish black. Pillows are rare, and as they are generally deformed they are difficult to recognize or make use of in structural determinations. Some, however, were definitely recognized in the two large bodies of volcanic rocks that extend from the Discovery shaft to the LaSalle camp and in the lenticular mass northwest of the Viking camp;

in both areas, some of the pillows were sufficiently well preserved to indicate an easterly top. A fragmental structure is common in both of the main bodies of volcanic rocks that extend from the northeastern end of Narrow Lake to the Discovery shaft, but nowhere affords a suggestion of fragmental flow tops. This fragmental structure is characterized by angular to elongated fragments of a light-coloured rock in a matrix of dark-coloured material. In places, the volcanic rocks have a patchy appearance, which is believed to represent a deformed fragmental structure. The most common and striking features of all the volcanic rocks of the area are their gneissic structure and coarse banding, which impart a streaky to layered appearance to the rocks and are in part probably relicts of pillow or fragmental structures, though some may be due to recrystallization.

Originally the volcanic rocks probably consisted of pillowed lava, volcanic breccia, and massive basalt to andesite, but they have all been transformed to plagioclase-hornblende gneisses and amphibolite, with garnet metacrysts developed abundantly in some parts of the rock, particularly in the vicinity of the Discovery shaft.

Under the microscope, these volcanic rocks show great variation in texture and composition. In massive types, the constituent minerals are more or less uniformly distributed, and consist mainly of hornblende and plagioclase, with minor amounts of quartz and opaque minerals such as pyrite and pyrrhotite. Hornblende is commonly the most abundant mineral and occurs generally as fresh, bluish green, similarly oriented rods. In places, it may be present in sufficient quantities to constitute an amphibolite. Untwinned plagioclase, varying from albite to andesine (An_{38+}), is next to hornblende in abundance and occurs in large, anhedral crystals interstitial to hornblende. Both minerals may be slightly altered. In banded types, certain minerals are concentrated into definite bands, which alternate at more or less regular intervals. Some of the bands are rich in dark green hornblende; others contain abundant brown biotite; some carry much tourmaline and opaque minerals, with only a little mica; and there are all the possible variations between these several types. All the bands contain untwinned plagioclase and some quartz, which are generally interstitial to the other minerals or comprise much of the groundmass for the others; in rare cases they may constitute individual bands virtually free of other minerals.

A diamond drill core sample, considered to be representative of the volcanic rocks of the area, was taken for chemical analysis, and the results of the analysis are given in Table I, analysis No. 1. In the hand specimen the sample is a hornblende-feldspar gneiss, with a banded or gneissic structure defined by a segregation of the mafic minerals into bands or unequal streaks that rest in a base composed mainly of felsic minerals. For comparison, other analyses are included. Analysis No. 2 was presented by Daly for an average quartz diabase. The similarities between it and No. 1 analysis suggest that the original volcanic rocks of the area were probably mainly of basaltic composition. The alkali content, however, is somewhat lower in the volcanic rocks of Giauque Lake map-area than in the quartz diabase. Analyses Nos. 3 and 4 are of the Keewatin pillowed basalts and of the Kisseynew gneisses respectively, and they are added here as they are from somewhat similar types of rocks in other parts of the Canadian Shield.

Table I

Chemical Analyses of Volcanic Rocks

—	1	2	3	4
SiO_2	51·29	52·34	49·43	50·62
Al_2O_3	13·76	13·70	16·68	15·44
Fe_2O_3	8·80	5·05	3·24	0·74
FeO	8·40	8·78	10·23	8·67
CaO	9·00	8·03	8·49	10·92
MgO	4·38	4·72	4·54	7·15
K_2O	0·18	1·17	0·72	0·73
Na_2O	1·55	2·60	2·56	1·42
H_2O+	1·34			1·51
		1·56	2·23	
H_2O-	0·14			0·13
TiO_2	0·68	1·82	....	0·55
C	....	....	....	0·44
CO_2	....	....	1·24	1·32
P_2O_5	....	....	....	0·48
Total	99·52	99·77	99·36	100·12

1. Basic volcanic rock, Giauque Lake area. Analyst, R. J. C. Fabry.
2. Quartz diabase; from Igneous Rocks and the Depth of the Earth, by R. A. Daly, p. 18 (1933). (Average of twelve analyses.)
3. Average of seven analyses of Keewatin pillowed basalts. Univ. Toronto Studies, Geol. Ser., vol. 46, p. 134 (1941), by J. Satterly.
4. Average of three analyses of the Kisseynew gneisses. Analyst, R. J. C. Fabry, Geol. Surv., Canada, Bull. 20, p. 39.

SEDIMENTARY ROCKS

Sedimentary rocks underlie more than 95 per cent of the Giauque Lake area. They are mainly siliceous greywacke, argillaceous grewacke, and argillite, with all possible gradations between each of these types. Small amounts of quartzite and granulitic rocks are also found. All are finely to coarsely interbedded, mainly fine-grained rocks, and vary in colour from light brown to black and from white to green. They are generally massive to slightly schistose and are rarely sheared. Some of the greywacke beds show grain gradation, from coarse at the base of a bed to fine at the top, current ripple-marks, and channelling; others exhibit occasional crossbedding. These sedimentary rocks are now standing vertically or nearly so, and are generally intensely folded or drag-folded and faulted. Under the microscope, apart from the granulitic rocks, they all are composed of the same minerals but in various proportions, and the matrix in all types is a mass of interlocking feldspar and quartz grains.

QUARTZITE AND GRANULITIC ROCKS

The group of rocks referred to on the accompanying map as consisting mainly of quartzite and granulite represents a finely interbedded mixture of metamorphosed, siliceous and calcareous sedimentary strata with some intercalated argillaceous beds. The term granulite represents the metamorphic equivalent of the calcareous rocks, whereas the siliceous strata are named quartzite. The argillaceous rocks are argillite and greywacke. This assemblage of rocks outcrops near the main bodies of volcanic rocks on the Discovery and LaSalle properties and along the western and northwestern shore of Giauque Lake, where they occupy a belt that varies in width from 100 to 1,400 feet and that extends northeasterly from the middle of Narrow Lake to a point about 3,000 feet southeast of Eclipse Lake. In the field, all the rocks of the belt are seen to be finely and intimately interbedded, but the quartzite and granulite are definitely the dominant and diagnostic rock types and they pass upward or northwesterly as well as along strike into greywacke and argillite. Another small belt of a somewhat similar assemblage of rocks was observed about 1,000 feet southwest of the southwestern end of Morris Lake, but ultimately was mapped with the siliceous greywacke, as greywacke beds are numerous and the granulitic rocks not as abundant and as typical as the granulite of the main belt. This small belt is indicated separately on the accompanying map.

Quartzite occurs mainly in well-defined beds (*See* Plate III A), but near the northeast end of the first main lens of volcanic rocks northeast of Narrow Lake it forms either a thick, structureless mass that contains many patches of granulite or occurs as irregular patches in granulite. All the quartzitic strata are in sharp contact with adjoining rocks, and although beds are not more than 18 inches thick, they are remarkably continuous along strike. The quartzite is a fine-grained to dense rock, much resembling rhyolite in places, as it normally exhibits a glassy white to grey, polished, weathered surface. Freshly broken surfaces are light to dark grey, with dull lustre, and commonly have a fine to dense, sandy appearance. In places, the quartzite carries abundant small nodules of andalusite, and weathered surfaces are rough, the nodules standing in relief. Thin sections reveal a fresh-looking rock, with obvious relicts of clastic structure, and composed of a few large fragments of quartz and feldspar in a very fine-grained groundmass of interlocking quartz, feldspars (andesine and albite), and oriented mica flakes. Either muscovite or biotite may occur, and together they comprise about 25 per cent of the rocks, biotite averaging 10 per cent.

Granulite is next to quartzite in abundance, and is regarded as the metamorphic equivalent of impure calcareous rocks. Quinn (15, p. 3) and Lord (9, p. 127) have suggested that some of the hornblende-bearing bands of these rocks could be recrystallized basic tuffs, the close proximity of basic volcanic rocks being the main reason for the suggestion. The writer, however, assigns them a sedimentary origin, as they are interbedded with true sedimentary rocks such as argillite and greywacke and as their field relations and mineral composition much resemble those of the diorite-like rock occuring as layers and lenses in the massive greywacke. These layers and lenses of dioritic rocks will be shown to be of sedimentary origin. The granulitic rocks are found in beds or lenses intimately mixed with the other sedimentary rock types; they may also form lenses (*See* Plate III B) and patches in quartzite and greywacke. Two main groups of granulites were observed in the field. Those of one group weather dark to rusty brown, are fine to coarse grained, and generally carry conspicuous garnet metacrysts in a dense, slightly schistose matrix. A narrow, white zone of apparently bleached material commonly surrounds bodies of this rock on weathered surfaces. Fresh surfaces are dark green to black, depending on the predominance of either hornblende or biotite, and the beds themselves, though greatly variable in thickness along strike, are remarkably persistent. These granulites also form lenticular bodies of fair size interbedded with quartzite, or lenses a few inches long within thick beds of massive greywacke and quartzite. Thin sections have shown that they are composed of about 65 to 80 per cent green hornblende and brown biotite, 5 per cent garnet, and 15 to 30 per cent calcic andesine and quartz, with small amounts of epidote and accessory minerals.

The other group of granulites is more variable in texture and is slightly different in mineral composition. Three main rock types have been recognized. One type is fine grained, of massive appearance, and dark green to black on the weathered surface. This rock is commonly traversed parallel with the bedding by irregularly spaced, thin seams of white feldspar, which impart a streaky appearance to the rock. A second type is represented by a fine- to coarse-grained rock, of dioritic appearance and exhibiting a massive to gneissic texture. Weathered surfaces are light to dark green and commonly show a lighter coloured core. A third type is found between the two main lenses of volcanic rocks north of Narrow Lake, where it occurs in thick beds mixed with greywacke and presenting a sandy, coarsely streaked to banded appearance. Garnet can be found in all three varieties of this group of granulites, but is found mainly in the darker beds; it is not as conspicuous as in the first group of granulites. Hornblende, andesine, and quartz are the principal mineral constituents, but tourmaline was the main mineral of some of the dark green bands. Epidote commonly forms about 5 per cent of the rock.

Greywacke and argillite are interbedded here and there with the quartzite and granulite, and become most abundant where the latter rocks pass westward into the belt of greywacke and argillite. West and north of the property of Discovery Yellowknife Mines Limited, the eastern contact of this belt of quartzite and granulite is more sharply defined, but around the northeast end of Narrow Lake it is in part gradational as along the northwestern contact of the belt.

GREYWACKE AND ARGILLITE

Siliceous greywacke, argillaceous greywacke, and argillite are the most common and the most widespread rocks of the map-area, and siliceous greywacke is the most abundant. They occur mainly in beds or thin, lenticular bodies, and are commonly intimately interbedded. Beds are normally of uniform thickness along strike, but where closely folded they exhibit in places a thickening at the nose of the folds, as can be seen on the accompanying map. The contacts between beds are generally sharp, and in detail very sinuous. Individual beds may vary in composition either from bottom to top or along strike. In thickness, they vary from a fraction of an inch to 30 feet, with greywacke usually more thickly bedded than the argillite. In the northwestern part of the area, where the rocks are better exposed due to a recent burn, it was possible to differentiate them into two main groups, based on colour, coarseness of grain, and abundance of mica flakes. These two groups, siliceous greywacke and argillaceous greywacke and argillite, were mapped separately wherever it was practicable to do so. Rocks of both groups carry scattered grains of tourmaline.

The siliceous greywacke is a massive rock, with, on weathered surfaces, a pronounced sandy appearance and a faint suggestion of schistose structure. Fresh surfaces commonly exhibit minute, rounded to subangular quartz fragments in a fine, dense, black to grey groundmass, but a general granular texture is apparent. Weathered surfaces are brownish grey to light brown and reddish brown, and generally monotonously uniform in texture and appearance, a feature particularly true of the more thickly bedded greywacke. In places, however, some of the thickest beds exhibit a faint banding, which strikes either parallel with, or at an angle of less than 45 degrees to, the bedding planes, and which may represent incipient bedding or crossbedding. Sun- or fire-cracked surfaces are common in the thick beds of massive greywacke. The coarsest varieties of siliceous greywacke carry rounded to subrounded grains of quartz and feldspars, some of them reaching ½ inch in diameter, concentrated at the base of a bed. In most beds this coarse-grained greywacke grades upward into finer and more argillaceous material, and this feature proved useful in determining tops of beds in outcrop areas. Current ripple-marks, channelling (*See* Figure 3), and rare crossbedding were also noted and used for top determinations at several places in the finely bedded greywacke. Thin sections of the greywacke are clear, and exhibit a definite clastic texture. The rock is composed of scattered, large, angular to oval, uniformly distributed fragments of quartz and feldspar (andesine) in a fine-grained, abundant groundmass mosaic of biotite, feldspar, and quartz, the feldspar amounting to probably as much as four times that of quartz. Calculations from the chemical analysis of greywacke of Giauque Lake area (*See* Table II, No. 3) suggest a higher content of feldspar than quartz. Biotite forms, on an average, about 30 per cent of the rock, and occurs as flakes of variable size all oriented in the same way. There are minor amounts of chlorite, sericite, zircon, and garnet.

A diorite-like rock, occurring in small, irregular lenses and narrow layers, was observed in many places in the siliceous greywacke, but rarely in the argillite. Most of the lenses are a few inches to a few feet long and occur in groups lying in planes parallel with the bedding planes. All individuals of a group are strung out along the same horizon with or without a thin connecting seam of the same diorite-like rock. The layers also parallel the bedding, and although most of them are only a couple of inches thick, they can be followed along strike for several hundred feet, their contacts with the greywacke being markedly sinuous. Weathered surfaces of these layers and lenses are light to yellowish green, have a dioritic appearance, and may show a banded or faintly gneissic structure. Commonly they stand in relief above the surrounding or adjacent rock. A rude zoning can be seen in many of these bodies of 'dioritic' rock, characterized by a white, apparently bleached, margin passing into a zone rich in dark minerals and thence to a light-coloured core where the mafic constituents appear to be in minority. Thin sections of rock from the unzoned lenses or layers give the following average mineral composition in volume per cent: hornblende, 32 per cent; epidote, 7 per cent; plagioclase (An_{49+}), 42 per cent; quartz, 18 per cent; and opaque substances and accessory minerals, 1 per cent. Thin sections of the light-coloured core in the zoned lenses and layers indicate that the amphibole content has remained constant but that the hornblende has been almost entirely bleached of colour; that most of the feldspar has been replaced by epidote; that the quartz content is about the same; and that the little feldspar remaining is albite. Because of these unusual mineral associations, these lenses and layers were probably once sedimentary nodules or concretions and beds rich in calcareous matter, which have recrystallized under the effects of some kind of metamorphism, and may be referred to as hornblende granulite. They are probably related to the granulite described previously in this chapter. Quinn (15, p. 3) refers to these layers and lenses as being magmatic replacement of sedimentary material, the magma being related to the diorite bodies described later on. A somewhat similar type of concretions has been described from Archæan rocks of Thunder Lake, Ontario, by Pettijohn (12, 13).

Nodules of pyrite, commonly less than ½ inch in size, and which are probably also concretions, are found scattered throughout the massive greywacke. On weathered surfaces they form depressions or pits.

The argillite of the map-area is a fine-grained, massive to schistose rock, normally greyish black to black on fresh and weathered surfaces, but the latter may be notably rusty due to oxidation of the abundant pyrite and pyrrhotite of some of the beds. Most of the argillite occurs in wide belts, with beds averaging ½ inch in thickness and grading upward from a grey sandy base to a prominent black, dense, argillaceous top. This colour distinction, however, was not found very reliable in the field for top determination. In many instances some of the argillite belts as mapped include a few siliceous greywacke beds that are too narrow to be mapped separately. The argillite occurs also in dense, pitch-black beds that commonly carry abundant pyrite and pyrrhotite. The zones of thinly bedded argillite when traced along strike commonly grade into argillaceous greywacke and in places to siliceous greywacke. As a result, a wide band of argillite may pass along strike into rock that is mainly greywacke, with only a few narrow beds of argillite remaining, and such beds become difficult or impossible to map. In some instances the width of the argillite bands, as shown on the accompanying map, has been exaggerated.

Thin sections show that the argillite is a rock composed of the same minerals as those that constitute the siliceous greywacke, but in different proportions. Large, ragged, uniformly distributed flakes of brown biotite and chlorite rest in a fine-grained matrix of quartz, feldspar, and tiny flakes of sericitic and chloritic material. Mica constitutes about 60 per cent of the rock, and the flakes are mostly oriented to impart a schistose appearance to the rock. Quartz and feldspar share about 30 to 35 per cent of the rock, with feldspar probably three times as abundant as quartz. Opaque substances are commonly abundant, amounting to almost 10 per cent of the rock, and are generally uniformly disseminated.

Rocks intermediate in composition between siliceous greywacke and argillite are not uncommon, and were mapped with either one or the other depending upon which they resembled most. Rocks that could be mapped as either were commonly termed argillaceous greywacke and most of it after examination was considered as part of the argillite. The argillaceous greywacke is a fine-grained, dark grey to greyish black rock with a sandy appearance on weathered surfaces. In its fine grain and dark colour it resembles the argillite, whereas its sandy texture is like that of the siliceous greywacke. Thin sections reveal that the rock is composed of the same minerals as those found in siliceous greywacke and argillite, but in different proportions, the micas comprising about 50 per cent of the rock.

In the area along and at some distance from the southeastern boundary of the map-area northeast of the Morris Lake fault, rock exposures are less plentiful than farther west. A thin veneer of drift and a rather thick growth of small trees obscure most of the bedrock, and where exposed most of the rock surface carries an abundant lichen growth. Furthermore, the rocks there have been more metamorphosed than to the west, and as minute flakes of biotite have developed abundantly throughout and have obscured in part the original colour and texture of the rocks, it was found difficult to distinguish one rock type from another. They appear also to be more finely bedded and more intimately mixed than on the west. Consequently, all the different types of rocks in these parts of the area have been mapped together as a mixture of finely interbedded siliceous greywacke, argillaceous greywacke, and argillite (*See* Plate IV A). This mixture is believed to be composed of approximately 60 per cent siliceous greywacke and 40 per cent argillaceous greywacke and argillite. Small bands of similarly mixed rocks have been recognized in other parts of the area.

Intraformational conglomerate, consisting of fragments of argillite in a sandy matrix, was seen at several places in the argillaceous rocks.

NODULAR SCHISTS

The metamorphic group of rocks occupying most of the area north, west, and in part south of Giauque Lake, and referred to on the accompanying map as nodular quartz-feldspar-mica schists and hornfels, is believed to be composed of rocks that were originally similar to the siliceous greywacke, the argillaceous greywacke, and argillite described above. Weathered surfaces of these rocks are grey to brownish grey, have a coarsely granular appearance, and generally exhibit a pronounced nodular structure. The southwest contact of this group of rocks with their less metamorphosed equivalents was drawn arbitrarily where nodules are first easily observable on weathered surfaces.

Fresh surfaces are light to dark grey, of massive, granular appearance, and rarely show conspicuous nodules. Bedding has been commonly preserved in these nodular schists, and although it is not as well defined as in the less metamorphosed sediments, it can easily be recognized, generally by a pronounced banding. Bands containing a high percentage of nodules alternate with others in which nodules are few or lacking. Also, individual beds may show a gradation from a base poor in nodules and apparently rather siliceous in composition to a top where the nodules are abundant and the rock is argillaceous. On weathered surfaces the nodules, which normally constitute about 35 per cent of the rock surface, appear as spherical to oval aggregates of biotite and quartz, but under the microscope they are seen to be metacrysts of cordierite, or more rarely of andalusite or staurolite, replete with inclusions of quartz, feldspar, and mica. The nodules reach 2 inches in diameter and rest in a fine- to medium-grained groundmass of interlocking quartz, feldspar, and brown biotite. Seen in vertical sections, the nodules are elongated and in many instances are standing vertically or almost so (*See* Plate IV B).

North of the northeast end of Maguire Lake, the passage from normal sedimentary rocks to nodular schist is clearly shown in a series of good outcrops, and its main features can be studied in some detail. Some variation in the first appearance of nodules in the different types of rocks is probably the most characteristic feature of this gradation. A few quartz veins and stringers traverse this series of outcrops, and nodules were first noted in a narrow zone, commonly less than 1 foot wide, in the rocks adjoining these veins. These nodules are generally less than $\frac{1}{8}$ inch in diameter near the contact of the veins and stringers and decrease gradually in size toward the outer limit of the nodular zones. Nodules are not found in any of the nearby rocks, which, however, show a strong development of secondary biotite. Nearer the main zone of nodular schists a few small nodules commence to appear in the argillite beds only; none can be observed in any of the greywacke beds, which are characterized only by slightly larger biotite flakes. Still nearer the main nodular schist zone, the nodules gradually become much larger and much more abundant in the argillite beds and are found also in some numbers in the argillaceous tops of greywacke beds, but not in the greywacke itself. Finally a stage is reached where nodules are found in all types of rocks, at first in small quantity in the greywacke beds, at which point it is still possible to differentiate the different types of rock, but later in abundance and of normal size in rocks of all types, where, in consequence, recrystallization has been so intense that it is practically impossible to distinguish one rock type from another. At this stage the strata have characteristic features in common, namely, those distinctive of the nodular schists. Where quartz veins occur in the nodular schists, the wall-rocks are coarser grained than average, and may carry hornblende and epidote in addition to biotite.

CHEMICAL COMPOSITION OF THE SEDIMENTARY ROCKS

A few samples typical of the sedimentary rocks of Giauque Lake area were collected for chemical analysis. The samples were obtained either from areas of outcrop or from diamond drill cores, and in all instances they were obtained from as fresh (unweathered) material as possible. The samples were large pieces of rock, each as representative as possible of the rock-unit mapped in the field and described in detail previously in this report.

The chemical analyses of the sedimentary rocks of Giauque Lake area are given in Table II. Analyses Nos. 1, 3, 5, 8, and 10 are those of the different sedimentary rocks of the area. A striking feature characteristic of all is their high alumina (Al_2O_3) content, suggesting a high content of aluminous silicates such as feldspar in these rocks. In all but analysis No. 1 (that of argillite) the soda (Na_2O) content is higher than that of potash (K_2O), suggesting that those with a higher soda content may have been derived from igneous rocks, as weathering of these tend to give a soda-potash ratio higher than unity. The magnesia (MgO) content is also higher than that of lime (CaO) in all analyses but those of argillite (analysis No. 1) and granulite (analysis No. 10). This high lime (CaO)

Table II

Chemical Analyses of Sedimentary Rocks

—	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	56·97	58·10	65·76	64·00	67·94	66·15	64·63	71·13	71·54	62·76	68·13	66·20
Al_2O_3	19·81	15·40	17·79	14·00	16·75	16·55	19·00	17·88	14·62	14·30	13·88	15·08
Fe_2O_3	0·20	4·02	0·32	1·3	1·17	1·12	1·56	0·82	0·69	2·04	0·77	0·04
FeO	8·64	2·45	4·68	4·1	4·44	3·80	3·63	1·67	1·64	5·05	3·83	2·94
CaO	4·19	3·11	1·90	3·4	1·42	1·42	3·48	0·55	2·08	8·78	9·04	12·31
MgO	3·41	2·44	2·97	2·9	2·63	2·84	2·49	1·54	0·77	3·92	1·68	1·12
K_2O	2·37	3·24	0·75	2·1	0·75	2·13	1·60	2·09	3·92	0·85	0·08	0·07
Na_2O	1·53	1·30	4·48	3·5	1·70	3·02	1·54	3·06	3·84	0·98	0·62	0·77
H_2O+	1·00	5·00	1·43	2·0	2·16	1·63	0·92	0·95	0·32	1·03	0·50	0·49
H_2O-	0·08		0·15	0·1	0·12	0·03	0·20	0·25		0·23	0·04	0·08
TiO_2	0·31	0·65	0·53	0·5	0·34	0·58	0·42	0·36	0·26	0·31	0·70	0·47
C	1·00	0·80	...	...	...	...	...	...	...	...	...	...
CO_2	...	2·63	...	1·5	...	...	...	...	0·14	...	0·27	0·53
P_2O_5	...	0·17	...	0·1	...	0·11	...	...	...	...	0·16	0·23
SO_3	...	0·64	...	...	...	...	...	...	...	...	...	...
Total	99·51	99·95	100·76	99·61[1]	99·42	99·38	100·32[1]	100·30	99·82	100·25	99·89[1]	100·51[1]

[1]This total includes minor constituents not entered in this table.

