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B of F

MEMO

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RE

GEOPHOTO DATA

KECHIKA AREA

March, 1969. R.H. Seraphim

TEL - OFFICE 685-2914
RES. 224-7309

R. H. SERAPHIM
PH.D., P.ENG.
GEOLOGICAL ENGINEERING

427-470 GRANVILLE
VANCOUVER 2, B.C.

Memo Re - Geophoto Data - your letter and included date of March 5, 1969.

INTRODUCTION

One of these days I'm hoping to surprise you by heartily recommending one of these outside submissions for prospecting. In fact I would recommend parts of this one, but certainly not the submission in its entirety.

First, by way of background, I should advise you that I did, a few months back, have the opportunity of reviewing a Geophoto report which was made at the completion of their stage I (the first seasons work). The program was similar in scope to this. Secondly, I know very little of this subject area except from the literature. I spent a few days on the Turnagain River just west of it a year or two ago, and I examined the Fort Reliance copper prospect, which is in the north-east part of the subject area, in 1958.

GENERAL

Geophoto goes at prospecting in an oil mans fashion. They seem to think that if they chew through a big enough chunk of country they'll find a mine, and why worry about the cost. I recall you had your problems with this line of thinking in your uranium exploration a year or two ago. Experienced mining people tend to be much more selective in their approach to exploration, and much more cost conscious. The other Geophoto project I reviewed was also far too fancy for my taste. They had obviously spent about as much for cartography as they would like to spend on this project ($46,200.00). That's 75% of our Talkeetna and Chistochina budget just to make base maps for a similar sized area of interest. Their total estimate, $166,000 is roughly twice as much as a more simple, but just as effective, job of geochemical sampling that area should cost.

I don't think Geophoto deserves the credit for pioneering the use of reconnaissance geochemical sampling of large areas. Kennecott was away ahead of every other company here in B.C. and probably elsewhere.

I doubt very much that Geophoto has any well experienced exploration personnel on their staff. Otherwise they wouldn't have set up such a large and rigid program which overlaps three terranes and two separate mineral belts. As discussed below, you would perhaps be interested in one of these belts, but not the entire program.

THE AREA

The area is to some extent neglected. It contains the least developed and populated area of B.C., the northern Rocky Mountain Trench. But it is neglected mainly because the mineral finds prospectors, trappers, and hunting parties have made to date have not been worth following up.

The terrane east of the Rocky Mountain Trench is actually the northern most range of the Canadian Rockies. The valleys are broad and U-shaped but the mountains rise steeply and have relief of four to five thousand feet. The ridges have much outcrop, which is composed of block-faulted and folded segments of late precambrian to early paleozoic sediments. The section around Toad River and Racing River, south of the Alaska Highway, is a mineralized belt which has had some attention. A dozen or fifteen vein-type copper deposits are known here. A Rio Tinto crew mapped and prospected most of them in the late 1950's but did not retain any ground. All the known deposits are in the late precambrian (Windermere?) series of argillite, quartzite, limestone, and slate. Most of the veins lie close to peridotite dykes. Two are now being actively explored or developed, Churchill and Davis-Keays. These have about the same tonnage per vertical foot as Denali, stoping widths of five to ten feet, and about 5% Cu grade. The chalcopyrite concentrate would have to be trucked and railroaded 1300 miles before it reaches the salt water at Vancouver, B.C., or 600 miles at Skagway, Alaska. I do not consider the potential of these vein deposits is large enough to recommend that Cities search for them.

The terrane in the northern Rocky Mountain Trench and Liard Plain is not well suited to prospecting. The area is underlain by thick glacial and fluvo-glacial deposits. This is undoubtedly the reason why the lower portions of the Kechika and Rabbit Rivers are excluded from Geophotos' subject area.

The Rocky Mountain Trench itself is a pronounced lineament, but not a major fault zone in this locality. A few mineral showings are known on the west side of the trench, so the area might be called a mineral belt. The lower cambrian strata along the trench,Unit 3 and perhaps part of A on the enclosed maps,are of interest. Gabrielse, the G.S.C. geologist who mapped this area, and much of the southern Yukon, has pointed out in a recent publication that all the important lead-zinc finds in the S.E. Yukon and Northeast B.C. lie in these lower cambrian rocks. He includes about fifteen deposits, several of which are likely to be mined in the next few decades. The largest known - the Cyprus controlled Anvil property has a reported 63 million tons of 9% Pb Zn plus 1 oz Ag which is now being prepared for open pit production.

Several of the other prospects - the Tom, and Quartz Lake and Norquest in particular, have a potential of at least several million tons. I could recommend silt sampling the portions of the Geophoto project area which contain these lower cambrian rocks. But I couldn't recommend Geophoto doing it for Cities because Geophoto's costs are far too high.

The third terrane contains the eastern portion of the Cassiar Batholith, in the southeast portion of the area. Its inaccessibility keeps this area vertually unknown except to trophy sheep hunting parties.