1. Argillite, Giauque Lake area. Analyst, R. J. C. Fabry.
2. Average shale. U.S. Geol. Surv., Bull. 770, 1924, p. 34.
3. Siliceous greywacke, Giauque Lake area. Analyst, R. J. C. Fabry.
4. Average greywacke. (14, p. 271, 1949.)
5. Nodular schist (cordierite-bearing), Giauque Lake area. Analyst, R. J. C. Fabry.
6. Average of two analyses of nodular schists, Yellowknife-Beaulieu Region, Northwest Territories. Analyst, R. E. Folinsbee, unpub. Ph.D. Thesis (1942), Univ. of Minn., U.S.A.
7. Staurolite schist, File Lake, Manitoba. Analyst, R. J. C. Fabry, Geol. Surv., Canada, Mem. 250, p. 26 (1949).
8. Quartzite, Giauque Lake area. Analyst, R. J. C. Fabry.
9. Fresh Morton gneiss, Cold Spring Granite Company quarry, Morton, Minn., U.S.A. Analyst, S. S. Goldish (14, p. 378).
10. Granulite, Giauque Lake area. Analyst, R. J. C. Fabry.
11. Metaconcretion from Abram series, Thunder Lake, Ont. Analyst, R. B. Ellested (12, p. 1847).
12. Concretion in mica schist, Tulolausaari, Sortarala, Finland (after Hackman, 1931) (12, p. 1847).

content of the argillite and granulite, even if no carbonates were found in these rocks, probably indicates that they were originally lime-rich rocks, the lime content now being found in the plagioclase, amphibole, and/or epidote. Analysis No. 1 is that of the typical argillite of the area, and much resembles the average composition of shales, analysis No. 2. Analysis No. 3 is that of greywacke of the area, and as compared with the average composition of greywacke, represented by analysis No. 4, shows an abnormally low potash (K_2O) and lime (CaO) content. The soda (Na_2O) content, however, is much higher than that of the average greywacke. A sample of the nodular schist of the area, in which the nodules were cordierite, is represented by analysis No. 5. This analysis more closely resembles that of the greywacke than that of the argillite of the area, suggesting that the greater abundance of greywacke than argillite, observed in the sequence of strata in the less metamorphosed rocks, still holds in the nodular zone. For comparison, analyses Nos. 6 and 7 of nodular schists from the Beaulieu region, Northwest Territories, and from Manitoba are added. Analysis No. 8 is of the quartzite of the area and is evidently impure. Analysis No. 9, of an orthogneiss, is added. The comparison of the ratio of lime (CaO) to magnesia (MgO) of the quartzite of the area with that of the orthogneiss suggests that this quartzite is not an acidic tuff. Analysis No. 10 of the granulite shows a relatively high lime content, and, consequently, suggests an impure calcareous rock. Analyses Nos. 11 and 12 are from somewhat similar types of rocks in other areas.

Figure 1 is a type of variation diagram illustrative of the various sedimentary rocks of Giauque Lake area. Silica is plotted as abscissæ and all the other oxides as ordinates. The diagram shows primarily that the argillite, the greywacke, the nodular schist, and the quartzite are related to each other and are parts of a same group of rocks, whereas the granulite appears to be a rock different in composition from the others and probably representative of a different clan, such as the calcareous rocks. As expected with increase in the silica content from argillite to quartzite, the Al_2O_3 curve shows a constant and gradual decline. The Al_2O_3 content of the granulite, however, falls a long way outside this curve. The MgO and CaO curves for the argillite-quartzite group of rocks are smooth, though slightly concave downward, and indicate a slight decrease in the content of these oxides as the silica (SiO_2) content increases. Again the MgO and CaO contents of the granulite do not fit these curves. The high iron content of the argillite is probably unusual[1], and in part due to secondary pyrite and pyrrhotite. The iron content of the granulite is again slightly off the curve. The alkalis curve shows several low and high points, suggesting great variations in content from one type of rock to another. The nodular schist is low in alkalis, possibly due to metamorphic processes by which much of the alkalis was removed and some silica added. If this had not taken place it is believed that the curve would be uniform, and would indicate an increase in the alkalis content as the silica content increased. The alkalis content of the granulite is too low to fall on the curve.

[1]*See* analysis No. 2 of an average shale. *See also* the diagram by Pettijohn illustrating the relation of iron oxides plus magnesia to silica for rocks such as basalt, shale, greywacke, quartzite, and granite (14, p. 251).

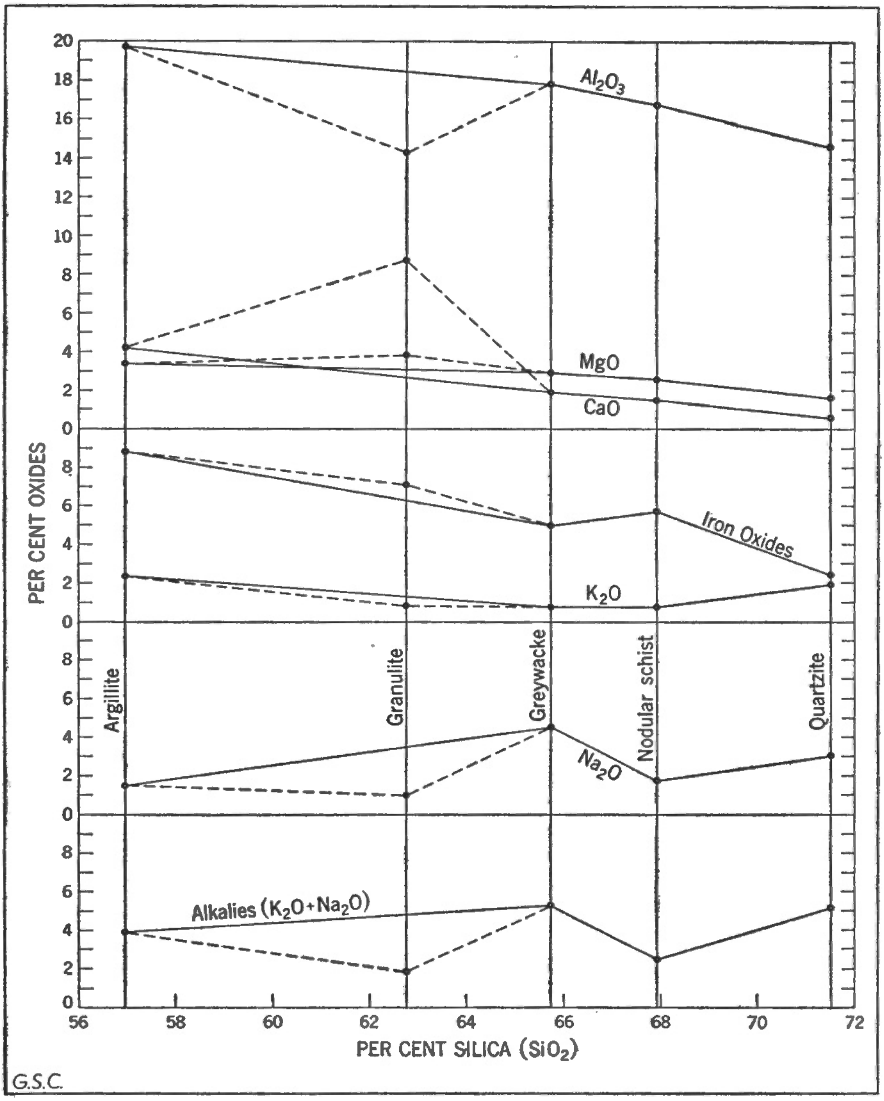


Figure 1. Diagram to illustrate the relations of the different oxides to total silica in the common sedimentary rocks of Giauque Lake area, Northwest Territories.

Figure 2 is a diagram by which the chemical compositions of the different sedimentary rocks of the area are compared. All the oxides except silica[1] are plotted at regular intervals as abscissæ and the percentages as ordinates. It can be foreseen that related types of rocks will have similar kinds of curves, with similar high and low points. For the rocks of this area the high points are those for the iron oxides and soda, except that the

[1] On the scale of the diagram the silica content of these rocks, which varies from about 57 to 71 per cent (*See* Table II), cannot be shown.

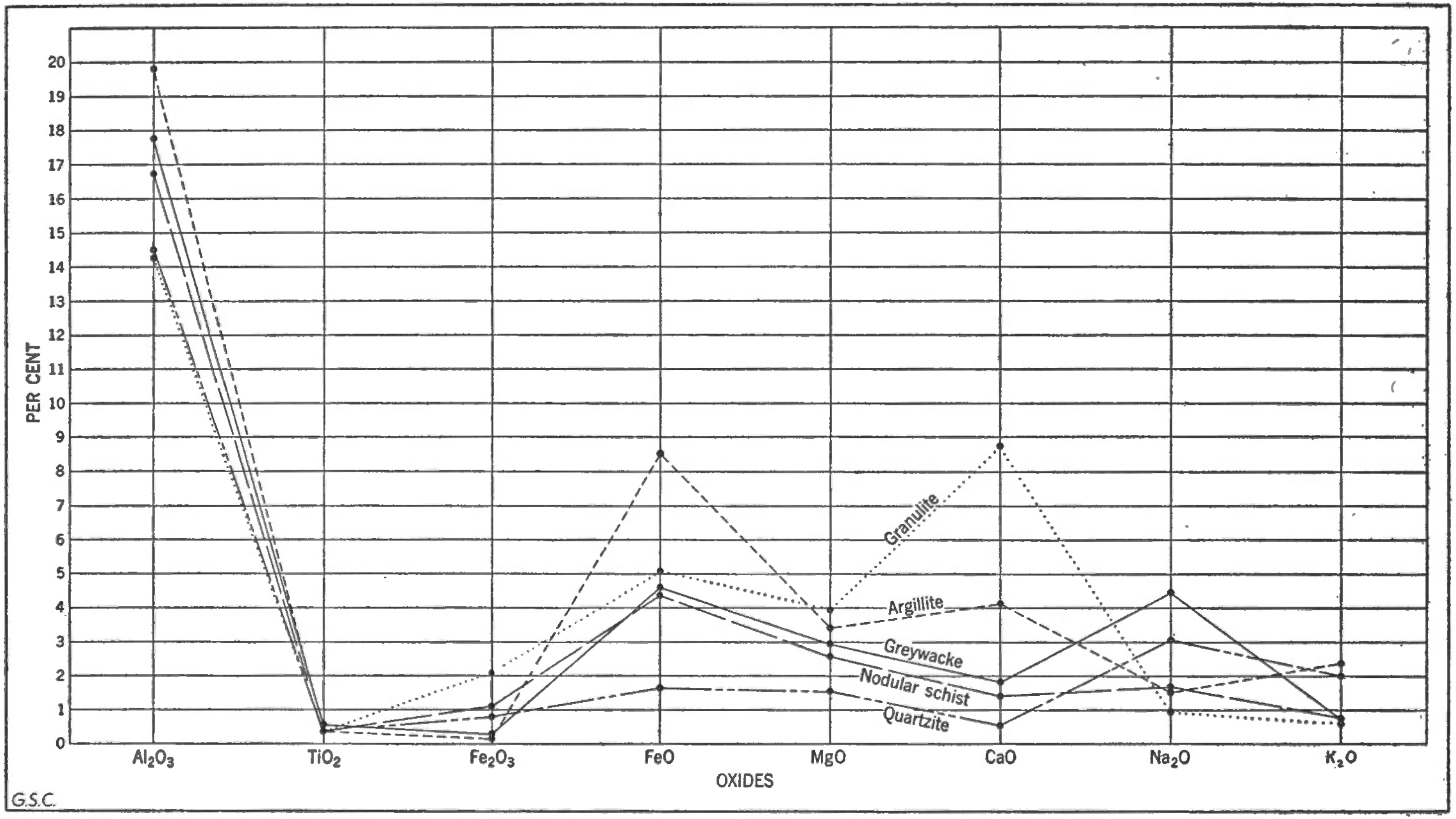


Figure 2. Diagram comparing the chemical analyses of the common sedimentary rocks of Giauque Lake area, Northwest Territories. For lack of space the silica (SiO_2) content, which varies from about 57 to 71 per cent, is not represented.

argillite shows a high lime instead of soda, suggesting that the feldspars are in greater quantity in the argillite than in the other rocks or are more calcic than those of the greywacke and quartzite, possibly as a result of a higher degree of metamorphism and indicating a lime content slightly more than normal. The lime content of the granulite suggests an original impure calcareous rock.

INTRUSIVE ROCKS

Intrusive rocks are common in Giauque Lake map-area, but constitute only a small proportion of the bedrock. They occur mainly as sills and dykes, but include some irregular masses. In composition they comprise diorite, porphyritic rhyolite, muscovite granite, and gabbro or diabase. The diorite and rhyolite are found in all the forms mentioned, and are probably of Archæan age as they appear to have been in part involved in the folding. The gabbro or diabase forms only dykes, which are definitely of post-Archæan age as they cut all other rocks and all structures. The granite, which forms irregular masses, may be of late Archæan or Proterozoic age.

DIORITE

Diorite was encountered mainly in the southwestern part of the map-area, where it occurs as small, irregular to lenticular masses, sills, and rare dykes, apparently all concentrated in, and distributed at, irregular intervals along a narrow zone that extends from about 1,500 feet southeast of the Viking shaft northeasterly past the Viking camp to the Morris Lake fault. On the northeast side of the fault, the zone that has been displaced 3,500 feet northwesterly continues northeasterly to the southwest end of Narrow Lake, passing by the Greenlee workings and the west shore of Lucky Lake.

The diorite is generally a massive and fine- to coarse-grained rock. Its weathered surfaces are light to dark reddish brown and light green to dark green, and in places in vertical sections it shows a pronounced linear texture. Fresh surfaces are grey to dark grey and dark green. In places, as a result of some assimilation of the intruded rocks, the diorite displays much variation in grain size and texture; it may be mottled, patchy, and faintly banded, or even slightly gneissic. Its contact zone with the intruded rock can be sharp or in part gradational. Where the contacts are sharp, commonly with argillite, the diorite is fine grained and shows chilled edges, and the intruded rocks are indurated for a few inches. Where the contacts are gradational, the sedimentary rocks, particularly the greywacke, are partly dioritized, through addition of much feldspar and amphibole, whereas the diorite contains much secondary biotite, probably as remnants of sedimentary material. In places the massive diorite carries white feldspar phenocrysts. In the outcrop the diorite appears either very fresh, where it is composed mainly of feldspar and hornblende, or much altered, where it contains much biotite, a fibrous amphibole, and some quartz as secondary minerals, in addition to the original white feldspar and hornblende.

As seen in thin sections, the diorite is a medium- to coarse-grained rock composed mainly of sodic andesine, hornblende, and minor amounts of sphene, apatite, zircon, pyrite, and pyrrhotite. The hornblende, which comprises 30 per cent of the rock, occurs commonly in ragged prisms up to

2·0 by 1·2 mm. in size; and in places may show some alteration to brown biotite and chloritic material. The feldspar is found in irregular grains up to 1·5 mm., which generally show very little alteration and are in places replete with smaller grains of feldspar and quartz. Where the diorite is much altered, the rock is finer grained, and much of the hornblende is changed either to an actinolitic amphibole or, in addition, to brown biotite, epidote, and chlorite; the associated feldspar is albite or sodic oligoclase; and some quartz is present. The actinolitic amphibole is commonly found in clusters of long fibres, all radiating from a common centre, or appears to form from irregular fragments of hornblende. The diorite masses at the Viking shaft and on the Greenlee workings show much alteration of this type.

Some areas of outcrop south of Narrow Lake probably represent parts of a diorite mass, but are massive to gneissic, and much resemble medium- to coarse-grained volcanic rocks. They are not in observed contact with other rocks, and their origin is uncertain. A few irregular masses of dioritic rocks, too small to be mapped separately, and irregularly distributed, were noted in the western part of the area. Although somewhat similar on weathered surfaces to the granulites, they have a different mineral composition, and definitely crosscut the formations, indicating an origin different from the granulites. They are probably related to the main diorite bodies.

In many places, the diorite is traversed by irregular quartz veins and stringers, which may or may not carry a little gold. Nowhere was the diorite seen in contact with the porphyritic rhyolite and the muscovite granite, so their relative ages are not known definitely, but the diorite is believed to be older than the others as it is much more altered.

A basic dyke, averaging 16 inches in width, was noted by A. P. Beavan[1] at a point about 500 feet northeast of the northeast end of Narrow Lake near the LaSalle baseline. It was traced for 35 feet in a north 92 degrees east direction where the formations trend north 45 degrees east. The dyke is a fine- to medium-grained, dark green rock composed of more than 90 per cent hornblende and biotite. Felsic minerals are quartz and feldspar, and they share the remaining 10 per cent of the rock. Other similar dykes are probably present in the area, but, as in the case of the one above, are too small to be mapped. It is possible that these small basic dykes are related to the diorite bodies.

PORPHYRITIC RHYOLITE

Porphyritic rhyolite outcrops only in the southwestern part of the map-area, where it occurs either as dykes and sills or small irregular masses. Its main occurrence is at the southeastern boundary of the southwestern part of the map-area, about 2,500 feet southeast of the centre of Morris Lake, where it forms irregular to lenticular bodies. A dyke, up to 12 feet wide, was traced northeasterly for 2,500 feet from a place about 1,000 feet southeast of Piloski Lake. Other dykes were noted and in part traced north of Wallie Lake and between that lake and the northeast end of Morris Lake. Several others were noted in the area west of the Viking shaft and Viking fault, but as they were all very narrow no attempt was made to map them separately.

[1] Personal communication.

The porphyritic rhyolite is a white to greyish white weathering, fine-grained rock of dense to glassy appearance. It is composed mainly of light-coloured feldspar and quartz. Apart from the main occurrence southeast of Morris Lake, which, apparently, carries only quartz phenocrysts, all other outcrops contain abundant feldspar phenocrysts in addition to quartz. The rock is commonly massive, but part of the main body southeast of Morris Lake is schistose, imparting to the rocks a somewhat dark, streaky appearance. Thin sections have revealed albite and quartz or only quartz phenocrysts in a fine-grained matrix of the same minerals, with a little biotite, muscovite, sphene, epidote, chlorite, apatite, and an iron oxide. The euhedral feldspar phenocrysts are slightly altered, and are up to 2·5 mm. across. Quartz phenocrysts commonly occur in nearly round, fractured grains up to 1·5 mm. in diameter, and show marked strain shadows. Grains of garnet were noted in the porphyry southeast of Morris Lake.

The rhyolite dykes commonly trend with the bedding, but in places, particularly where the formations have been closely folded, they cut across the strata without much deflexion in trend. Many of them were observed to be traversed by quartz veins and stringers and late gabbro dykes.

MUSCOVITE GRANITE

The muscovite granite is a light grey to pinkish white, coarse- to medium-grained, massive rock, in part gneissic, and composed of quartz, pink orthoclase, in part perthitic, white albite, and some muscovite. It occurs as small, irregular masses in areas north of Giauque Lake and east of Eclipse Lake. Two of them are shown on the map.

GABBRO

Gabbro is the most common intrusive rock of the map-area and occurs as dykes cutting all the other formations and all structures. Most of the dykes trend north 30 degrees west, but a few were observed striking either about due east or north 40 degrees east. These three directions correspond with those of fracture planes in the rocks, such as faults and joints. The dykes vary in width from a few inches to 120 feet, and many of the larger ones can be traced for miles. They all dip steeply to vertically.

The gabbro dykes consist of massive rock varying in grain size from fine at the edges to relatively coarse in the centre, depending on the width of the dyke. Weathered surfaces are dark green to black and light brown to reddish brown; fresh surfaces, dark green to black. Although most of the gabbro dykes are of rather uniform composition, one of them situated about a mile east of Wallie Lake displays a considerable variation in feldspar content; part of it is composed mainly of plagioclase, and the rock resembles an anorthosite; other parts are rich in pyroxene. Some dykes are characterized by a uniformly distributed pink to red feldspar; others are porphyritic, with white feldspar phenocrysts or amygdules of white carbonate and possibly zeolites. Some of the diabase dykes occupying fault zones are traversed from wall to wall by quartz veins or contain irregular quartz patches. There is no doubt, however, that the gabbro is younger than most of the quartz veins and stringers of the map-area, as it was seen at several places cutting quartz veins. Most of the dykes, especially the larger ones, have altered the adjacent sedimentary or volcanic rocks along both contacts for widths varying from a few inches to more than 100 feet, depending on the width of the dykes. The alteration has consisted mainly in the induration of the rock, with the possible addition of albite and carbonate. This altered rock is fine grained to dense, weathers pinkish white, and is very hard. Near the contact it contains numerous laths of feldspar, large enough to be seen with the naked eye. Greywacke appears to have been more deeply altered than the fine-grained argillite or the volcanic rocks.

Under the microscope, the gabbro is seen to be composed mainly of pyroxene and feldspar, with minor amounts of iron oxides, quartz, and quartz and feldspar micrographic intergrowths. Sphene, pyrite, and leucoxene were also observed in a few slides. The pyroxene is probably augite, and amounts to about 50 per cent of the rock. It may be either wholly or partly altered to a green chloritic material, and in places partly to amphibole. The feldspar is plagioclase, at least as calcic as labradorite, with some of the laths of the chilled edges as calcic as bytownite (An_{82}). Feldspars comprise about 45 per cent of the rock and occur in lath-shaped grains mixed with the pyroxene and imparting to the rock in places an ophitic texture. They are partly to largely altered to white mica and, or, epidote. Quartz is a very minor constituent, and is commonly interstitial to the other minerals. In some dykes it forms with a feldspar, believed to be a plagioclase, a plumose micrographic intergrowth, which is also interstitial to the other minerals and is pink on weathered surfaces. The feldspar of these intergrowths corresponds with the pink feldspar mentioned above and noted abundantly on weathered surfaces in some of the dykes. The iron oxide mineral is probably mainly hematite, as specular hematite was noted in a hand specimen.

PLEISTOCENE

Giauque Lake map-area has been glaciated, and the direction of the ice movement was from the northeast to the southwest. Glacial striæ trend between south 45 degrees west and south 65 degrees west; rock ridges, in places much resembling *roches moutonnées*, have a roughly similar trend.

Glacial drift is widespread in the map-area, and commonly occurs as a thin layer of morainal material over the bedrock. In places, however, where it occurs as eskers it forms thick deposits. Two eskers, in part dissected, were traced in the southeastern half of the map-area, and indicate a direction of ice movement similar to the one indicated by the glacial striæ. In each case, the ground in the vicinity of these eskers and for some distance from them is covered with much drift and sand.

Clay is not found in deposits as conspicuous as those of morainic material, but has accumulated in some quantity in all valley bottoms, possibly soon after the retreat of the ice, or in glacial lakes.

A few erratics of a conglomerate up to 6 feet in diameter were noted here and there near the north and east ends of Morris Lake. A large one on the Greenlee property is composed of assorted, rounded to subrounded, mostly reddish, pebbles, cobbles, and boulders set in a fine to coarse, well indurated, reddish, sandy matrix. The roundstones constitute about 80 per cent of the conglomerate and are mainly sandstone, rhyolite, dacite, and quartz. A somewhat similar conglomerate is known to occur at the base of, and at several higher horizons in, the rocks of the Great Slave group of Proterozoic age (1). Areas of these Proterozoic rocks are known from several places to the northwest of Giauque Lake area (10) and in the basin of the east arm of Great Slave Lake, a distance of about 120 miles to the southeast. They have also been reported from north of Lake Beechey (10) in the area of the headwaters of Western River, a distance of about 280 miles to the northeast. As the direction of ice movement is southwesterly in the area, these erratics were probably derived from areas to the northeast, but as some of the boulders are large it is unlikely that they have been transported far, and probable that they were derived from nearby exposures, to the northeast of Giauque Lake area, now completely removed by erosion.

Since the retreat of the last ice-sheet, little weathering has occurred in this area. Its effects on all the rocks have been limited to a narrow zone, commonly a fraction of an inch thick, at the surface or along fracture planes in the rock. Rocks rich in sulphides, such as pyrite and pyrrhotite, may be more deeply weathered, or may become somewhat pitted or porous as a result of the solution of the sulphide minerals.

CHAPTER III

STRUCTURAL GEOLOGY

GENERAL STATEMENT

The formations in Giauque Lake area trend in general northeasterly. However, variations from this trend are common, particularly near the noses of plunging folds, where the formations pass uniformly within relatively short distances from a northeast to a northwest trend. Most of the strata dip steeply to vertically, and in many instances they were observed to thicken around the noses of plunging folds. Two main cleavages were observed; an early one, which strikes almost parallel with the bedding, and a late cleavage, which cuts uniformly across bedding planes and folded structures. Both cleavages and the bedding are steeply inclined, the early cleavage dipping approximately parallel with the bedding. The formations have been deformed in places into tight isoclinal folds, and a linear structure observed on the bedding planes indicates that these folds plunge steeply to the northeast to almost vertically. All formations and folds are traversed by faults of at least two sets and possibly three. One set, trending northwesterly, is characterized by steep to vertical dips and predominant horizontal movements. A second, easterly trending set of faults seems to have similar characteristics. Another set includes the thrust faults, which trend northeasterly and have a low dip. Movement along the thrust faults is also mainly horizontal, as in the case of the Discovery fault, which is a typical example.

BEDDING

Bedding is the most common and apparent structural feature of Giauque Lake area. It can be observed almost everywhere in the sedimentary formations, which are rather finely bedded, and has provided numerous and widely distributed measurements that have been of great help in tracing structures throughout the area. The general trend of the bedding is northeasterly. The dip is in either direction from 65 degrees to vertical, but commonly very steep to vertical. Bedding is particularly well developed in the vicinity of Shona and Morris Lakes, where the rocks are little weathered and are well exposed as a result, in part, of recent forest fires. It is less apparent in the slightly more metamorphosed sedimentary rocks about and east of Wallie Lake, and is generally obscure in the nodular schists, where it is defined by an alternation of bands rich in nodules with others in which nodules are lacking.

Tops of beds were determined at as many places as possible, with the use of features such as grain gradation (from coarse, sandy material at the base of a bed to fine, argillaceous rock at the top), channelling, ripple-marks, and, rarely, by crossbedding. Graded bedding was most commonly and widely used, and gave most reliable information. Not all the beds, however, are graded, and it was found that those in which this

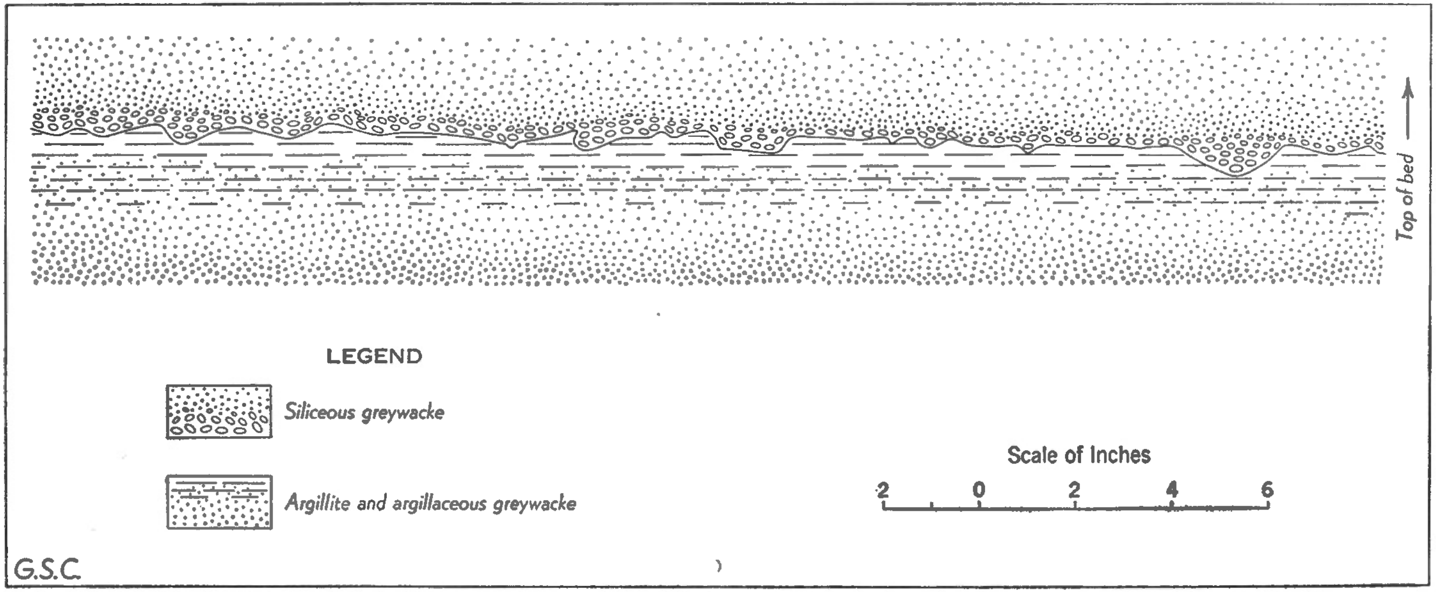


Figure 3. Sketch illustrating abundant channels in the argillaceous top of a bed exposed in a flat outcrop about 600 feet south of the southwestern end of Shona Lake. Width and depth of channels are to scale; thickness of materials above and below bedding plane is approximate.

feature was most clearly shown were those averaging 6 to 10 inches in thickness, of sandy appearance, and reddish grey colour on weathered surfaces. Evidence of channelling was seen at several places in the area, but normally not as clearly or as commonly as grain gradation. Channels up to 5 inches deep, but commonly smaller, are found along the bedding planes and generally lay in argillaceous rocks. It is believed that if the bedding planes were well exposed, this feature would be much more commonly recognized and, consequently, would be of greater use in determining tops of beds (*See* Figure 3). It was seen commonly associated with grain gradation. Ripple-marks of the current type were noted at a few places in the area. Although they cannot normally be used to determine tops of beds, they were made use of here in a few instances, as they had in places a concentration of coarse material in their troughs on one side of the ripples. Crossbedding was noted at a few places and was made use of rarely in determining tops of beds. Colour gradation, from a light-coloured bottom to a dark-coloured top, was employed tentatively in the finely bedded argillaceous sedimentary rocks, but was found to be generally unreliable. None of these minor structural features was observed in the nodular schists, as they had been obliterated by recrystallization during metamorphism, but the concentration of nodules in the argillaceous tops of beds was in places made use of in structural determinations.

CLEAVAGE

Cleavage, characterized by the presence of flaky minerals parallel with the cleavage planes, is another common, structural feature, almost as widespread in its occurrence as bedding, but definitely not as conspicuous. It appears to be localized in its distribution to the narrow beds of argillite and argillaceous greywacke, whereas the siliceous greywacke and the thick beds of pitch-black argillite are commonly massive.

Many measurements on this cleavage were made in the field in the hope that they might assist in solving some of the complex folds of the area. It was found, however, that it could not be employed successfully in interpreting the structure with which it is found associated in the area as it does not appear to be genetically related to it. Two cleavages were distinguished: one, an early cleavage, is nearly parallel with the bedding[1], and is confined to beds of argillite; the other, a late cleavage, cuts across folded structures, and although it is also confined to the argilite beds appears to have a regional trend (*See* Figure 4).

The early cleavage is probably the more common, but was not observed in the nodular schist nor in the argillaceous rocks at several places along the southeastern boundary of the map-area. It was observed to parallel the bedding planes only at the apices of plunging folds. On the limbs of the folds, it strikes at a small angle, 10 to 25 degrees, to the bedding planes, the strikes on each limb converging toward the plunging region of the folds. Like the bedding, its dip is steep to vertical and both bedding and cleavage are generally almost parallel in dip. This cleavage was probably developed when the steeply plunging folds of the area were formed, as a result of the elongation of the beds accompanied by flowage under a

[1]In the writer's opinion, this cleavage might be referred to as a bedding cleavage.

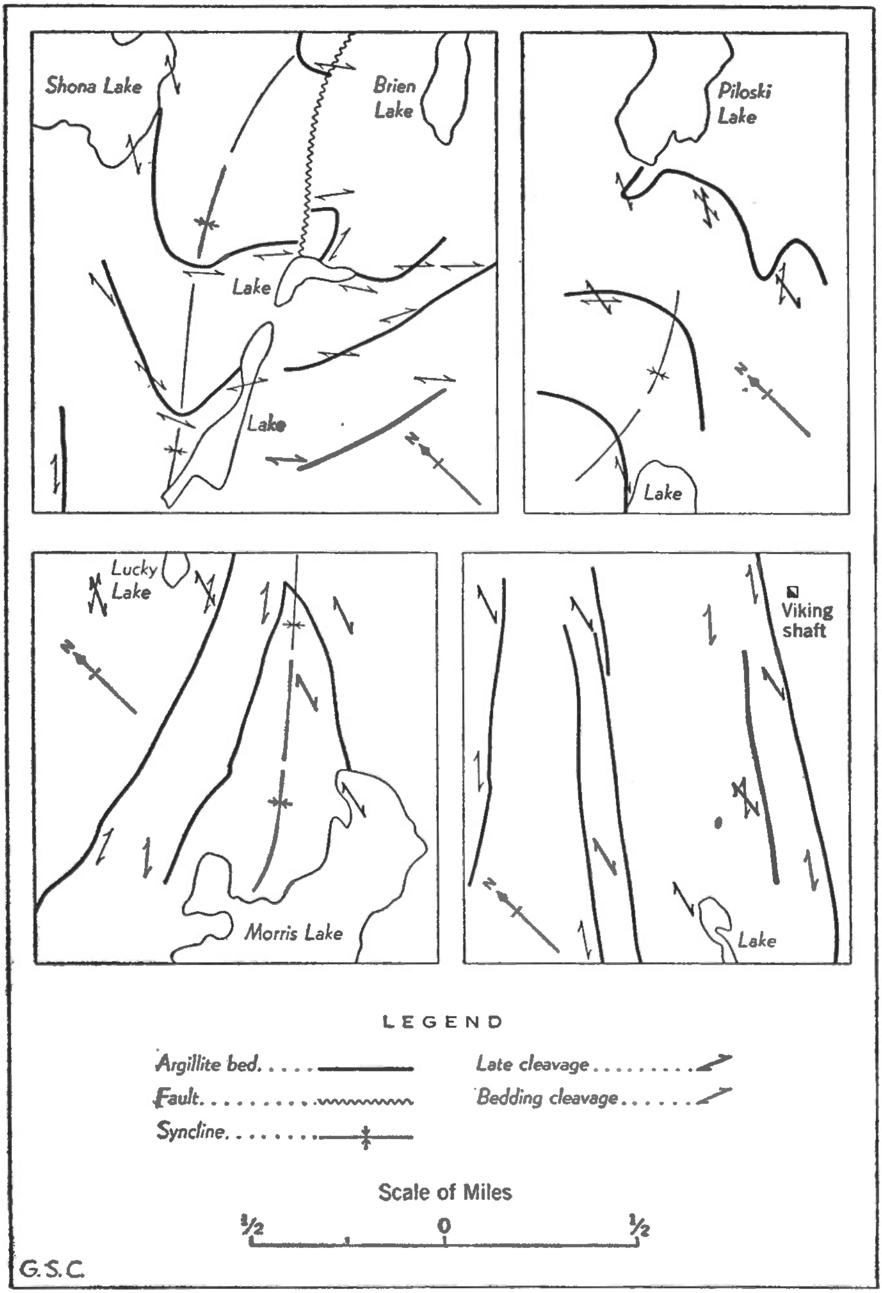


Figure 4. Sketches illustrating field relations of early cleavage and late cleavage to the bedding in different parts of Giauque Lake area, Northwest Territories. The cleavages apply only to the argillite beds, in which alone they are clearly developed.

heavy load. The crosscutting relationship on the limbs of the folds is probably due to a deformation that was not carried far enough to produce parallelism of cleavage and bedding. This cleavage is definitely not an axial plane cleavage that has been folded with the beds as it has a different strike on the two limbs of the folds.

The late cleavage strikes about 15 degrees east of north and was observed cutting bedding planes and folds. It is particularly noticeable in the nodular schists and in the southeastern parts of the map-area, but was also observed here and there in other parts. It probably resulted from forces associated with the deformations that accompanied the granitic intrusions that outcrop north and west beyond the map-area. No evidence, however, has been found in support of this assumption.

A pronounced gneissic structure was observed in most of the volcanic rocks. It probably developed with the early cleavage of the adjoining sedimentary beds as its trend is almost parallel with the trend of the volcanic lenses.

LINEATION

Linear structures have been observed at several places within the map-area. As they are not strongly developed features they may be easily overlooked. Wherever measured, they were observed either on the bedding planes or on joint planes parallel with the bedding, and plunging steeply to vertically to the north at an average angle of about 75 degrees. South of the Viking shaft, however, in addition to the above-mentioned lineations, others were seen at two to three places lying in the bedding planes, and dipping gently to the northeast, suggesting a lineation different in origin from the steeply plunging one.

The steeply plunging lineation appears to be due to at least three different sets of conditions: most commonly it is a result of intersections of cleavage and bedding planes and appears on the bedding planes as fine streaks and wrinkles; in other places it is probably the result of flexing, and is represented by minor crenulations along the bedding planes; and in still other places it appears to be due to slippage on the bedding planes. In all instances this lineation is steeply plunging and lies parallel with the axial line (b-axis) of the folds.

The nodules of the nodular schists are oval to lenticular in shape, and although no systematic readings were made on the long dimension of the nodules, it is believed that the nodules have a preferred orientation in line with the direction of lineation.

No structures have been observed in the area that could explain the gently dipping lineation, but by inference from the known structures it is probably related to a major, probably earlier, structure that possibly can be observed northwest of the map-area in the Wecho River area. This major, earlier structure, which is assumed to be an anticline, is described later in this chapter.

In addition to these linear elements described above, there are several prominent lineaments, visible on air photographs, caused by the outcrop of such features as dykes, faults, bedding, or joints.

FOLDS

A striking structural feature of Giauque Lake map-area, apparent from numerous measurements of bedding attitudes, is the intensity and complexity with which the strata have been folded. Formations that, as depicted on the accompanying map, may appear to strike uniformly for long distances, are seen in detail to show much variation in strike, and to be complicated by numerous minor folds and crenulations. Many of the folds are seen to involve in places extremely intricate structures, in part due to the extreme compression to which they have been subjected. One feature common to all folds is the steep dip of the strata on the limbs and nose of the folds, most if not all of which could be considered as tight isoclinal folds varying mainly in size and all plunging steeply to the northeast or vertically. This steep to vertical plunge is revealed by the steep dip of the bedding and bedding cleavage, by the steeply plunging lineation, and by the steep northerly plunge of the minor folds. The surface trace of the axial planes of each of the numerous folds, as observed in the field and indicated on the accompanying map, consequently, lies nearly at right angles to the normal axis or axial line (b-axis) of the fold. It has a general northeasterly trend, and in part follows a sinuous course that is not the result of topographic features. In places it is curved as if it had been subjected to later deformation, possibly the one accompanying the formation of the thrust faults. The actual trend, however, varies slightly from place to place: in the eastern part of the area, it has a north-northeasterly strike whereas on the western side it is more nearly northeast by east. At many places the formations thicken in the area of the nose of the folds, suggesting that flowage or plastic deformation is a common feature of these folds.

Several major anticlinal and synclinal folds were traced in the field, and it was found that they lay about a mile, or slightly less, apart and that this spacing seemed fairly constant throughout the map-area, suggesting that the same sequence of formations is repeated from north to south across the area. That it cannot be traced throughout is due in part to numerous faults, to gradation of the different types of rocks into each other, and to variations in thickness of the formations along strike and at different positions on the folds. No definite folds were traced or recognized in the nodular schists due to intense metamorphism, but no doubt they have been folded too, as the beds are steeply dipping.

Minor folds and, or, drag-folds were measured wherever possible. Their axes appear to trend about parallel with the major anticlinal and synclinal axes, but in many instances the shape of the drag-folds does not seem to indicate the true position of the major fold axes, probably due to local features not recognized in the field.

The steeply plunging anticlinal and synclinal structures west of the Discovery fault are for the most part tight folds that, however, appear to become more open towards the northeast or southwest near the noses of the folds. In these directions, the anticlinal and synclinal folds in places appear to bifurcate and give rise to two smaller structures of similar types to the main one. The smaller structures may end when traced farther northeast or southwest, or may coalesce to form a single major structure similar to the original one.

Formations east of Piloski Lake vary so much in composition along strike and are so highly deformed that their structure is imperfectly known. A drag-fold feature has been suggested, but this may not represent the actual structure involved in that area, and faulting may be much more important than shown on the map.

In the area east of the northeast end of Morris Lake, minor folds and, or, drag-folds are so common that it is impossible to trace for any considerable distance along strike the same sequence of formations; the major structure, however, which is a northerly trending anticline, can be easily recognized.

The anticlinal structure on which the Viking property is located has a much deformed eastern limb. This is a feature that is apparently characteristic of other anticlinal structures of the area, including the anticline on the Discovery property.

FAULTS

Faults are numerous in Giauque Lake area. The more significant ones commonly appear on air photographs as strong lineaments, represented by a succession of long, narrow lakes, by more or less straight topographic depressions, or by long narrow ridges formed in part of continuous diabase material injected along the fault zone. Consequently, the surface traces of many such faults may be deeply covered by overburden; minor faults on the other hand are generally exposed. The position of many of the faults have been definitely determined, those of others were inferred in the course of geological mapping, and no doubt many faults occur in the area that were not recognized. Those shown on the accompanying map are the most significant, both as to continuity and amount of displacement; several others seen in the field were of too little consequence or too small to map.

The faults strike mainly northwesterly and northeasterly, and in detail the surface traces of some of them are markedly sinuous. This is particularly so of the thrust faults, as drilling has shown that their dip varies greatly. They were formed probably later than the folds as they cut across them, and it is possible that some of them are closely connected with the period of deformation that bent the axial planes of the folds. Most of them indicate a left-hand displacement; right-hand displacements have been noted but are rare and are observed ordinarily along minor faults. Minor faults are seen to be filled with quartz, which in a few places contains a little pyrite; some of them also show shearing across widths of as much as a foot. The larger ones, on the other hand, are drift covered and, consequently, cannot generally be studied.

Faults vary in dip from a very low angle to very steep and vertical, and on this basis they have been classified as high-angle faults and low-angle or thrust faults. The high-angle faults appear to be the most common. Movement along them is believed to be mainly horizontal, brecciation is a typical feature, and generally appears to have been accompanied by the introduction of carbonates, feldspar, and much quartz, forming quartz networks; late diabase or gabbro dykes have in several places been introduced along these high-angle fault zones.

The Morris Lake fault is an example of a high-angle fault, and is one of the best known faults of the area. It has a horizontal displacement of at least 3,500 feet, as indicated by the offset of formations on either side. A synclinal structure southeast of Morris Lake has been traced from the southwest side of the fault to the southwestern boundary of the area. The same structure reappears on the northeast side of the fault on the northwestern shore of Morris Lake, offset to the northwest a distance of about 3,500 feet. A northeasterly trending band of diorite passes by the Viking camp on the southwest side of the fault and appears to have its continuation on the northeast side of the Morris Lake fault on the Greenlee property, where a similar diorite band has been mapped. This fault is possibly a continuation of the one mapped by Yardley (19) at the north end of Fishing Lake northwest of Giauque Lake area. Wilson (21) has interpreted the lineament, as observed on air photographs, that marks the position of the fault as that of a left-hand crosscutting fault extending for long distances in both directions beyond Giauque Lake area.

Two other faults of somewhat similar type to the Morris Lake fault have been traced in the area south of this fault, and are also the loci of late diabase dykes. They are both, however, relatively minor features. All the other faults in the area, except the Discovery and Viking faults, are probably of similar type, but little is known of them as their occurrence has been inferred from the geological mapping.

Low-angle or thrust faults are known in the area, and the characteristic features of one of them, the Discovery fault, are probably typical of the others. These features are a low dip to the southeast, a northeasterly trend, and a zone of shearing, with mud seams, gouge, and introduced material such as quartz, carbonates, and sulphides.

DISCOVERY FAULT

The Discovery fault was named after the property of Discovery Yellowknife Mines Limited where it was first noted and where it displaces the ore zones at an approximate depth of 375 feet. The trace of the fault at the surface passes a few hundred feet north of the Discovery shaft and occupies a strong topographic depression, which trends about north 65 degrees east. It was traced on the ground for at least 4 miles, from Giauque Lake to about the middle of the northwestern boundary of the area. Much information has been obtained on this fault from the field mapping and from underground drilling and workings. The following facts are available.

(1) Two different markers have been traced across the fault and both are offset. The wide band of quartzite and granulite shown on the accompanying plan (*See* Figure 5) is one, and although its southeastern contact does not appear to have been displaced by the fault its northwestern contact is apparently offset 750 feet to the northeast on the southeast side of the fault. Approximately 150 feet southwest of the northwestern contact of this band, south of the fault, there is a small lens of quartzite and granulite that may at one time have been connected with the main mass and now separated from it due to movement on the fault plane. This small lens serves to illustrate the apparent offset of the western contact along the fault. The other marker is a group of two bands of argillite, which shows an offset of about 250 feet.

(2) Both markers are offset to the left.

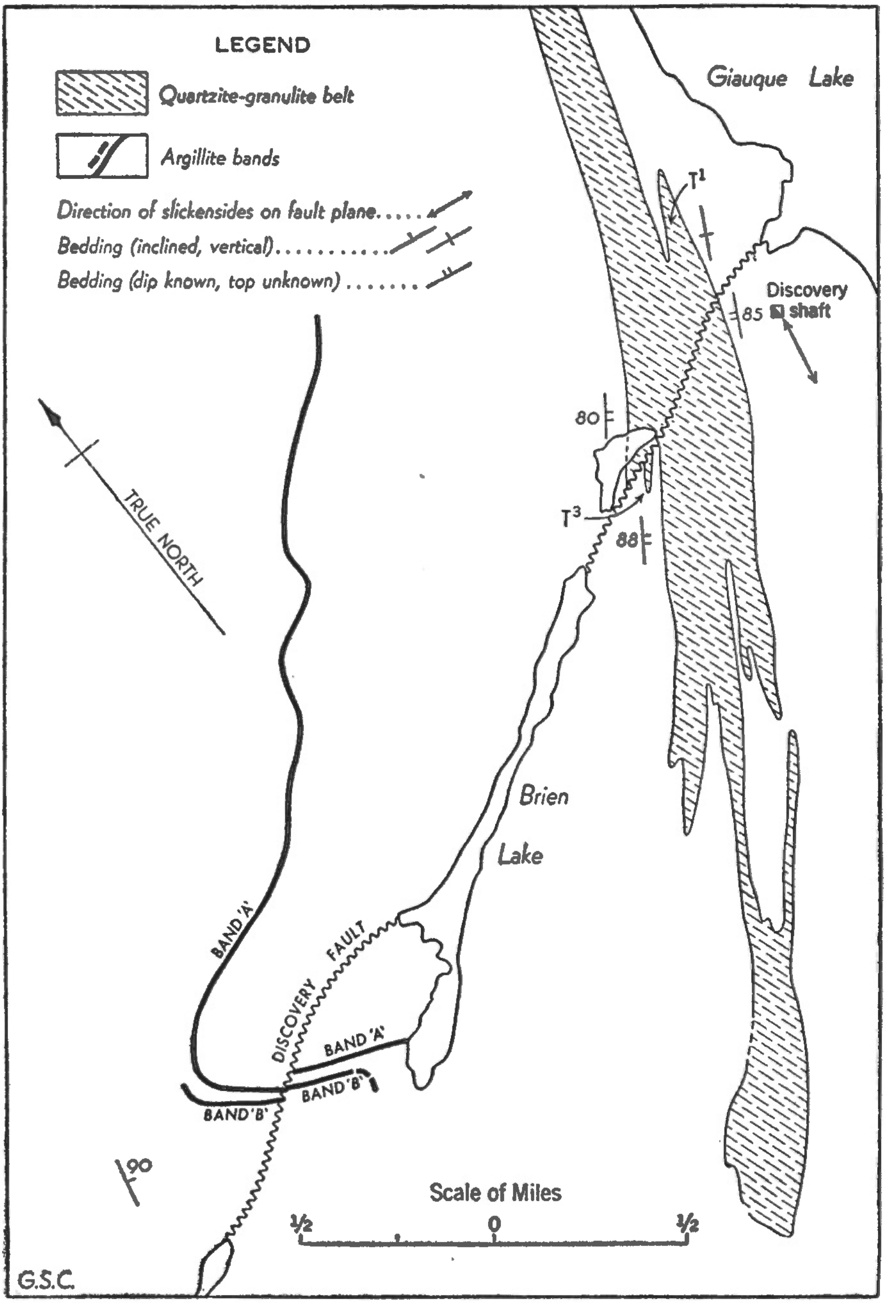


Figure 5. Sketch-map illustrating the structural relations of formations on either side of the Discovery fault, Giauque Lake area, Northwest Territories.

(3) The dip of the formations on both sides of the fault is steep to vertical. The beds of the quartzite and granulite band north of the fault appear to dip steeply to the east whereas south of the fault they dip steeply in either direction. The argillite bands have a steep dip.

(4) The intersections of the fault by several diamond drill-holes and by the Discovery shaft have shown that the fault is represented by about a foot of sheared and brecciated rock interspersed with several narrow mud seams, in which pyrite, pyrrhotite, and carbonates are common and vugs were observed. The fault is bordered on both sides by 2 to 10 feet of schistose material that contains, and is cut by, many quartz and carbonate stringers. For short distances, the fault appears to be represented by more or less minor parallel breaks that merge into the main fault in both directions.

(5) As determined by mapping, the strike of the fault is approximately north 65 degrees east.

(6) From the intersections of the fault by several drill-holes and the Discovery shaft, it has been calculated that the dip of the fault averages about 22 degrees to the southeast, but in places may be much flatter or steeper.

(7) The relative direction of the last movement, as suggested by slickensides on the fault surface underground, is north 15 degrees east. This direction is approximately parallel with the eastern contact of the quartzite and granulite band, which apparently has not been displaced, suggesting that the last movement on the fault was approximately parallel with the strike of this contact. The western contact of this band north of the fault has a different strike from the contact south of the fault, and both western contacts differ in strike from that of the eastern contact.

(8) From the underground drilling, it is believed that the relative horizontal displacement is about 220 feet, whereas the vertical displacement is approximately 70 feet, indicating that the movement is mainly horizontal.

(9) It is accepted that the fault is a thrust fault, and that an ordinary oblique thrust is sufficient to explain all its features.

An explanation of the Discovery fault requires some knowledge of regional and local geology. In attempting to trace the quartzite and granulite band, it was found that these two rock types graded along strike, in some places within very short distances, either to the northeast or to the southwest, into greywacke and argillite. In all probability the same gradation occurred down dip, as there is a gradation visible at the surface across the strike of the formations. The contacts of the quartzite-granulite band are in places straight, striking almost parallel with the bedding planes. In other places, as a result of the lithological gradation, they angle irregularly across the bedding planes, the contacts passing from a higher or lower horizon in the stratigraphic sequence to a lower or higher level, respectively, in the same sequence. Such a gradation along the contact serves to explain the tongue-like feature T^1 (Figures 5, 6) mapped along the southeastern contact of the quartzite-granulite band north of the fault. Before faulting, a similar feature may have been present along the northwestern contact of the band near the present location of the fault (*See* T^2, Figure 6), a remnant of it being represented by the small tongue-like body (T[3], Figure 5) south of the fault near the northwestern contact. Consequently, a fault crossing the contact at a point where there has been lithological gradation may exhibit an apparent appreciable offset where little or none has occurred. It would appear that the apparent offset of the western contact of the quartzite-granulite band south of the fault is a result of such a condition.

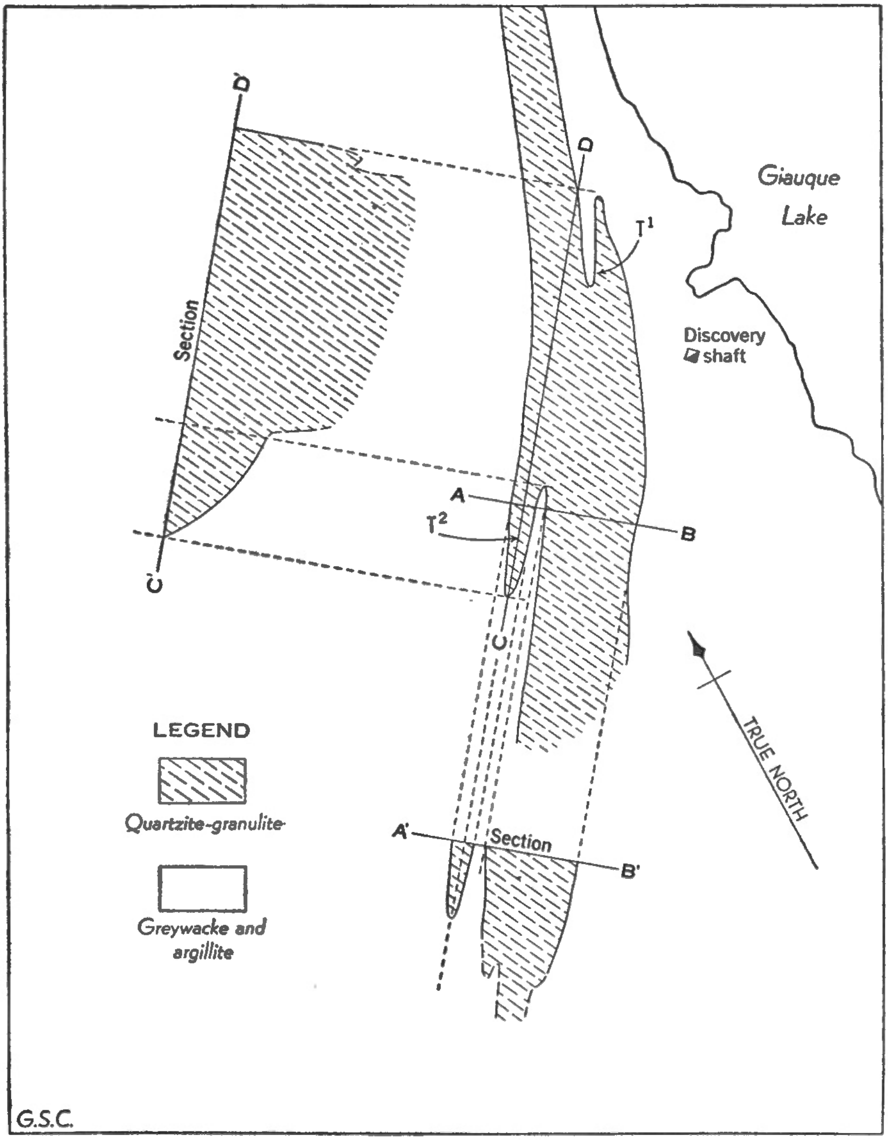


Figure 6. Sketch (not to scale) illustrating the gradation of the quartzite-granulite band, Giauque Lake area, into greywacke and argillite along the strike and at depth.

VIKING FAULT

The Viking fault was named after the property of Viking Yellowknife Gold Mines Limited, which it traverses and where it was first noted underground in 1947. It was traced about 2 miles from Morris Lake, passing about 200 feet north of the Viking camp and by a point about 600 feet north of the Viking shaft to a little over a mile southwest of the shaft. It is marked on the ground by a strong topographic depression. It is probably a strike fault southwest and northeast of the shaft, but north of the shaft it cuts across the formations, and a left-hand horizontal displacement of about 200 feet is indicated. As suggested by the underground workings, this fault is probably a thrust with a low dip to the southeast.

Quinn (15) has described this fault based on underground and drilling data. He refers to two faults, one of which is possibly a branch of the other. According to him they strike easterly and "dip to the south at 14 degrees and 24 degrees respectively. Each is marked by a zone up to 2 feet wide containing much gouge and brecciated rock, and the walls have slickensides and striæ . . . They displace 'a' sill of altered diorite and the orebodies in it, their hanging walls having moved short distances northeasterly". At the time the writer visited the property, the underground workings were full of water.

AGE OF THE FAULTS

From the field mapping it seems probable that the faults were formed later than the folding of the formations, as they cut across folds. The late diabase or gabbro dykes of the area are not displaced by the thrust faults and, consequently, must be younger. They are emplaced, however, in places along the high-angle faults and in general trend in the same direction, thus suggesting that both thrust and high-angle faults are earlier than the late gabbro dykes.

JOINTS

Joint fractures are abundant in the area (Plate V A). Most of them strike either parallel with the bedding (longitudinal joints) or about at right angles to it, the latter dipping in part steeply and in part at low angles in either direction, thus forming two sets of transverse joints (*See* Figure 7). The longitudinal joints dip with the bedding planes. The joints may be traced for variable distances; longitudinal joints can generally be followed more continuously than the transverse joints, whose lengths will be determined largely by the thickness of the bed traversed. In places the transverse joints may traverse several beds, but commonly they are stepped from one bed to another across a series of several beds.

Joints are not developed to the same degree in rocks of different types. This is particularly true of the transverse joints, which are well developed in the massive greywacke and nodular schist and are rarely noted in the argillite. The longitudinal joints, on the other hand, occur wherever there is a bedding plane to follow. These three sets of joints were probably the first structural features to develop in this area. They appear to be controlled in their occurrence by the bedded structures, as some joints are known to

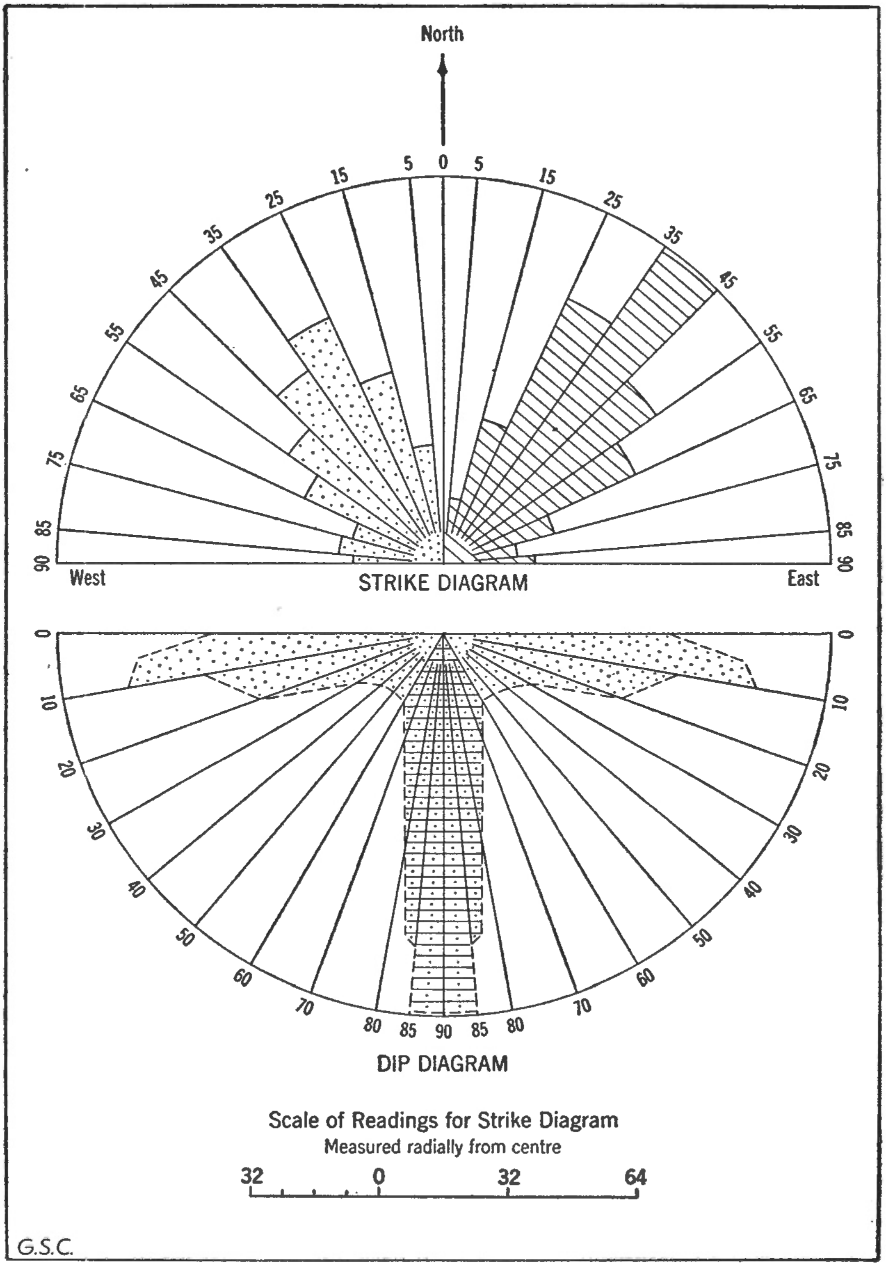


Figure 7. Diagrams illustrating joint systems, Giauque Lake area, Northwest Territories. Longitudinal joints are indicated by rulings, and transverse joints by stipple. The dip diagram is based on about one-tenth as many readings as those used in preparing the strike diagram, and its scale is relative only.

parallel the bedding at the noses of folds whereas others there are transverse to it. Their relationships to the faults are not completely known, but the joints are believed to be earlier.

Figure 5 was obtained by plotting strike readings directly on half a circle (upper half of Figure 7). These readings were plotted to scale, each division being equal to four readings. The longest dimension of each sector represents the total number of readings falling within a 10-degree arc of circle. The dips of the joints were plotted in a similar fashion, but as the number of dip readings is not as numerous as the strike readings, the diagram was not made to scale. It shows, however, diagrammatically, the principal directions of dip of the different sets of joint planes.

REGIONAL RELATIONSHIPS

The structure of Giauque Lake area might be interpreted broadly as part of the southeastern flank of a great northeasterly trending anticlinal structure, in which the major Giauque Lake folds represent only large dragfolds on its eastern limb, and the small folds, in turn, still smaller features of a similar nature. On the basis of such an interpretation it should be possible to trace the same sequence of sedimentary rocks, which is here believed to have an aggregate thickness of about a mile, around the folds and throughout the area from the north and to the south. This has not been found possible, probably due to the numerous faults and to gradation of the different types of rocks along their strike and dip. However, there are strong indications of such a broad regional structure, as the principal fold axes are spaced at fairly uniform distances, averaging about a mile apart, suggesting that the same sequence of rocks is carried through. The gently dipping lineation noted at two to three places in the southwestern part of the area may be related to that northeasterly trending regional anticlinal structure and be an indication of its plunge, which should be to the northeast at a very low angle, as the lineation dips about 10 degrees to the northeast. Yardley (19) found some gently dipping strata just east of Yellowknife River, in Wecho River map-area, northwest of Giauque Lake, which may be related to this proposed regional structure.

CHAPTER IV

ECONOMIC GEOLOGY

GENERAL STATEMENT

Gold is the only metal of present economic interest in Giauque Lake map-area, and is being produced at the property of Discovery Yellowknife Mines Limited. Elsewhere, the area has been prospected for gold rather carefully, judging from the numerous, scattered test pits, trenches, diamond drill-holes, and broken fragments of quartz veins and stringers. Much of this work has been concentrated along a belt trending southwesterly from the Discovery shaft past Narrow Lake to the Viking shaft in the southern part of the area, a distance of about 8 miles.

Although the area is at a distance of only 50 miles from Yellowknife, it was prospected much later than the Yellowknife area, probably because it is not readily accessible by water routes. The first discovery of gold was not made until the summer of 1944, when free gold is reported to have been found at several places in the volcanic rocks southwest of Giauque Lake. The following 3 years, however, from early in 1945 to late in 1947, witnessed much prospecting, mapping, and exploratory work. Since 1948, most of the work has been concentrated on the property of Discovery Yellowknife Mines Limited. At present (1951), apart from the Discovery mine, little work is being done in the area.

CHARACTERISTICS OF GOLD OCCURRENCES

The gold of Giauque Lake area is commonly found in close association with quartz veins and stringers, and has been panned from many vein outcrops in encouraging amounts. However, the gold content of samples from the fresh rock below the outcrop of these veins has in many instances proved disappointing, and has led to the view that the better values at the surface may have been due to secondary enrichment. It has appeared, too, that the gold is associated in particular with the quartz veins and stringers that occur in the volcanic and dioritic rocks and, to a lesser extent, across narrow widths in the adjoining wall-rocks. Gold occurs also in quartz veins in sedimentary rocks, but in such places the sedimentary strata are closely folded and faulted, suggesting that such structural features are necessary factors for the deposition of gold although not necessarily indicative of the presence of gold. In such occurrences, it is possible that the size of the quartz veins is of some importance, indicating a greater quantity of circulating solutions.

It is not clearly known what features controlled the location and distribution of the gold in this area, but it appears that the nature of the rocks as indicated above has been an important factor. It appears, also, that the gold is more abundantly found in those areas of the volcanic or dioritic rocks where these rocks are intimately interbanded with the sedimentary formations, as on the Discovery property. Gold is found, too, in and along the contact zones of dioritic or volcanic rocks with sedimentary strata, as at the Viking and Discovery properties, and in volcanic rocks that bear evidence of considerable silicification. In all these instances, the presence of quartz veins and stringers is held to be a primary and necessary element for the presence of gold.

It is possible that some of the faults, such as the Discovery fault, have acted as channelways for ore-bearing solutions, and that any offsets of orebodies along them has been due to later, post-mineral movements. If so, then, these faults or others involving similar rocks should be worth prospecting.

The different kinds of quartz are described later, but it can be said here that the gold is generally associated with a grey to black quartz and also occurs commonly where there is evidence of some sulphide mineralization, although the gold content is not held to vary proportionally with the abundance of the sulphide minerals in the quartz veins and stringers.

Pyrite and pyrrhotite are rather common minerals of the argillite beds, but are probably syngenetic. The pyrite cubes or nodules found in the greywacke have probably a similar origin, and it is doubtful if any gold is associated with such sulphide occurrences.

QUARTZ VEINS AND STRINGERS

Quartz veins and stringers are numerous in the area, and were observed on almost every group of outcrops. They become less abundant beyond a belt about 2 miles wide that extends from the Discovery shaft to the Viking shaft. Their loci of deposition appear to be the joint planes, as there exists an apparent relationship between the attitude and concentration of the quartz veins and those of the joints (*See* Figures 7 and 8). In the sedimentary rocks, both veins and joints strike approximately parallel with, or at right angles to, the bedding planes. The veins are more abundant along or parallel with the bedding planes than across them, and they are more common in the argillite than in the greywacke, probably because the argillaceous rocks are the more finely bedded, and, consequently, more abundantly jointed along the bedding planes. The veins are also more numerous in areas of sheared, contorted, and folded rocks than where the formations are less disturbed. This is so evident a feature that where a quartz vein is noted it is generally found to occur where there is a deviation, in some instances barely noticeable, in the trend of the bedding. In the volcanic rocks, the veins generally strike parallel with the gneissic structure, which may or may not be a direction of jointing, but they are also found in joint planes that correspond in strike and dip with joint planes in the adjoining sedimentary rocks. The dip of the quartz veins and stringers corresponds in general with that of the joints (*See* Figures 7 and 8).

Most of the quartz veins and stringers are lenticular to irregular bodies that vary greatly in width along both strike and dip. Most of them are short; in places they may be as much as 100 to 150 feet long, but commonly they are represented by a discontinuous series of small, lenticular bodies of quartz that can be traced for relatively long distances along the same horizon. Of such, for example, is the western limb of the North vein at the property of Discovery Yellowknife Mines Limited. In width, the veins are generally less than 2 feet, but may reach 6 feet in places. Most of them

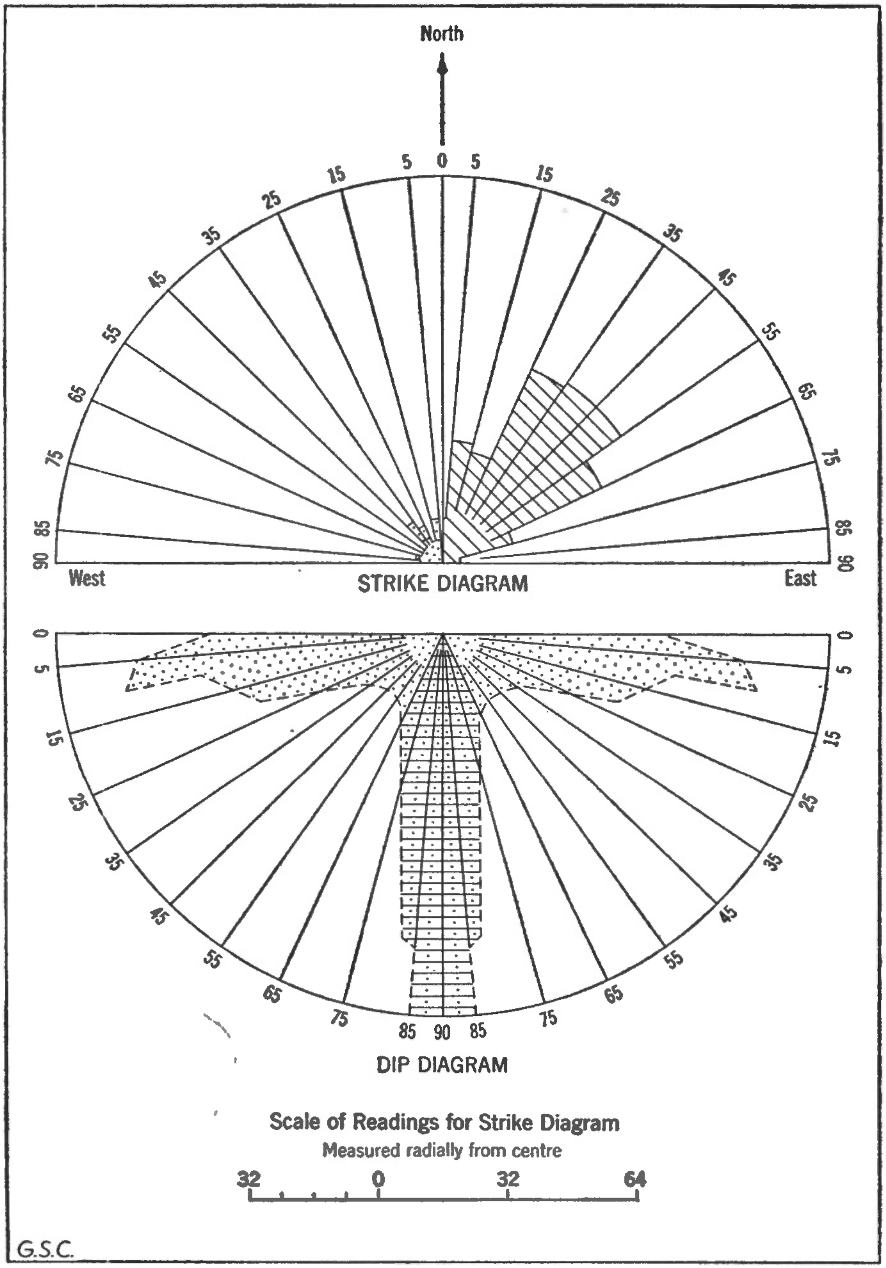


Figure 8. Diagrams illustrating vein pattern in Giauque Lake area, Northwest Territories. Veins striking parallel with longitudinal joints indicated by rulings, and those parallel with transverse joints by stipple. The scale of dip diagram is relative only.

carry a little white feldspar (oligoclase), either as irregular and discontinuous seams along the contacts of the veins with the wall-rocks or as irregular patches and blebs in the quartz masses. Some of the feldspar may also extend into the wall-rocks. Many of the quartz veins, especially those in the sedimentary rocks, carry, in addition to white feldspar, much mica, some inclusions of wall-rocks, and, in place along their margins, narrow, discontinuous bands of hornblende, chloritic material, or epidote. The mica is mainly biotite and lends a dark colour to the quartz. It is held to represent the remnants of the parts of the wall-rocks that have been almost completely assimilated by the quartz. The inclusions of the wall-rocks, however, that have not been assimilated, are commonly much altered at their margins to biotitic and chloritic aggregates. Much of the vein quartz in the volcanic and dioritic rocks carries scattered rosettes of actinolite believed also to be the remnants of the parts of the wall-rocks that have been almost completely absorbed by the quartz. The wall-rocks adjoining the quartz veins and stringers are in places characterized by the development of much biotite or chlorite, or rarely an amphibole. Some of the quartz veins carry a little, generally less than 1 per cent, of pyrite, pyrrhotite, arsenopyrite, chalcopyrite, galena, and sphalerite; but such mineralization is not common.

Four polished sections of specimens containing these sulphide minerals were studied under the microscope and the paragenetic relations of the sulphides to each other were in part determined. The specimens were collected by the writer and probably represent the most complete sulphide association. Two of the specimens were from deposits reported to assay 0·50 ounce of gold a ton. The sequence of mineral deposition as determined from the specimens is believed to be fairly representative for the area in general. From earliest to latest, this sequence is as follows: quartz, arsenopyrite, magnetite, pyrite, pyrrhotite, chalcopyrite, pyrite(?), quartz, and carbonates. There is probably overlapping of the quartz and carbonates. The relationship of other sulphides, such as galena and spalerite, could not be determined as they were nowhere in close association with the sulphides listed. According to Quinn (15), sphalerite should precede chalcopyrite and galena follow it.

Arsenopyrite occurs in large to small, generally euhedral crystals, although some of the small grains may be partly rounded and corroded by other sulphides such as pyrrhotite and pyrite. In places, as along the southeastern contact of the main body of volcanic rocks on the LaSalle ground, and in the vicinity of the Viking shaft, it occurs in abundance and in crystals up to ½ inch long. Normally, it is restricted mainly to a few narrow zones.

Pyrite is an abundant sulphide in the Giauque Lake area; although nowhere as spectacular as arsenopyrite, or as widespread as pyrrhotite, it is common, occurring in large to small grains, generally well-formed cubes, and in some instances forming an intergrowth with pyrrhotite, as if the latter had formed by exsolution from the pyrite. Some irregular grains are probably the result of corrosion; others have a vein-like form as if younger than other sulphides, so there are possibly two generations of pyrite, as indicated in the paragenetic sequence presented above.

Pyrrhotite is the most widespread and abundant sulphide of the area, occurring in irregular, generally small grains and distributed not only in the quartz veins and bodies but also in the volcanic and dioritic rocks and in some of the argillite beds and metamorphic rocks. It appears to have been deposited later than the other sulphides with the exception of chalcopyrite. Some of the pyrrhotite in the argillite and greywacke is believed to be syngenetic.

Chalcopyrite is a very rare sulphide occurring in tiny specks scattered here and there in pyrrhotite or in small irregular grains in the carbonate minerals.

The quartz of the veins and stringers carrying the above sulphides varies greatly in colour and appearance. It may be glassy, glassy white to milky white, and grey to dark grey and black. Some of the white quartz is granular, and although most of the glassy and white quartz is massive and barren it may in places carry a little gold. The grey to black quartz is more commonly well fractured and is believed to owe its colour to impurities resulting from incomplete digestion of wall-rock material. It is the most commonly mineralized quartz in the area, and also the one that carries the most gold. The white quartz is at least in part later than the grey to black quartz, as it cuts the black quartz at several places in the area. This is well shown in the underground workings at the property of Discovery Yellowknife Mines Limited.

The quartz veins and stringers are believed to be of Precambrian age. They were observed in the sedimentary and volcanic rocks, the diorite sills, and the porphyry masses, and they cut across the minor structural features of the area; but they were seen to be cut by the late gabbro and diabase dykes. So, the quartz material was probably deposited in late Archæan or early Proterozoic time, but definitely before the injection of the gabbro dykes. It is probably related to the granite bodies that outcrop to the west or to the north at some distance beyond the map-area. On the other hand, a few irregular quartz masses were seen within the gabbro dykes emplaced along the Morris Lake fault north of the Viking camp. These quartz masses represent probably some of the quartz that has circulated along, and was deposited in, this fault zone; they are not believed to be related to the quartz veins and stringers occurring here and there throughout the area, but are probably much younger.

DESCRIPTION OF PROPERTIES

The properties described in this chapter are those of incorporated companies, and are described more or less in the order of amount of work done. Aside from these properties, a little exploratory work has been done on neighbouring ground, but has not proved significant, and in most instances the claims where this work has been done have lapsed and little description seems required. In summary, this work commonly represents either trenches or X-ray diamond drilling, and involves either quartz veins and stringers or mineralized argillite bands. In all instances, the locations where such work has been done have been indicated on the map.

DISCOVERY YELLOWKNIFE MINES LIMITED

The property of Discovery Yellowknife Mines Limited is near the western shore of Giauque Lake. It comprises eight surveyed claims and fractions, the Lux No. 1 to No. 4 claims and Avis No. 1 and No. 2 claims, and the Discovery and Quinn fractions. The property is bordered on the north by that of Typhoon Yellowknife Mines Limited, on the west by that of Goldpac Yellowknife Mines Limited, and on the south by the holdings of LaSalle Yellowknife Gold Mines Limited. The Discovery camp is located on the top of a high hill on the west shore of Giauque Lake and can accommodate from seventy to one hundred men (*See* Plate I).

History

The Lux-Avis claims were staked by A. V. Giauque and sons in the late summer of 1944, and the two fractions were staked since by the present company. The original six claims were subsequently optioned to Jakeway Prospecting Syndicate, who organized Discovery Yellowknife Mines Limited and incorporated it as a company in February 1945. In the following spring, an X-ray diamond drilling program was started to explore a few quartz veinlets in recrystallized basic volcanic rocks, and by August amounted to about 2,400 feet. The results of this drilling were further investigated in November 1945 by N. W. Byrne, who has since acted as consulting engineer for the company. These investigations led to the discovery of the 'North vein' by the prospector Bert Wagenitz, and by the end of November twenty-seven rock trenches had been excavated across the vein at intervals of 20 to 25 feet, the aggregate length of the trenches amounting to 375 feet. In December of the same year the company was reorganized, and a new, extensive diamond-drilling program was inaugurated in January 1946 to explore the North vein and adjoining area. Initial work was with an X-ray machine, but standard drilling commenced in February and continued into September, at which time total drilling, apart from the original 2,400 feet mentioned above, aggregated 979 feet of X-ray and 20,087 feet of of standard drilling. By June 1946 enough information had been obtained from the drilling and surface work to warrant underground development, and to indicate the type of plant necessary for such operations. Orders for the necessary machinery were sent in July. During this drilling program no further surface trenching or stripping was done on the property. Pending the arrival of the machinery, a portable sinking machine was flown to the property in October 1946. Sinking of a three-compartment shaft was begun in November, and by March 1947 the portable sinking machine was replaced by the permanent plant, which was then installed. Sinking was discontinued for a time to permit development on the 125-foot level, but in July 1947 was resumed, and the shaft deepened to the 250-foot level. Underground work on these two levels continued throughout 1947, and extended into April 1948. Most of the necessary camp buildings were erected in 1947, and those in use during the winter of 1947-48 were of permanent construction and well insulated. Further work was done during the years 1948 and 1949 in preparation for the installation of a 100-ton mill. The mill, purchased in April 1948 from the Mount Washington mine in Montana, was on its way to Yellowknife in September 1948 when the barge carrying it sank on Great Slave Lake. It was immediately replaced by another mill obtained from Cariboo Hudson Gold Mines Limited of British Columbia, and most of it transported to Yellowknife before the freeze-up in 1948. The mill as now installed includes amalgamation and cyanidation units, the ore passing through the amalgamation unit first, then through the cyanide plant, resulting in a total recovery of about 96 per cent of the gold content. In the autumn of 1949, underground operations were resumed in order to bring the mine into production by January 1950; the mill was completed, and the shaft deepened to a new level at 365 feet. Work on this level commenced in April 1950, and by January 1951 the 365-foot level had been opened to near its present face. Since January 1950, the mine has been producing at a rate varying from 60 to 100 tons a day, with a total recovery to the end of the first year of 18,033 fine ounces of gold. This came from the treatment of 30,000 tons of ore averaging 0·624 ounce of gold a ton, with a net receipt plus estimated cost-aid equalling $853,117. Operating profits for that year were of the order of $272,000. By January 1951, the shaft had been deepened to the 500-foot level, a new station was opened on it, and development in this new level planned.

Development

The property has been explored from the surface by trenches and diamond drilling. At least sixty rock trenches, varying in size from a small pit to excavations 60 feet long, 6 feet wide, and 4 feet deep, have explored the North vein, the West zone, the South zone, and several other small occurrences of quartz. Twenty-seven of them are across the North vein and gave results that warranted diamond drilling from the surface to explore possibilities at depth. Three of them are above the West zone. Drilling was also done to explore the different ore zones at depth, and particularly to explore the contact zones between volcanic and sedimentary rocks. Surface drilling to January 1950 aggregated at least 3,350 feet with an X-ray machine and 20,087 feet by standard drilling. All this surface work has been concentrated on the Lux Nos. 3 and 4 claims and on the Discovery fraction, most of it on the Lux No. 3.

Underground development (Figure 9) has been concentrated on the Lux No. 3 claim close to its boundary with the Discovery fraction. Up to the end of February 1951, underground work included a three-compartment shaft to a depth of 520 feet, with stations cut at 125, 250, 365, and 500 feet, and levels opened at these stations. Lateral development on the 125-foot level consisted of 958 feet of drift, 425 feet of crosscut, a raise at the nose of the North vein to the surface, and arrangements for stoping. Lateral work done on the 250-foot level comprised 557 feet of drift, 374 feet of crosscut, two raises—one from the west limb of the North vein to the 125-foot level, the other in the West zone up to the 125-foot level—and also stope development. The 365-foot level comprises at least 1,025 feet of lateral development, whereas such work has only commenced on the 500-foot level. Diamond drilling done underground up to January 1950 has aggregated about 11,760 feet.

Geology

The property of Discovery Yellowknife Mines Limited is underlain by volcanic and sedimentary rocks, with the latter greatly predominating. Volcanic rocks occur in a belt that extends southwesterly from the middle

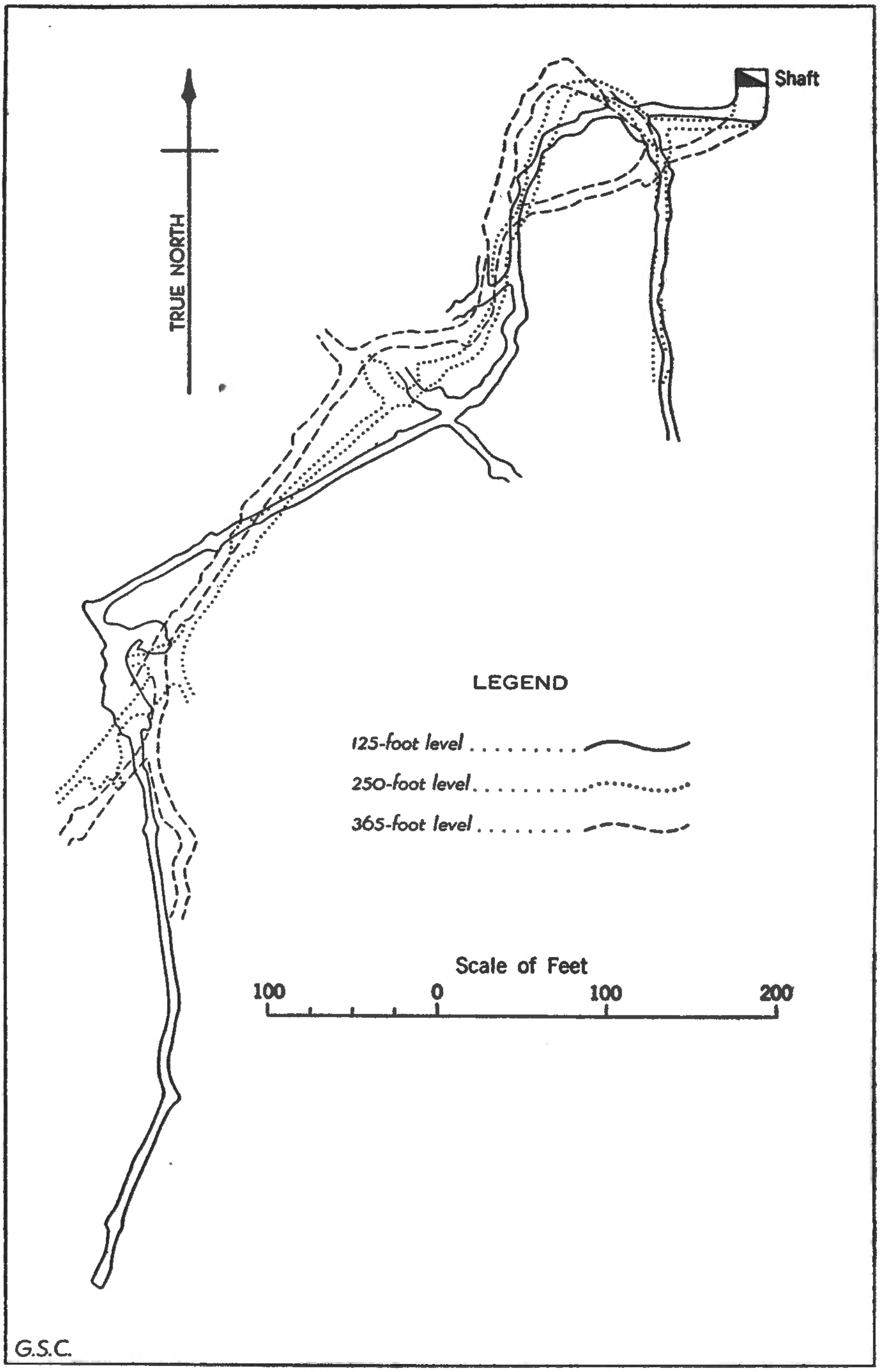


Figure 9. Composite plan of the underground workings at the Discovery mine, Discovery Yellowknife Mines Limited (to January 1951), Giauque Lake area, Northwest Territories. (Prepared from official plans of the Company.)

of the Lux No. 3 claim to about midway of the La Salle-Discovery boundary, a distance of about 2,000 feet, and continues for 1,300 feet on LaSalle ground. This belt is between 400 and 550 feet wide, and is composed mainly of garnetiferous hornblende-feldspar gneiss in places showing pillowed and fragmental structures. Another body of similar volcanic rocks, approximately 700 feet long and less than 100 feet wide, was traced slightly northeast of the northern end of the main volcanic belt. It is separated from the main body by relatively undeformed to highly contorted sedimentary strata. North and east of the main volcanic mass lies a complex of greywacke and argillite, now closely folded and altered to quartz-feldspar-mica schists and nodular schists, the nodules being commonly cordierite metacrysts, rarely andalusite. In close proximity to the northern tip of the main volcanic belt, these sedimentary rocks are mixed with some beds of dark green material believed to resemble the granulite seen farther west. A band, 1,300 to 1,700 feet wide, of finely interbedded quartzite and granulite occupies most of the area west of the volcanic belt. A dyke of porphyritic gabbro, which intersects all the other formations in a northwesterly direction, outcrops in the southwestern corner of the property and can be traced beyond for long distances in either direction.

Structure

All the formations on the Discovery Yellowknife property have a general northeasterly trend, and except in a few places the dip is steep to the northwest; in the northwestern corner of the property, north of the Discovery fault, on the Lux No. 2 claim, the dip of the formations ranges from 75 degrees southeast to vertical. The northwestern contact of the main volcanic mass also dips steeply southeast to vertically, but its southeastern contact dips steeply northwest to vertically. At its northeastern extremity, the volcanic belt plunges steeply to the southwest, and although its northwestern contact near this northeastern end is vertical the southeastern contact has a dip of between 70 and 85 degrees to the northwest, suggesting that the belt is a lenticular body narrowing and shortening with depth. The small body of volcanic rock appears also to dip as a unit northwesterly and parallel with the southeastern contact of the main mass, and probably to narrow with depth.

The formational trend is in general northeasterly, but at the nose of the main volcanic mass and near its southeastern contact with the sedimentary strata, the latter appear to trend in all directions. The suggestion from field mapping is that they have been intensely and complexly drag-folded, the drag-folds occurring apparently in a continuous series extending from the LaSalle property to the Discovery shaft. The axes of these drag-folds trend slightly east of north and, as a deduction from mapping beyond the limits of this property, they probably indicate a position on the southeastern limb of a major anticlinal structure. The axis of this major anticline would pass somewhere near the northwestern contact of the nose of the main volcanic body. Along their southeastern contact, the volcanic rocks show pillows apparently facing southeast, and all the sedimentary strata southeast of the volcanic rocks also appear to face southeast and, therefore, to overlie the volcanic rocks in that direction. On the LaSalle ground beyond the Discovery property, there are suggestions of an angular unconformity between the volcanic and sedimentary rocks, as the flow structure appears to be truncated by the sedimentary formations along the southeastern contact of the volcanic belt; on the other hand, all the sedimentary formations northwest of the volcanic belt face northwest, suggesting that the structure on either side of this belt is anticlinal.

The property is traversed by several faults. Most of them are of small displacement and of minor importance structurally and economically. One, however, the Discovery fault, is of some significance as it offsets the ore-bodies, and has a horizontal displacement of about 220 feet. It has been described in detail in the preceding chapter.

Ore Zones

North Vein. This vein (Figure 10) occurs in sedimentary rocks about 300 feet northeast of the northeast end of the main body of volcanic rocks. In plan, the vein is U-shaped, open to the south and with the arms trending southerly. At the time of mapping, only discontinuous and small parts of the vein could be seen at the surface, but, as reported in 1945, it was continuously exposed for 600 feet, with a width varying between 2 and 28 feet. As determined by underground exploration, the vein is continuous from the surface to the Discovery fault at an approximate depth of 380 feet. The vein was apparently picked up below the fault at a depth of about 460 feet, and appears to extend to greater depth. Above the fault the vein plunges northerly at an angle varying from 85 degrees to as low as 70 degrees in the western limb. Its east limb dips from 87 degrees west to vertically, whereas the west limb dips about 73 degrees west to as low as 65 degrees in its southwestern extremity, so that the limbs of the U gradually diverge with depth. On the 125-foot level they are 90 feet apart; on the 250-foot level, 100 feet; and on the 365-foot level, 120 feet.

The sedimentary rocks in which the vein lies have been recrystallized to quart-feldspar-mica schists and nodular schists. Bedding trends are apparent at several places, but top determinations are rarely possible. However, from the available information, it appears probable that the vein occupies an anticlinal position on a drag-fold on the eastern limb of the main anticlinal structure on this property.

The North vein is now incompletely exposed, due to construction work and surface modifications, and most of the following details have been assembled from what could be seen underground when the property was examined. The vein was followed on the 125-foot level for 540 feet, on the 250-foot level for 460 feet, and on the 365-foot level for 340 feet along the nose and the west limb of the vein. In general the vein is irregular in width, but is continuous from the southern end of the east limb to the northern end of the west limb. The east limb is almost straight, particularly as exposed along the 250-foot level. The west limb, however, is represented by a succession of small, sinuous, elongate bodies of quartz difficult to follow. In width, the east limb averages about 1·8 feet on the 125-foot level and 3·8 feet on the 250-foot level. At the nose, its average width is about 5·7 feet on the 125-foot level, 4·2 feet on the 250-foot level, and 3·3 feet on the 365-foot level. Widths along the west limb vary from a few inches or less to 12 feet, and as the vein is not continuous no satisfactory average figure could be obtained.

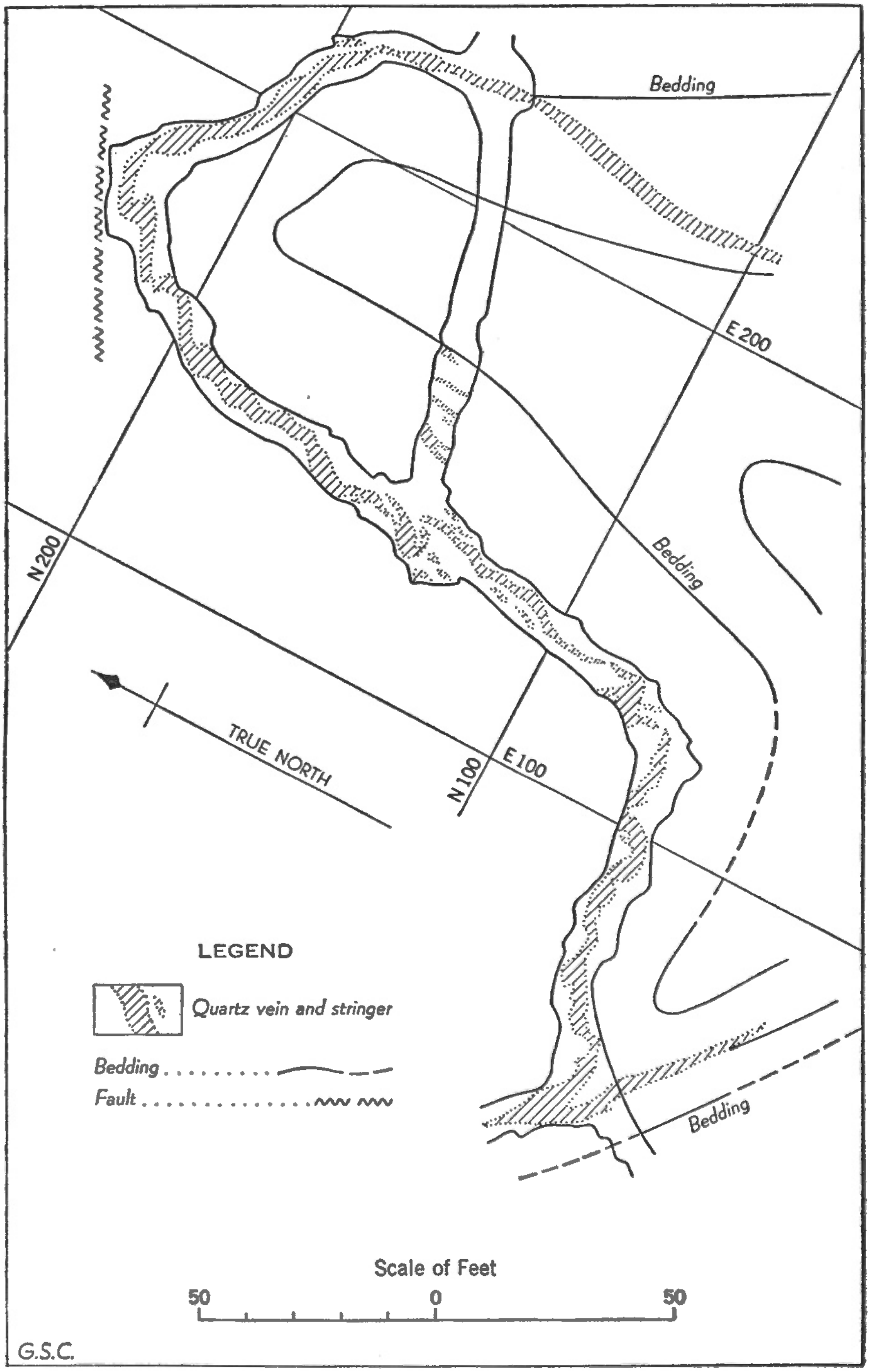


Figure 10. Plan of North vein on the 365-foot level of the Discovery mine, Discovery Yellowknife Mines Limited, Giauque Lake area, Northwest Territories, September 1950. Extensions of the quartz bodies beyond the drift were determined by drilling. (Prepared from official plan of the Company.)

The North vein is composed mainly of quartz. Its contacts are sharp, and commonly the quartz adheres firmly to the wall-rock, which is impregnated with large flakes of biotite within a narrow zone along the vein walls. At places where the biotite is most abundant the vein parts more easily from the wall-rocks. Two main types of quartz were noted, a black or dark grey and a milky white quartz. Although in many places the types appear to grade into each other, in some sections of the vein the milky quartz definitely cuts across the black quartz, and for this reason appears to have formed later. The black quartz contains much biotite, which is commonly distributed either in patches or seams and is not everywhere uniform in texture. Along the east limb of the vein, for example, there is evidence to indicate that the black quartz has digested much of the wall-rock and that its mottled and banded appearance in places is the result of this process. At the nose and along the west limb of the vein, the black quartz is mottled and banded, but not as noticeably as along the east limb, where banding is especially pronounced. Milky quartz occurs in every part of the vein, and in the area of the west limb extends beyond the main vein itself into the adjacent wall-rocks. The banded structure of the black to grey quartz is commonly parallel in strike and dip with the walls of the vein, and in many places is more pronounced near the walls than in the centre. In addition to quartz and biotite flakes, the vein contains small amounts of gold, pyrrhotite, pyrite, arsenopyrite, pentlandite, galena, chalcopyrite, magnetite, ilmenite, calcite, apatite, and oligoclase. Altogether, the metallic minerals account for less than 1 per cent of the vein, and commonly are found in close association with concentrations of biotite flakes and in fractures in the quartz. The calcite is found as seams.

Gold is the most important ore mineral, and although it is distributed throughout, it is definitely more concentrated in some parts of the vein, particularly at the nose and at places along the west limb and close to the foot-wall, where the orebodies occur. From the surface to a depth of 365 feet, 47,000 tons of ore averaging 0·86 ounce gold a ton are reported to have been proved in this vein. The gold is reported to occur free, and to be quite coarse in places. It is not believed to be closely associated with the sulphides.

In addition to the North vein northeast of the main belt of volcanic rocks, another quartz vein about 3 feet wide and containing some gold was encountered underground. The vein lies some 100 feet northwest of the southwestern extremity of the North vein and was first intersected by drilling from the drifts leading from the southwestern end of the North vein to the West zone on the 250- and 365-foot levels. Later a crosscut was driven on the 365-foot level from the main drift to reach it. Some 53 tons obtained from it are reported to have averaged 0·60 ounce of gold a ton.

West Zone. This zone lies in and near the northern tip of the main belt of volcanic rocks, about 450 feet southwest of the nose of the North vein. It is an area of dense, dark green volcanic rocks cut in a northerly direction by numerous irregular bodies of quartz, most of which are small (Figure 11). The volcanic rock in which they occur has been recrystallized to a dense, dark green, massive to gneissic quartz-feldspar-hornblende rock, in part garnetiferous. The West zone was prospected first from the surface by three trenches and several diamond drill-holes, and later was explored

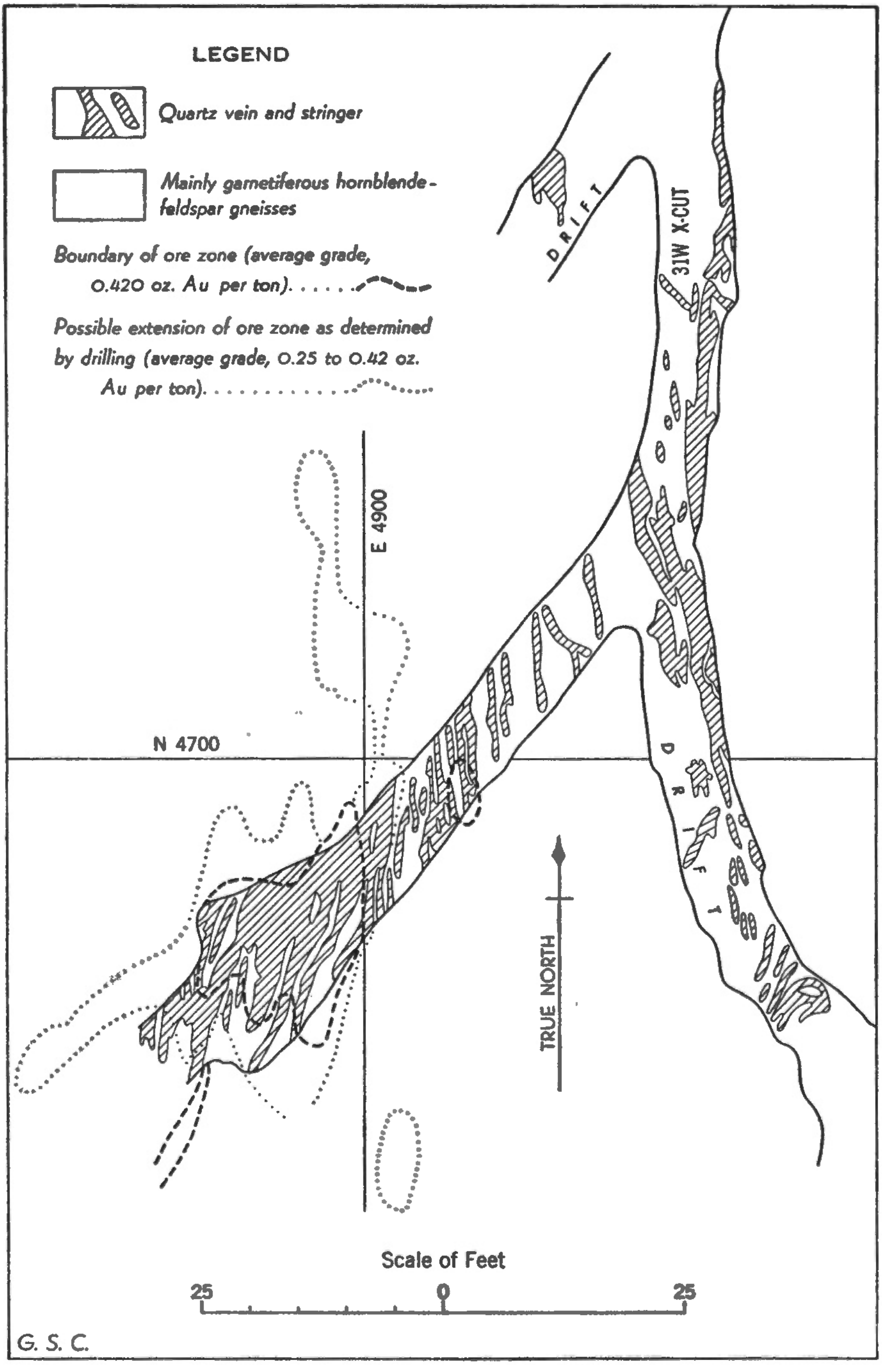


Figure 11. Plan of West zone area on the 365-foot level of the Discovery mine, Discovery Yellowknife Mines Limited, Giauque Lake area, Northwest Territories. (Prepared from official plan of the Company.)

on the 125-, 250-, and 365-foot levels by 100 feet of drift on each level and some lateral slashing, and by a raise from the 250-foot level to about 80 feet from the surface.

Both black and milky white quartz occur in the West zone, and, as in the case of the North vein, the black quartz is in part mottled and banded, possibly as a result of incomplete digestion of wall-rock material. Where the quartz occurs as seams, veinlets, and small masses, it presents sharp contacts with the wall-rock and adheres firmly to it, but where the quartz is found in large irregular masses, it appears to have irregular and gradational contacts and to include much wall-rock in the form of inclusions and rosettes of dark green amphibole. In general, the quartz contains a little gold, pyrite, pyrrhotite, chalcopyrite, sphalerite, and white feldspar. The wall-rocks are also slightly mineralized, and on the whole the percentage of sulphide minerals is greater in the West zone than in the North vein. An orebody of 32,000 tons, averaging 0·37 ounce gold a ton, has been outlined by drilling, and its vertical continuity established between the 125- and 365-foot levels. This orebody is of irregular shape and increases in area and grade to the 250-foot level, below which it appears to decrease rapidly in area if not in grade. This is shown by the following figures:

Level	Area of horizontal section in square feet	Grade, ounces of gold per ton
125-foot	1,332	0·225
165-foot	1,560	0·302
210-foot	1,657	0·382
250-foot	1,890	0·44
365-foot	640	0·420

Apparently, the gold is found not only in the vein quartz but also in the wall-rock, and for this reason the orebody is a mixture of both. Gold is in the native state, and, apparently, not necessarily in close association with the sulphide minerals.

South Zone. What is known as the South zone at the Discovery Yellowknife mine is a contact zone between volcanic rocks and argillite. It lies along the eastern contact of the main volcanic belt and about 700 feet southwest of the northern end of the North vein. The South zone was prospected at first from the surface by trenches and X-ray diamond drill-holes, and afterwards was opened on the 125-foot level by 150 feet of drift. Although high assays were obtained from the surface work, underground development has indicated a gold content of less than 0·3 ounce a ton across an average width of 36 inches.

Early in 1951, the zone was explored by, and from, 100 feet of drift run on the 365-foot level. Samples of ore grade are reported to have been obtained from the drilling done from this drift into the adjoining volcanic rocks. The rock encountered and forming the ore-bearing zone is reported to be similar to the rocks of the West zone.

Several quartz stringers were observed in the South zone at the surface, but only a few of them, and these rather small, were encountered on the 125-foot level. The zone is heavily mineralized, pyrite, pyrrhotite, and arsenopyrite being common not only in the volcanic and sedimentary rocks but also in the quartz stringers. A little white feldspar occurs in the quartz, which comprises both black and milky white types.

VIKING YELLOWKNIFE GOLD MINES LIMITED

The property of Viking Yellowknife Gold Mines Limited (Plate V B) lies at the west and southwest end of Morris Lake, about 8 miles southwest of the Discovery shaft, and comprises forty-nine, unsurveyed, adjoining claims, namely, the Arlene Nos. 1 to 6, the Ola Nos. 7 to 24, the BBB Nos. 1 to 12, the KAM No. 1, and the DEI Nos. 1 to 12 claims. It is bordered on the north and northeast by the properties of Greenlee Mines Limited and Centrix Yellowknife Mines Limited. The Viking camp includes a wood-framed cook-house and five tents, and is located on the west shore toward the southern end of Morris Lake. K. A. Matheson and Henry Lepp were resident engineers during the period of exploration.

History

Gold was first discovered on the Viking property in the spring of 1945. The original property, comprising the Arlene, Ola, and BBB groups of claims, was optioned in January 1946 to Athona Mines (1937) Limited, who subsequently purchased the adjoining KAM and DEI claims to the east. A program of trenching and diamond drilling commenced in the spring of 1946 and continued into early 1947. In March 1947, a portable sinking machine was flown from the Discovery mine to the property and a prospect shaft was begun in April and completed by the end of June. In May of the same year, the company was reorganized and the property was transferred to Viking Yellowknife Gold Mines Limited, who took over to continue shaft sinking and proceed with underground explorations. The latter, including drifting, crosscutting, and drilling, was continued to the end of September 1947 when the camp closed for the winter. No further work has been reported.

Development

Most of the exploratory work has been concentrated on the Ola No. 9 and BBB No. 1 claims, or what is known as the Main zone on the property (Figure 12). Surface work on this zone comprises about 850 linear feet of rock and surface trenching in more than twenty-six trenches; thirty-five standard diamond drill-holes, aggregating 13,123 feet, most of them to an average vertical depth of 150 feet; and nine X-ray diamond drill-holes, aggregating about 1,000 feet. The Main zone was also explored from the surface by a two-compartment prospect shaft (8) inclined to the northeast in the trend of the zone, at an angle of 65 degrees. The shaft was sunk in the north end of the zone about 3,500 feet due west of the Viking camp. It is 7 by 10 feet in size, with one compartment serving as man-way, and has an uncovered headframe about 32 feet high. The shaft is 159 feet long and a station was opened at 150 feet slope depth. Underground exploration consisted of slightly more than 400 feet of drifting, crosscutting, and slashing, and 734 feet of standard diamond drilling (Figure 13).

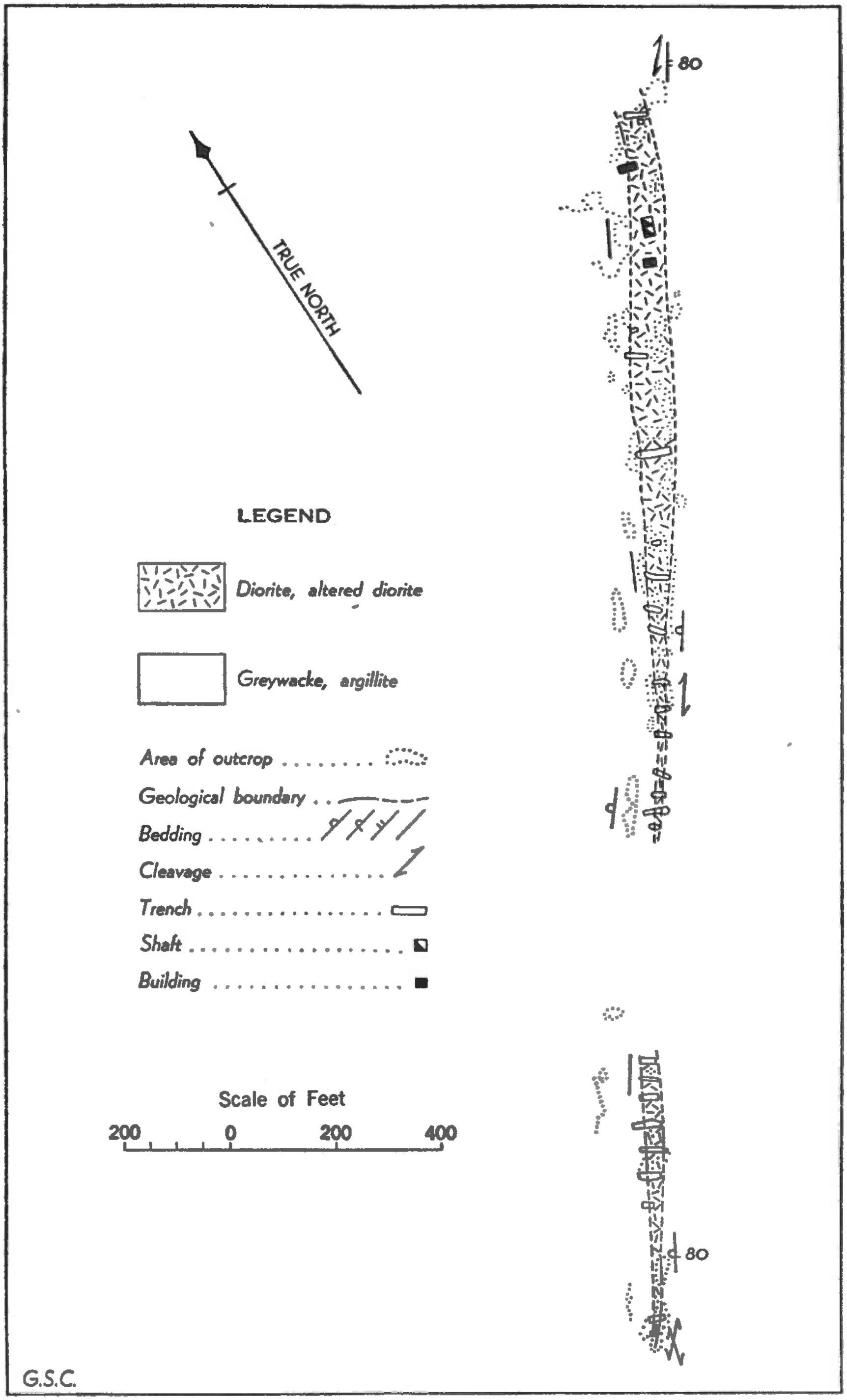


Figure 12. Geological plan of workings on the Main zone of Viking mine, Viking Yellowknife Gold Mines Limited, Giauque Lake area, Northwest Territories.

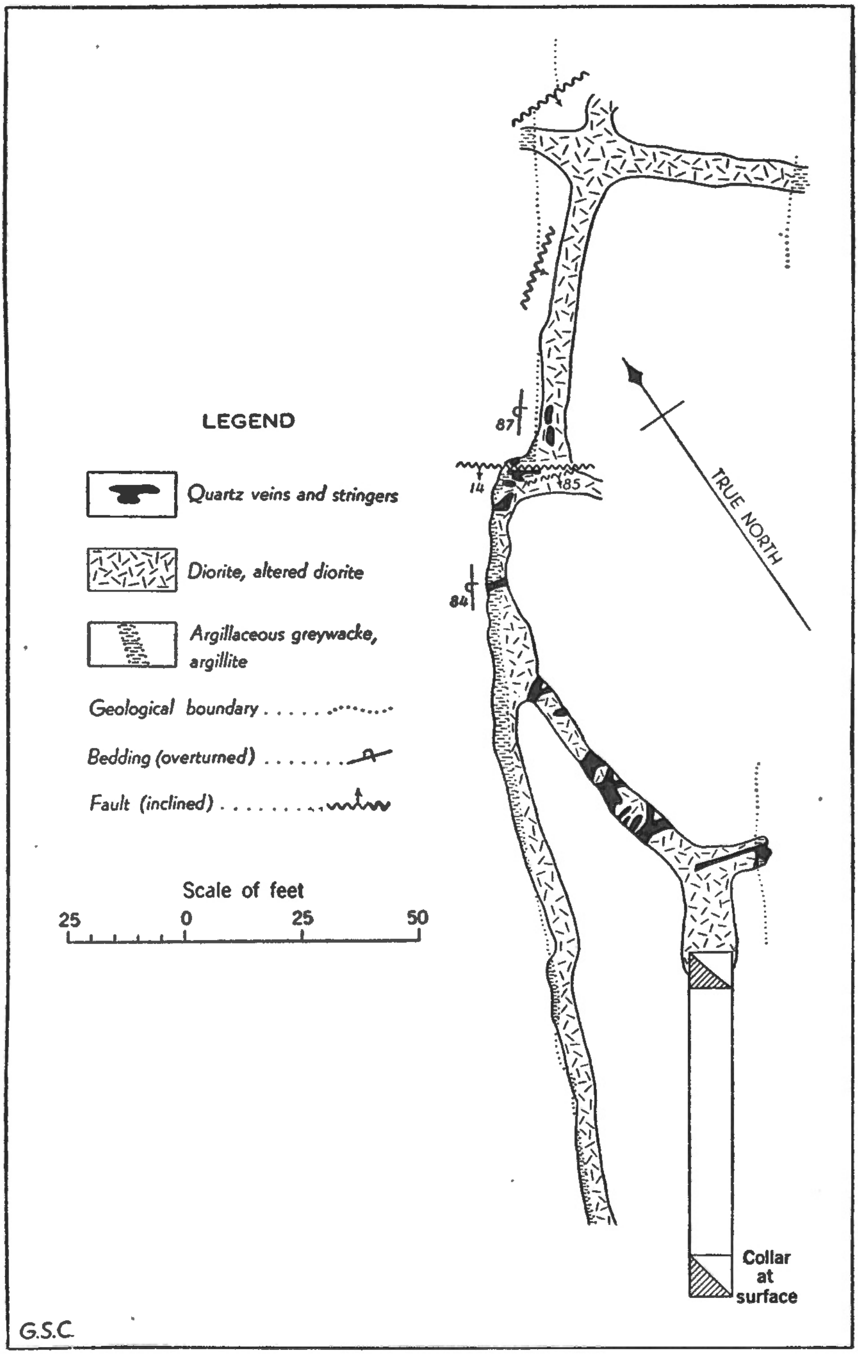


Figure 13. Geological plan, 150-foot level, Main zone, Viking mine, Viking Yellowknife Gold Mines Limited, Giauque Lake area, Northwest Territories. (Prepared from official plan of the Company.)

A little exploratory work was also done on the BBB No. 4 claim about 3,900 feet south of the inclined shaft, or about 6,000 feet southwest of the main camp. This place, known on the property as the East zone, was explored by three rock trenches and at least five X-ray diamond drill-holes.

Other rock trenches were observed at several places on the property, but apparently encountered nothing of interest.

Geology

The Viking property is underlain almost entirely by sedimentary rocks. These vary in composition from argillite and argillaceous greywacke to siliceous greywacke and minor quartzite, and are all finely to coarsely interbedded. A small lens of volcanic rocks, in part pillowed and in part highly gneissic, outcrops about 800 feet northwest of the Viking camp. The lens is 2,500 feet long by 50 to 300 feet wide. There are also four narrow sills of diorite, which vary greatly in length and appearance and which outcrop in the vicinity of the shaft and the camp. A few gabbro dykes striking northwesterly and others northeasterly to easterly cut all the other rocks on the property. Some carry pink feldspar, and most of them appear to occupy parts of fault zones.

Structure

Most of the rocks on the Viking property trend north 30 to 75 degrees east, and all dip steeply. Top determinations indicate that all strata northwest of the shaft appear to face northwest; the shaft itself is on the northwestern limb of an anticline but not far from the anticlinal axis, as a few hundred feet southeast of the shaft the formations face southeast. The shaft was sunk on a diorite sill, which was traced southwesterly for about 2,000 feet, where it apparently ends. Farther southwest it appears to be continued by another sill that begins slightly southeast of the end of the first sill and continues southwest to, and around, the nose of the anticline, where it follows the bedding and was traced almost as far as the southwestern end of Morris Lake along the southeastern limb of the fold. Although the strata on the northwestern limb of the anticline and for long distances west of the shaft are uniformly bedded, those on the southeastern limb are greatly crumpled and drag-folded.

Several faults cross the property in northwesterly and northeasterly directions, and those mapped have been described in a previous section of this report.

Ore Zones

Main Zone. What is regarded as the Main zone on the Viking property is a sill of altered diorite traversed by many irregular to lenticular bodies of quartz and carrying some gold (*See* Figure 12). It outcrops at irregular intervals for a distance of 2,300 feet in a north 33 degrees east direction, its northernmost exposure lying about 200 feet northeast of the Viking shaft. The sill was traced about 800 feet farther northeast by drilling, but appears to end to the southwest within a few feet beyond the southernmost rock trench. The sill varies in width from about 10 feet to a maximum of 60 feet within relatively short distances and has a dip of

70 to 80 degrees to the southeast. From a point about 100 feet northeast of the shaft to a point about 400 feet south of it, and at about 10 feet from the southeast contact of the sill, the latter encloses a band of sedimentary material about 10 feet wide.

The diorite is a fine-grained massive rock jointed in two directions, one parallel with the sill, the other almost at right angles to it, and greatly altered. Its weathered surface is light brown to brownish green and rusty; the fresh rock is dark grey. Sedimentary rocks along both contacts of the diorite sill are altered; they contain abundant coarse biotite associated with some green amphibole. Rosettes and clusters of radiating actinolitic amphibole, some reaching ½ inch in diameter, are common in the sill, and are particularly noticeable in zones a few inches thick adjoining the quartz masses, as well as in irregular patches throughout the sill where no vein matter can be seen. Some rosettes have also been noted in the quartz masses and stringers. Grains and small agglomerations of pyrrhotite and pyrite occur abundantly throughout the diorite sill, particularly associated with the amphibole clusters and concentrated in the contact zones of the sills with the sedimentary rocks and along narrow zones adjoining the quartz bodies. Arsenopyrite was seen in the vicinity of the shaft in some of the quartz masses, in places forming large crystals.

Under the microscope, the diorite is seen to be composed of sparsely distributed clusters of radiating actinolitic amphibole forming about 20 per cent of the rock; of subhedral to anhedral grains of oligoclase amounting to about 50 per cent of the diorite; and of minor amounts of quartz, sphene, and biotite. In addition, there is much opaque material in large to dust-like grains scattered through the rock. This mineral composition and the texture of the rock suggest a greatly altered rock in which most of the original mineral constituents have been altered by hydrothermal action. This has been described more fully in the description of the intrusive rocks in Chapter II.

The diorite is traversed by numerous, irregular to lenticular bodies of quartz, many of which are concentrated along and near the western contact of the diorite sill with the intruded rocks. Most of them were probably introduced along joint planes in the sill. These quartz bodies are composed mainly of quartz, which may be black, light to dark grey, white to milky white, and, or, glassy. In addition to quartz there are rosettes or clusters of radiating green amphibole, some white, green, and pink feldspars, and a little pyrrhotite, pyrite, arsenopyrite, chalcopyrite, galena, and sphalerite. The quartz is commonly well fractured, and adheres firmly to the wall-rocks. There is no definite pattern to the distribution of the black or light-coloured quartz, but as previously suggested it seems probable that the darker quartz contains much partly digested material from the wall-rocks, and that its colour is due to this undigested material. The feldspars constitute only a small proportion of the vein matter, occurring mainly as seams along the edges of the quartz masses and in irregular patches and veinlets in the quartz. They are more abundant where the quartz is white, and they are all plagioclase—the white and green feldspars being calcic oligoclase and the pink feldspar albite. The sulphides commonly occur along fractures in the quartz, along the contacts of the quartz bodies with the wall-rocks, or in the areas of quartz rich in amphibole clusters and along the inclusions of wall-rocks in the quartz. Native gold was observed by the writer in the quartz exposed in some of the trenches; it is also reported to occur in the adjacent diorite and altered diorite, but it is possible that all the gold is related to the quartz bodies. Two interesting occurrences have been described by Quinn (15): "One notable occurrence of gold in altered rock was found at a depth of 30 feet in the shaft. There the gold was exceptionally coarse (in grains up to ½ inch long) and was accompanied by very coarse grains of arsenopyrite and feldspar. These minerals are developed in the walls of a quartz vein contained in altered diorite. Gold also occurs in amphibolitized diorite just below the northernmost thrust fault about 150 feet northeast of the shaft. The gold, which is rather evenly disseminated in grains up to 3 mm. in diameter, is accompanied by a little fine-grained pyrrhotite, pyrite, and arsenopyrite".

No definite orebodies have been outlined so far, although several gold-bearing samples of ore grade have been obtained in drilling and underground. The first 61 feet of the shaft, which is sunk near the foot-wall of the sill, have been reported to carry an average of 0·65 ounce of gold a ton across an average width of 8·8 feet. The first 50 feet of drift along the foot-wall northeast of the shaft on the 150-foot level gave an average of 0·32 ounce of gold a ton across the width of the drift.

East Zone. The east zone lies about 3,900 feet south of the shaft and on the southeast side of, and close to, the northeast end of a cigar-shaped ridge. There, a group of irregular bodies of quartz outcrops close to the edges of the ridge by a muskeg in an area about 200 feet long by 40 feet wide (Figure 14). The southwestern part of the ridge up to a point a few feet northeast of this area of quartz is composed of finely bedded massive argillite and argillaceous greywacke. An occasional thin bed of siliceous greywacke was noted. Northeast of the area of quartz, however, the ridge is a mixture of finely bedded siliceous greywacke, argillite, and argillaceous greywacke containing much dark green material in lenses or patches elongated parallel with the trend of the bedding. These beds are much contorted, and show intense crenulation and drag-folding; southwest of the quartz zone the formations have their normal northeasterly trend.

Quartz occurs as irregular to lenticular bodies and narrow stringers that trend in part parallel with and in part at right angles to the enclosing strata. The largest body of quartz is 27 feet long by 14 feet wide and is connected with narrow veins and stringers along the trend of the formations.

The quartz is commonly grey to white, but in places is mottled with black. It is generally well fractured and carries a little radiating actinolitic amphibole, some white feldspar—distributed mainly along the edges of the quartz bodies or stringers—and very little sulphide minerals, including pyrite, galena, chalcopyrite, and sphalerite. As native gold was found in some of these quartz bodies, trenches were excavated at three different places across the zone, but only low and erratic assays were obtained from the surface samples. Drilling to a depth of 90 feet encountered very little quartz and but little gold, except in one hole where a core sample 2·5 feet long assayed 1·67 ounces gold a ton.

Other Workings. Rock trenches were excavated at a few other places in addition to the Main and East zones on the Viking property. They were placed along or across small, irregular to lenticular bodies of quartz that pinch out within short distances along strike and probably also at depth,

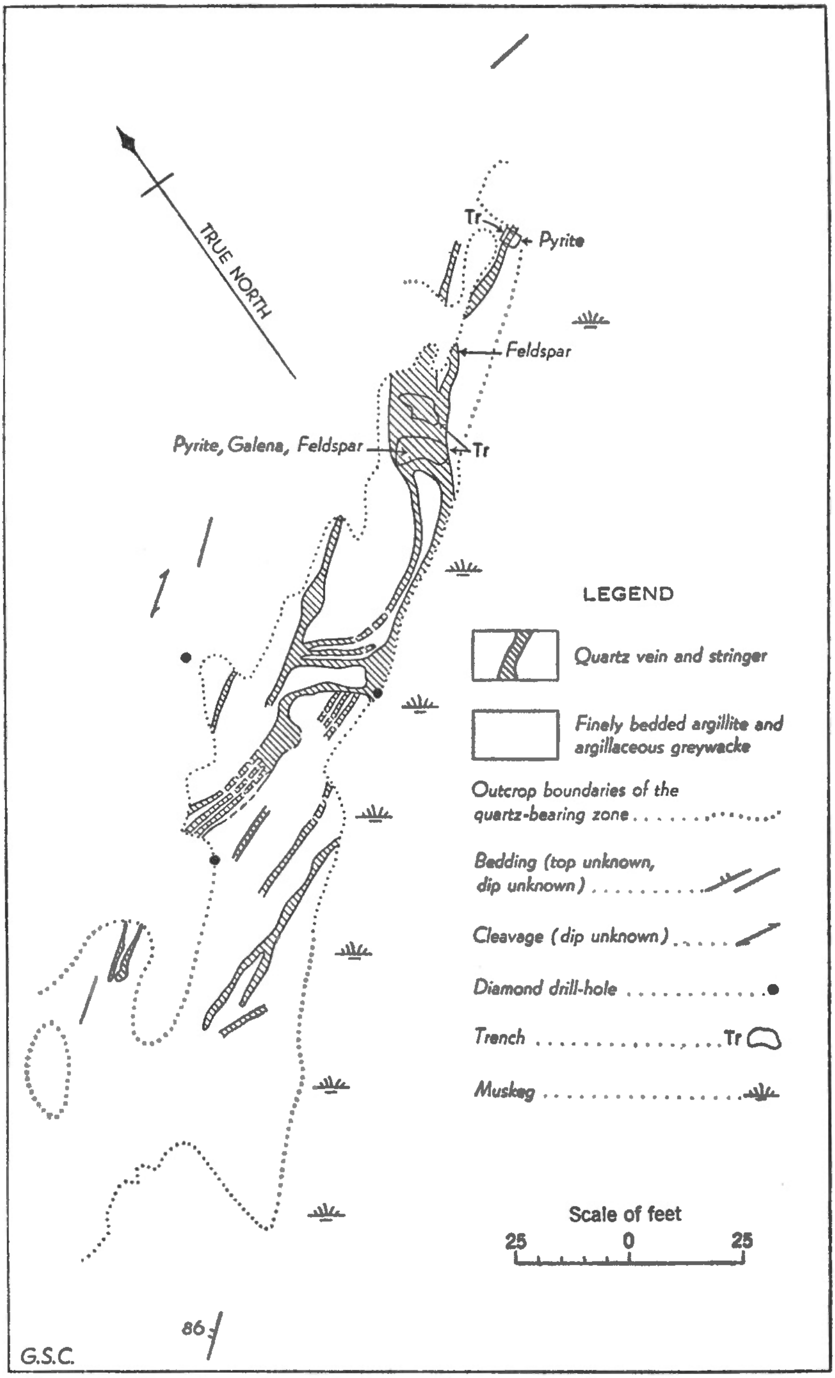


Figure 14. Geological plan of East zone, Viking mine, Viking Yellowknife Gold Mines Limited, Giauque Lake area, Northwest Territories.

and that commonly occur along bedding or joint planes. The quartz is milky white to black, in places well fractured, and generally sparsely mineralized. It carries in places a little white feldspar along the contacts with the wall-rocks. No information on the gold content of this quartz is available to the writer.

LASALLE YELLOWKNIFE GOLD MINES LIMITED

The property of LaSalle Yellowknife Gold Mines Limited occupies an area about 7,200 feet long and 4,200 feet wide extending northeast from the northeast end of Narrow Lake. It is bordered on the northeast by the property of Discovery Yellowknife Mines Limited, on the southwest by that of Oro Yellowknife Gold Mines Limited, and on the west by the holdings of Goldpac Yellowknife Mines Limited. It comprises twelve adjoining unsurveyed claims, Bruce Nos. 1 to 8 claims and Avis Nos. 3 to 6 claims. These claims were staked by A. V. Giauque in August 1944 and later sold to LaSalle Yellowknife Gold Mines Limited, which was incorporated late in 1944. The LaSalle camp lies at the northeast end of Narrow Lake.

Much exploratory work has been done on the property, including surface stripping, rock trenching, sampling, and diamond drilling. This work commenced soon after the incorporation of the company and continued steadily until June 1946 when the operations were concluded temporarily. By that time most of the surface work had been done, including about 9,742 feet of standard and 5,658 feet of X-ray diamond drilling distributed over sixty holes. In November 1946 the company was reorganized. Operations, consisting of systematic sampling and detailed surveying, were resumed in April 1947 to be suspended again by early August of the same year. During the summer of 1948 the property was geologically mapped, and 535 feet of X-ray drilling done. In August 1950, an option was taken on the property for a year by Discovery Yellowknife Mines Limited and has since been abandoned.

The LaSalle property is underlain by large and small lenticular bodies of basic volcanic rocks intercalated in sedimentary formations and dipping steeply to the northwest. The main mass of volcanic rocks outcrops in a high ridge elongated northeasterly along the boundary line of the Bruce Nos. 1, 2, and 3 claims with the Bruce Nos. 5, 6, and 7 claims.

Almost all the exploratory work that has been done on this property has been concentrated on this mass of volcanic rock or along its contacts. The rock is now an andesine-amphibole gneiss with generally a pronounced fragmental structure, and at places heavily mineralized with pyrite, pyrrhotite, and arsenopyrite. It is cut at irregular intervals by narrow and commonly short quartz veins and stringers. Due to the abundant iron sulphides the weathered surface of this rock is in places notably rusty, thereby obscuring most of the structural features and obstructing prospecting and exploration. At least sixty stripped areas and rock trenches were counted on the property, most of them either along and across quartz veins and stringers found in volcanic rocks or in areas of heavily mineralized volcanic rocks. A few of them cross the contact zones between volcanic and sedimentary rocks, and four were observed to cross quartz stringers in sedimentary beds.

Quartz veins and stringers are numerous on this property. Most of them trend between north and north 40 degrees east; others, however, strike about northwest and north 65 degrees east. As these are also the common directions for joint fractures on the property and in the adjoining sedimentary strata, it seems probable that these structures are joints and guided the vein-bearing solutions. Most of the veins dip vertically to steeply in either direction or westerly at angles of 40 to 55 degrees. Some are almost flat for short distances. Most of the veins are short and narrow, generally less than 2 feet wide, but some have been traced for 100 feet or more. The quartz is commonly milky white, but in places, particularly in the best gold-bearing veins found on this property, it is light to dark grey or black and well fractured. It may or may not be sparsely mineralized with pyrite, pyrrhotite, and arsenopyrite; and some of the veins carry a little white feldspar along their margins or here and there throughout the quartz. The grey to black quartz appears to carry small amounts of biotite and amphibole, which are believed to represent partly digested material from the wall-rock. The contacts of the quartz veins or stringers with the wall-rock are generally sharp, and the wall-rocks themselves are commonly massive and only slightly altered.

Most of the work on the LaSalle property has been concentrated in a small area, about 1,700 feet long, in a northeasterly direction, by 600 feet wide, lying northwest of the northwest end of Winter Lake, either along the shore of the lake or along, and a few hundred feet northwest of, the southeastern contact of the main volcanic mass. There, at least eight quartz veins were tested by trenching and diamond drilling, and so far as known have provided the best assays on the property. Thus, the No. 5 vein has been traced for 92 feet and averages, as reported, 0·787 ounce gold a ton across an average width of 1·37 feet. In December 1947, it was reported that the No. 4 vein had been traced for 125 feet and averaged 0·889 ounce gold a ton across an average width of 1·02 feet. Much surface stripping was also done along the northwestern contact of the main volcanic mass about 1,000 feet northwest of the northwest end of Winter Lake. There, several wide milky quartz veins were exposed and sampled, but apparently contain very little gold. At least five rock trenches were excavated and several drill-holes were put down at the northeastern end of, and particularly close to, the northwestern contact of the main volcanic mass. There the trenches are in rusty, mineralized, basic, volcanic rocks and across narrow, short quartz stringers. Encouraging gold assays are reported from these trenches.

Some work, including a few shallow diamond drill-holes, was also done near the southwest end of the band of volcanic rock that extends from the Discovery shaft to near the north end of Winter Lake. No information is available on the results of this work, but at least eleven rock trenches or pits were noted either in the rusty volcanic rocks or across quartz stringers in mineralized sedimentary rocks. A little work has also been done in other parts of the property.

In summary, although the promising areas of the property have been extensively prospected and explored, records of the results of the work done so far on this property are fragmentary, and it is not yet possible to outline the possible ore zones. Except for about half a dozen assays averaging 1·50 ounces gold a ton across widths of 3 to 21 inches, most of the other returns obtained by sampling core and trenches fall below 0·40 ounce gold a ton across an average width of 36 inches.

GREENLEE MINES LIMITED

The property of Greenlee Mines Limited in Giauque Lake map-area lies a short distance north of the north shore of Morris Lake and comprises the Pool Nos. 1 to 18 claims. The company was formed in 1938, but did not acquire this group of claims until 1946. The claims are bordered on the south by the property of Viking Yellowknife Gold Mines Limited and Centrix Yellowknife Mines Limited and on the east by that of Northland Mines Limited and Circle Yellowknife Mines Limited. The Greenlee camp, including in 1946 seven framed tents, is situated on the north shore, and almost at the east end, of Morris Lake.

Much work was done on this property during the summer and autumn of 1946. The Pool Nos. 1 to 6 claims were surveyed and geologically mapped and about 1,100 linear feet of stripping and rock trenching and 4,197 feet of diamond drilling were done on an area 1,400 by 400 feet on the Pool Nos. 4 and 5 claims (Figure 15). Altogether, fifty-one trenches were excavated on these two claims. In the autumn of 1950, about 800 more feet of drilling was done on the property in the vicinity of the previous work. This area lies about a mile north of the Greenlee camp, and a good trail leads to it from the end of a small bay on Morris Lake slightly west of the camp. Three other trenches were noted on Pool No. 3 claim.

The Greenlee property is underlain almost entirely by greywacke, argillaceous greywacke, and argillite, which are finely to coarsely interbedded. On the Pool Nos. 4 to 6 claims they have been intruded, in part along the bedding planes, by lenticular to irregular bodies of diorite. A fault with a horizontal displacement of about 3,500 feet and striking northwesterly cuts the property close to the eastern boundaries of the Pool Nos. 16 and 17 claims. The sedimentary beds all strike northeasterly and dip steeply to vertically in either direction. In the area covered by the six surveyed claims (Pool Nos. 1 to 6), the strata form part of the southeastern limb of an anticlinal structure, the surface trace of whose axial plane passes along the northern boundaries of the Pool Nos. 4 to 6 claims. The diorite masses outcrop near this axial region, and most of the exploratory work that has been done on this property has been concentrated on the most southeastern body of diorite or the one outcropping near the southern boundaries of the Pool Nos. 4 and 5 claims (Figure 15).

Although in general the diorite bodies are sparsely mineralized with pyrite and pyrrhotite, the most southeastern mass of diorite on this property is more heavily mineralized than the others, is also more altered, and is traversed by numerous veins, stringers, and irregular masses of quartz, which in places carry some native gold. The diorite body varies greatly in width, and although trending in general northeasterly, bends slightly to the south or to the north in conformity with folds in the enclosing sedimentary formations. It dips steeply to the southeast, and the intruded rocks are silicified and amphibolitized, especially along the northwestern contact. Some of the quartz veins and masses are found in

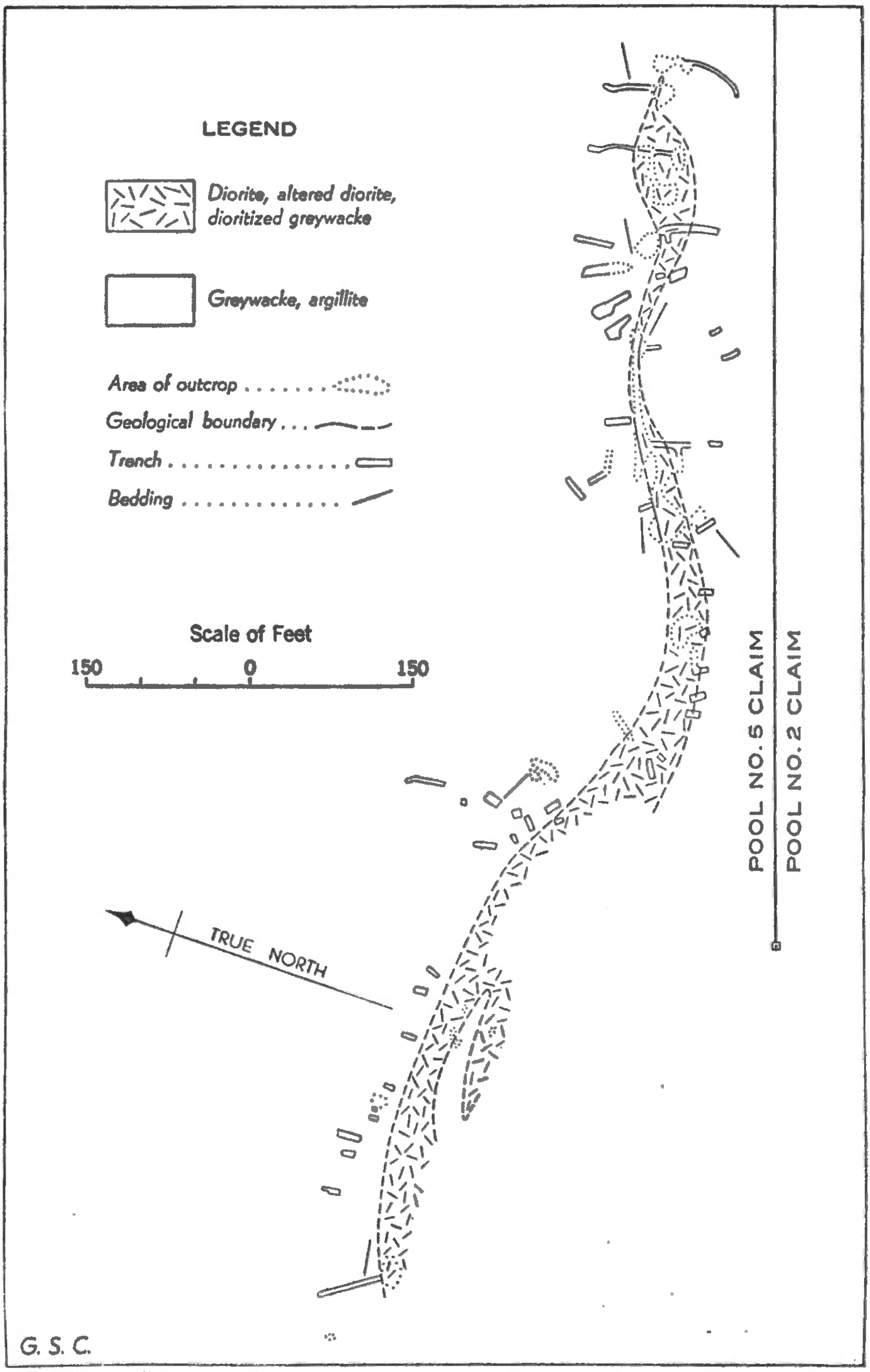


Figure 15. Geological plan of area of main workings, Greenlee mine, Greenlee Mines Limited, Giauque Lake area, Northwest Territories.

the sedimentary rocks close to the contacts of the diorite mass, being more common along the northwestern contact than along the southeastern one.

The quartz of the veins and irregular masses is black to milky white, and carries in places patches of green amphibole, a little white feldspar, and sparse sulphides, including pyrite, pyrrhotite, galena, and arsenopyrite. Native gold was found at several places in the trenches and in the drill cores. Good assays have been obtained, but seem to indicate an erratic distribution of the gold. Thus, eight diamond drill-holes, aggregating 240 feet in a mineralized zone, gave assays of from 0·28 ounce to 1·16 ounces of gold a ton over lengths ranging from 7 to 56 inches at depths varying from 20 to 170 feet.

TYPHOON YELLOWKNIFE MINES LIMITED

Typhoon Yellowknife Mines Limited was incorporated in February 1946, and was controlled jointly by Omnitrans Exploration Limited and Continental Diamond Drilling and Exploration Company Limited. The company owns twenty-one claims, consisting of the Joan group of ten claims, the GPS group of six claims, and five others; all of these claims except the Joan Nos. 4, 5, 6, and 10 claims have been surveyed. The property adjoins to the south that of Discovery Yellowknife Mines Limited. Exploration commenced in early March 1946, was suspended in early autumn of the same year, and consisted of prospecting, mapping, dip-needle surveying, trenching, and diamond drilling. At least six rock trenches were observed on the property, all of them across rusty, mineralized zones containing some pyrite and pyrrhotite and intersected by some quartz stringers. There are several other rusty outcrops that have not been trenched. Diamond drilling on the property aggregates 6,220 feet, and represents the major part of the exploratory work.

Much of the ground owned by this company is under the waters of Giauque Lake. Only the northeastern and southwestern parts are land, and all exploration has been concentrated in the southwestern part of the property on the GPS group of claims and not far from the boundary line with the claims of Discovery Yellowknife Mines Limited.

The property is underlain entirely by sedimentary strata, which trend northeasterly. Apart from a wide band of quartzite and granulites in the southwestern part of the property, all the other rocks are nodular schists. These are highly schistose along the western shore of Giauque Lake, and are traversed at several places by short, narrow quartz stringers. There are also several zones and areas of rusty weathering rocks, commonly black argillaceous types. These are impregnated with grains of pyrite and pyrrhotite or are cut by seams ⅛ inch wide of these two sulphide minerals, by carbonates veinlets, and by many quartz seams and stringers that may or may not be mineralized. Most of this quartz is milky white, and in places may be associated with white feldspar. Some of it is glassy.

No assays have been seen by the writer on samples obtained from this property, but gold has been reported.

BEAUREGARD YELLOWKNIFE MINES LIMITED

The property of Beauregard Yellowknife Mines Limited, consisting of the S.B. Nos. 1 to 12 unsurveyed claims at the northeast end of Morris

Lake, was incorporated in May 1945. It is bordered on the west by the property of Centrix Yellowknife Mines Limited and on the north by the holdings of Northland Mines (1940) Limited and Circle Yellowknife Mines Limited. The property was prospected during the summers of 1945 and 1946 and standard diamond drilling aggregating 4,984 feet was done during 1946. No further work has been reported. The diamond drill-holes are concentrated along a line that extends northeasterly from the Company's dock for 3,000 feet.

The area occupied by this group of twelve claims is underlain by finely interbedded siliceous greywacke, argillite, and argillaceous greywacke, intruded by northwesterly trending dykes of diabase and gabbro. The sedimentary rocks are believed to be part of the northwestern limb of a large anticline, the axial region of which passes near the southeastern boundary of the property. Two faults are inferred to cut across the property, and their assumed positions are indicated on the accompanying geological map. In addition to these major features, the strata are involved in many drag-folds and minor faults. In places, quartz veins, stringers, and masses are abundant, particularly in those areas of more intense deformation and faulting, and all the drilling has been done in these places. A little pyrite was seen in the quartz and wall-rocks, and the latter are partly altered to chlorite and green amphibole.

CENTRIX YELLOWKNIFE MINES LIMITED

Centrix Yellowknife Mines Limited, incorporated in January 1947, owns the R.B. Nos. 1 to 9 unsurveyed claims, which occupy most of the central part of Morris Lake and small land areas along the north and south shores of the lake. During the summers of 1947 and 1948, much prospecting, rock trenching, and diamond drilling were done here and there on this group of claims; fifteen rock trenches, aggregating 213 linear feet, were excavated on the company's ground along and a short distance north of the north shore of Morris Lake, and about 650 feet of X-ray drilling was done at different places on the property. No further work has been reported.

The property is underlain almost entirely by finely to coarsely interbedded sedimentary rocks varying in composition from argillite to siliceous greywacke. Parts of the property are traversed by several northwesterly trending gabbro and diabase dykes and by a fault with a horizontal displacement of about 3,500 feet. The sedimentary strata in general trend northeasterly and dip steeply to vertically. On the peninsula north of the lake, where the gabbro dykes have been traced and a major fault found, the formations indicate the nose of a steeply plunging syncline.

The sedimentary rocks are traversed in places by large to small, irregular bodies of quartz and by quartz veins and stringers. The quartz is either black and well fractured or milky white and massive. It is sparsely mineralized with pyrite, and carries a little white to pink feldspar. Most of the trenches have been excavated across or along quartz bodies and veins, particularly where some mineralization is in evidence, and in general the drilling was done in similar places or to substantiate the information obtained from the trenches. The writer has no information on the results of this work.

NORTHLAND MINES (1940) LIMITED

Northland Mines (1940) Limited, incorporated in 1940, acquired the Lucky Nos. 1 to 8 surveyed claims in 1946, which occupy much of the area around Lucky Lake. The property is bordered on the west by that of Greenlee Mines Limited and on the east and north by that of Circle Yellowknife Mines Limited.

In the early summer of 1946 the Lucky group of claims was geologically mapped and prospected, and six X-ray diamond drill-holes, aggregating about 800 feet, were put down. They are located in a small area about 1,800 feet northwest of the northwest shore of Lucky Lake, on the Lucky No. 5 claim.

The Lucky group is underlain mainly by finely to coarsely interbedded argillite and greywacke. All the strata have a general northeasterly trend and they are held to be part of an anticlinal structure the surface trace of whose axial plane crosses the Lucky No. 5 claim. Cutting northeasterly across the centre of the property are sills and lenticular bodies of diorite including, about midway of the Lucky Nos. 5 and 6 claims, a zone of altered sedimentary rocks, in part dioritized and in part intruded by small lenticular bodies of diorite. In places this zone was observed to be heavily mineralized with pyrite, pyrrhotite, and, possibly, arsenopyrite, and to be traversed by numerous seams or veinlets of quartz and feldspar. Most of the drilling has been done in the vicinity of this zone, and some gold is reported to have been discovered there.

CIRCLE YELLOWKNIFE MINES LIMITED

Circle Yellowknife Mines Limited was incorporated in February 1946. Its original holdings comprised thirty contiguous, surveyed claims, the Tri Nos. 1 to 18 and the Wallie Nos. 1 to 12, lying between Lucky and Piloski Lakes. In 1950, the property was reduced to nineteen claims. It adjoins to the east the property of Oro Yellowknife Gold Mines Limited and to the south the properties of Northland Mines (1940) Limited and Greenlee Mines Limited.

Much geological mapping and prospecting, trenching, and diamond drilling were done on the property during the summers of 1946 and 1947. Altogether about 1,500 feet of X-ray diamond drilling was done, of which about 600 feet was completed in August 1950. All the drilling was concentrated on the Tri No. 16 claim about 600 feet north of the camp on Lucky Lake. The trenches are scattered here and there on the property.

The property is underlain almost entirely by sedimentary rocks, which vary in composition from argillite to siliceous greywacke, and which are all coarsely to finely interbedded. In places the argillite is heavily mineralized with pyrrhotite and pyrite and, consequently, weathers very rusty. Bands of it have been trenched and sampled for gold at different places. Sills of diorite intrude these sedimentary rocks. One such lies a few hundred feet north of the north end of Lucky Lake, and most of the drilling on the property has been concentrated on or near it. This sill is sparsely mineralized with pyrite and pyrrhotite, and is traversed in places by numerous quartz veins and stringers. The mixed zone of dioritic rocks, argillite, and amphibolitized greywacke that was drilled on the Northland property to the south extends into the Circle Yellowknife property and has been trenched on the Tri Nos. 15 and 16 claims.

Veins, stringers, and irregular masses of quartz were encountered at different places throughout the property. The quartz is commonly milky white and massive. It is mineralized in a few places with pyrite or pyrrhotite, and occurs mainly along bedding planes, particularly where these change their trend slightly or where there are minor folds.

ORO YELLOWKNIFE GOLD MINES LIMITED

Oro Yellowknife Gold Mines Limited was incorporated as a company in February 1946 to take over and explore the Matt and Dorr groups of ten and eighteen contiguous, unsurveyed mineral claims that had been previously jointly optioned by American Yellowknife Gold Mines Limited and by Goldcrest Mines Limited. The area occupied by these two groups of claims, about 8,000 feet long, in a north 43 degrees east direction, by 7,000 feet wide, extends around Narrow Lake and southwest of Winter Lake. It adjoins to the northeast the properties of LaSalle Yellowknife Gold Mines Limited and Goldpac Yellowknife Mines Limited, and to the southwest that of Circle Yellowknife Mines Limited. The Oro Yellowknife camp lies on the west shore, and ½ mile north, of the southwest end of Narrow Lake, about 1½ miles southwest of the Discovery shaft.

During the summer of 1946, much surface work was done on this property. The area was mapped geologically and prospected and trenched at several places. At least twenty-eight rock trenches were excavated, and these and several stripped areas were sampled, but none of the assay returns is known to the writer. Most of the trenches are on the northwest shore and southwest of the southwest shore of Narrow Lake.

Apart from a small mass of volcanic rock at the northeast end of Narrow Lake and small areas of dioritic and possible volcanic rocks southwest of the lake, the property is underlain by sedimentary rocks such as greywacke, argillaceous greywacke, and argillite, all of which are so closely interbedded that in most places it has been impracticable to map them separately. West of the southwestern end of Narrow Lake, however, a few large bands of black, dense argillite were differentiated from the other rocks and traced for several hundred feet. These argillite bands are in places heavily mineralized with pyrite and pyrrhotite, and are cut by narrow, short, quartz stringers, which may or may not be mineralized. At least fifteen of the rock trenches seen on this property have been excavated at right angles to the trend of, and in, these argillite bands, and commonly where the effects of mineralization are most noticeable and where quartz stringers are abundant. Generally these quartz stringers contain little or no sulphide minerals, but are slightly pegmatitic, and carry a little white oligoclase, carbonate, green chloritic material, and apatite. Most of the remaining trenches were excavated in volcanic and dioritic rocks, or across the contacts between dioritic rock and greywacke or argillite, and commonly where the rock is heavily mineralized and intersected by a few small quartz stringers.

Several other quartz stringers were seen on this property. They are particularly abundant in a wide zone trending about east across the central part of the property, but in general they are apparently unmineralized and for this reason have not been trenched. Quartz on this property is most commonly milky white, but some of it is grey to bluish grey; most of the stringers strike parallel with the bedding or at a small angle to it.

WOLFPACK YELLOWKNIFE MINES LIMITED

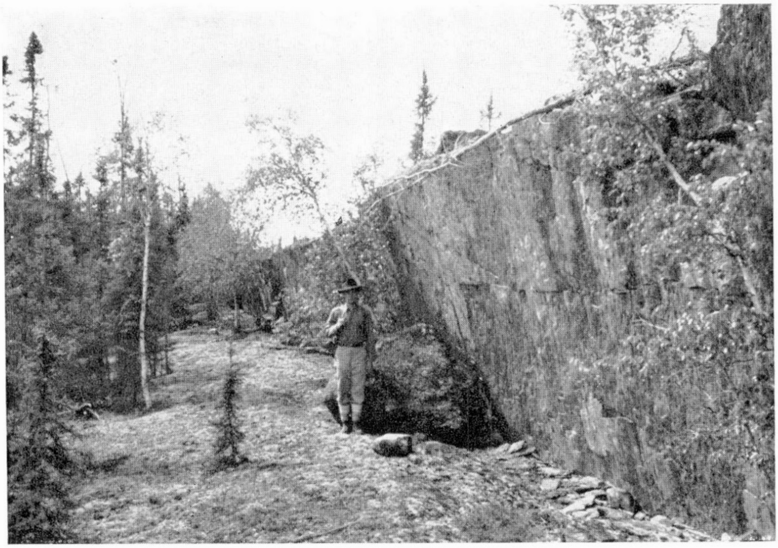
Wolfpack Yellowknife Mines Limited owns the AB group of nine unsurveyed claims and was incorporated in early 1946. The company is controlled jointly by Omnitrans Exploration Limited and Continental Diamond Drilling and Exploration Company Limited. It is bordered on the south by the property of Typhoon Yellowknife Mines Limited.

In the summer of 1946, some preliminary surface exploration and dip-needle surveying were done.

All the rocks underlying the property are nodular schists, cut at a few places by short, narrow, unmineralized quartz stringers and veins.

GOLDPAC YELLOWKNIFE MINES LIMITED

Goldpac Yellowknife Mines Limited owns the BDD group of six unsurveyed claims and adjoins the property of Discovery Yellowknife Mines Limited to the northeast and the LaSalle Yellowknife Gold Mines Limited property to the southeast. Some surface stripping and trenching and geological mapping were done on the property in 1946, and in August 1949 some trenches were excavated.



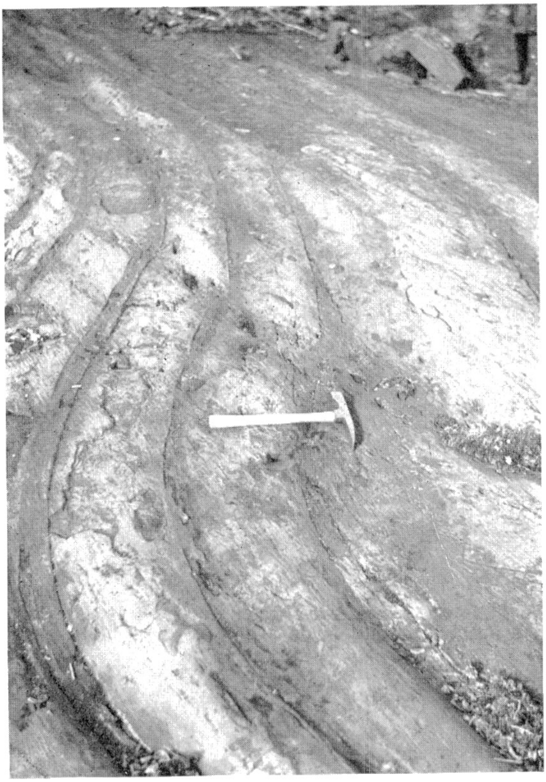
1-1, 1948
A. Frost-thrusting in nodular schist. Note the size of thrusted block. (Page 4.)

2-8, 1949
B. Crater-like depression about 8 feet in diameter formed by frost action. (Page 4.)

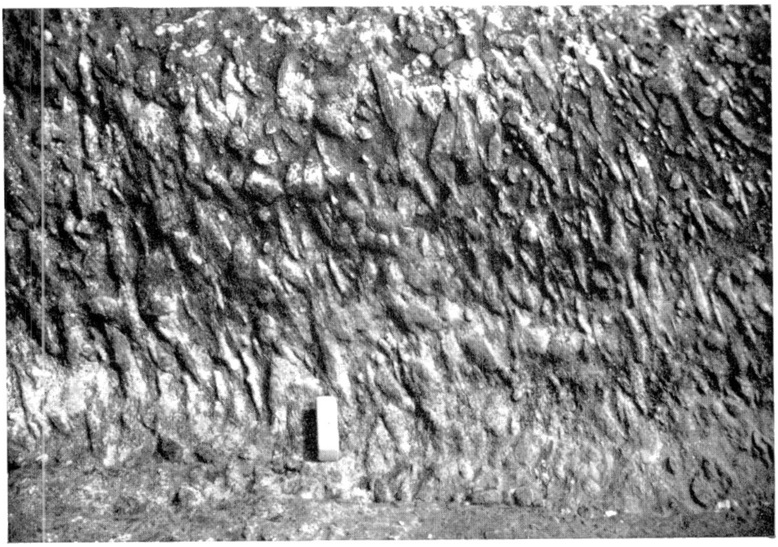
PLATE III

2-7, 1948
A. Interbedded quartzite (light grey) and granulite rocks (dark grey). (Page 10.)

3-1, 1948
B. Irregular layers and lenticular bodies of granulitic rocks (dark grey), uniformly oriented and unevenly spaced in a relatively thick bed of impure quartzite (light grey). (Page 10.)



3-3, 1949
A. Photograph of a typical mixture of finely interbedded greywacke and argillite. (Page 14.)



4-8, 1948
B. Nodular schist in vertical section (eraser, $21\frac{1}{2}$ inches by $\frac{3}{4}$ inch, for scale). Nodules are andalusite. (Page 15.)

PLATE V

1-7, 1950
A. Joints in sedimentary rocks. The longest fracture is a bedding joint; the others nearly at right angle are transverse joints. (Page 36.)

4-6, 1950
B. Viking Yellowknife Gold Mines Limited in June 1950. Headframe and power house in left background; the larger building in right foreground is a combination dry and repair shop. (Page 53.)

INDEX

PAGE

AB claims 68
American Yellowknife Gold Mines Ltd. 67
Anderson, T., acknowledgment 2
Analyses, chemical 8, 9, 12, 15-20
Andalusite 10, 14
Anticline, characteristics of 31
Apatite 50, 67
Argillite 13
  Chemical analysis of 16
Arlene claims 53
Arsenopyrite 42, 50, 53, 57, 58, 60, 61, 64, 66
Athona Mines (1937) Ltd. 53
Avis claims 44, 60
Axis (b-) of folds 29, 30
b-axis of folds 29, 30
Beavan, A. P. 21
Bedding 25-27
  Top determination of 27
Bedding cleavage 27
Bell, C. K., acknowledgments 2
BBB claims 53
BDD claims 68
Bibliography 4, 5
Bruce claims 60
Byrne, N. W., acknowledgment 2
Calcite 50
Carbonate 23, 42, 43, 64, 67
Cariboo Hudson Gold Mines Ltd. ... 44
Carp Lake map-area 1
Centrix Yellowknife Mines Ltd. 53, 62, 65
Chalcopyrite 42, 43, 50, 52, 57, 58
Channelling 9, 12, 26, 27
Chemical analyses of volcanic rocks ..8, 9
  Sedimentary rocks 12, 15-20
Circle Yellowknife Mines Ltd. .. 62, 65-67
Claims, AB 68
  Arlene 53
  Avis 44, 60
  BBB 53
  BDD 68
  Bruce 60
  Dei 53
  Dorr 67
  GPS 64
  Joan 64
  Kam 53
  Lucky 66
  Lux 44
  Matt 67
  Ola 53
  Pool 62
  RB 65
  SB 64
  Tri 66
Cleavage 27-29
  Bedding 27
Colour gradation 27, 43
Concretions in greywacke 13

PAGE

Conglomerate, boulders of 23
  Intraformational 14
Continental Diamond Drilling and Exploration Co. Ltd. 64, 68
Cordierite 14
Crossbedding 9, 12, 27
Dei claims 53
Diabase 22
Diorite 20, 21
  Dykes of 21
Diorite-like rocks in greywacke .. 12, 13
Discovery fault 32-35, 48
Discovery fraction 44
Discovery shaft, distance to 1
Discovery Yellowknife Mines Ltd. 11, 32, 39, 40, 43-53, 60, 64, 68
Dorr claims 67
Drag-folds 30
Drainage 3
Dykes, diorite 21
  Gabbro 22
Elevation of lakes 3
Erratics 4, 23, 24
Faults 31-36
  Age 36
  Discovery 32-35
  Morris Lake 31
  Viking 36
Fire-cracks 12
Fishing Lake 32
Folds 30, 31
  Drag-folds 30
Formations, table of 6
Frost-thrusting 4
Gabbro 22, 23
  Alteration by 23
  Red feldspar in 23
Galena 42, 50, 57, 58, 64
Garnet 8, 10-12, 22
Giauque, A. V. 44, 60
Glaciation 3, 23, 24
Gold 1, 39, 40
Goldcrest Mines Ltd. 67
Goldpac Yellowknife Mines Ltd. ..44, 60, 67, 68
GPS claims 64
Graded bedding 25, 27
Granite, muscovite 22
Granulite 10, 11, 13
  Chemical analysis of 16
Greenlee Mines Ltd. ... 32, 53, 62-64, 66
Greywacke, siliceous 12
  Chemical analysis of 16
Hematite, specular 23
Hornfels 14
Ilmenite 50
Intrusive rocks 20-23
Jakeway Prospecting Synd. 44
Joan claims 64
Joints 36-38, 40, 61

PAGE

Kam claims 53
Keskiness, O. J., acknowledgment ... 2
LaSalle Yellowknife Gold Mines Ltd. 42, 44, 47, 60, 61, 67, 68
Lepp, Henry 53
Lineation 29
Lowrie, D. A., acknowledgment 2
Lucky claims 66
Lux claims 44
Manitoba, nodular schists from 17
McDougall, D. E., acknowledgment 2
Magnetite 42, 50
Matheson, K. A. 53
Matt claims 67
Melihercoik, S. J., acknowledgment.. 2
Miller, M. L. 2
Morris Lake fault 14, 31
Mount Washington mine 44
Muscovite granite 21, 22
Nodular schists 14, 15
From Manitoba 17
From Northwest Territories 17
Nodular structure 14
Northland Mines Ltd. 62, 65, 66
Oja, R. V., acknowledgment 2
Ola claims 53
Omnitrous Exploration Ltd. 64, 68
Oro Yellowknife Gold Mines Ltd. 60, 66, 67
Pallett, K. F., acknowledgment 2
Patrick, T. O. H., acknowledgment.. 2
Pentlandite 50
Physical features 2-4
Piloski, M., acknowledgment 2
Pleistocene 23, 24
Pool claims 62
Porphyritic rhyolite 21
Prospecting 39
Pyrite 13, 23, 42, 50, 52, 53, 57, 58, 60, 62, 64, 67
Pyrrhotite ...13, 42, 50, 52, 53, 57, 58, 60-62, 64, 66, 67

PAGE

Quartz, age of 43
Associated with gold 43
Types 43
Veins 40-43
Quartzite 10
Chemical analysis of 16
Quinn fraction 44
Rancourt, G., acknowledgment 2
RB claim 64
Relief of area 2
Rhyolite, porphyritic 21
Ripple-marks 9, 25, 27
Roches moutonnées 23
SB claims 64
Sedimentary rocks 9-14
Siliceous greywacke 12
Specular hematite 23
Sphalerite 52, 57, 58
Staurolite 14
Sulphides 40, 42, 50, 52
Sun-cracks 12
Thompson, W. H., ackowledgment.. 2
Thrust-faults 31, 32
Thunder Lake area, Ontario 13
Timber 3
Topography, control of 3
Tourmaline 12
Tri claims 66
Typhoon Yellowknife Mines Ltd... 44, 68
Unconformity 47
Viking fault 36
Viking shaft, distance to 1
Viking Yellowknife Gold Mines Ltd. 36, 53-60, 62
Volcanic rocks 7-9
Chemical analysis of 8, 9
Wagenitz, Bert 44
Wallie claims 66
Wecho River map-area 1, 38
Yardley, D. H. 2, 32, 38