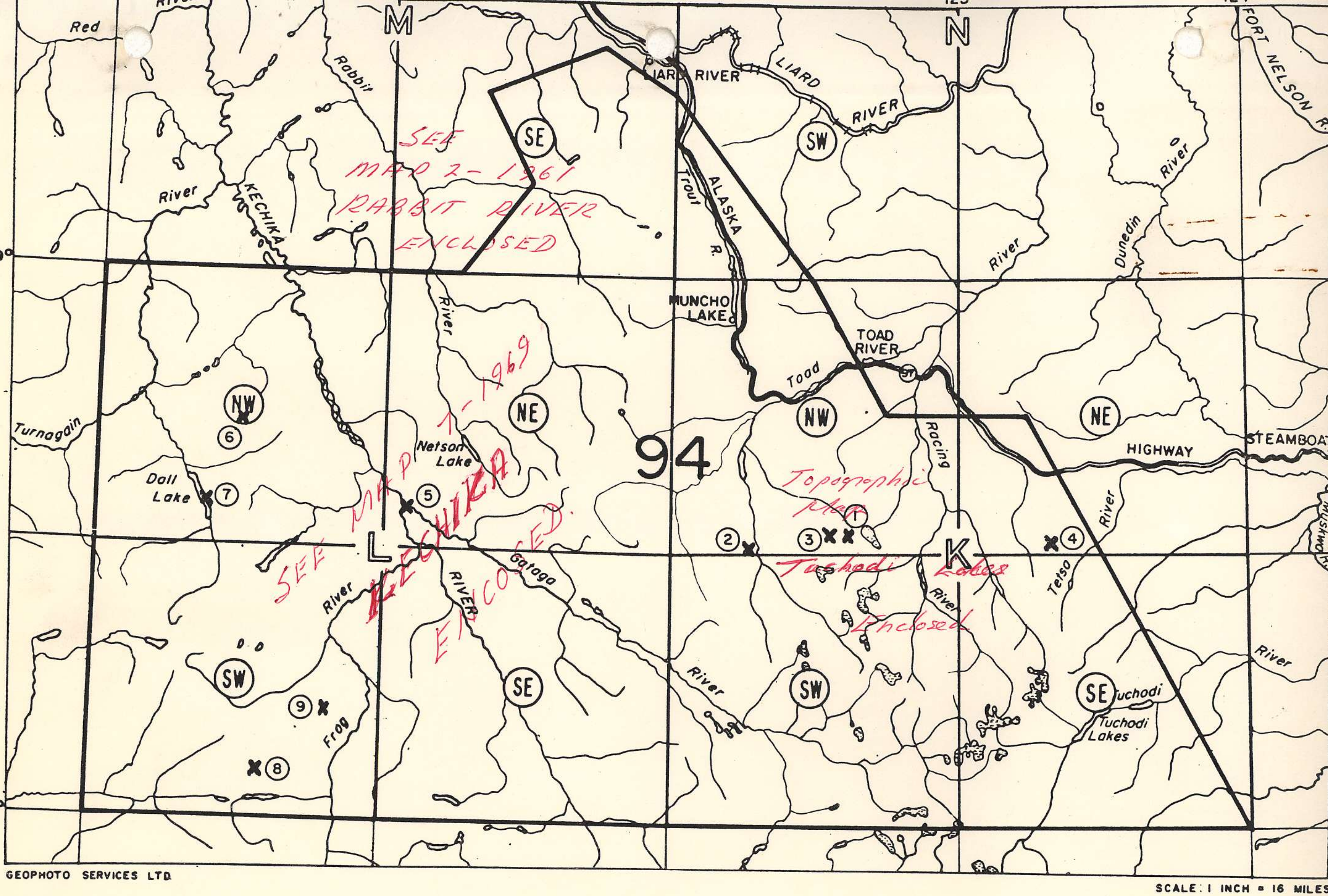
SUMMARY

The difficult accessibility, and consequent high costs of transportation are not conducive to low mining or exploration costs in this area. On top of this, Geophoto's method of approach to exploration and particularly their cartography, lead to costs which are close to double those commonly obtained by more economical operators. The area itself is known to contain a number of chalcopyrite bearing veins which are too small to be of major interest to 'Cities'. Prospecting for large base metal bodies in the lower cambrian strata along the Rocky Mountain Trench would be an attractive part of the venture, but likely impossible to split off from the whole and have completed at reasonable costs. For these reasons the project is not recommended.

R.H. Seraphim

March 14, 1969.

R.H. Seraphim.



KECHIKA RIVER AREA, B.C.

✖⑤ Area of mineral occurrence

APPENDIX 1
SUMMARY OF SOME MINERAL OCCURRENCES
IN OR NEAR
THE KECHIKA RIVER PROJECT AREA.

A brief literature survey has disclosed reports of more than ten mineral occurrences in or near the Kechika River area. All but one (occurrence 10), are shown on the accompanying index map. A brief summary of each is given below. Occurrence 10 is south of the project area.

Area 1 Churchill (Magnum Copper, N.P.L., Magnum Copper Limited, Magnum Consolidated Mining Co. Ltd., Churchill Copper Corporation Ltd).

The Magnum deposit is located at the head of the north branch of Delano Creek, about two and one-half miles southwest of Yedhe Lakes and five and one-half miles northwest of Mount Roosevelt.

An initial group of eleven claims was staked in 1957, since that time, approximately 451 additional claims have been staked.

The area in which the showings occur is underlain by late Precambrian or early Paleozoic black slate, limestone, and interbedded calcareous siltstone and slates which are folded about northwesterly trending axes. These rocks are intruded by northeasterly striking, steeply dipping diabase dykes.

Mineralization consists of chalcopyrite in quartz-ankerite fissure fillings and replacement bodies. The veins lie between two northeast striking faults, occupying northeast trending shear fractures and north striking tension fractures produced by movement of the faults. Both types of veins are discontinuous in plan, a result of the attitude and competency of the slate and siltstone between the faults. The siltstone is more highly fractured and mineralized than the interbedded slate. The veins vary in width from four to fourteen feet and may have a length of one hundred feet.

Work to the end of 1959 consisted of surface sampling, trenching and 7,376 feet of diamond drilling on 57 claims. In 1965, the group consisted of 69 claims under option to Canex Aerial Exploration Ltd., who did a limited amount of geological mapping. In 1966, the group was increased to about 467 claims. Canex carried out detailed geological studies, trenching, drove two short adits to provide drill stations, and drilled 692 feet.

Early in 1968, it was announced that Churchill Copper (Magnum Consolidated Mining) had entered into an agreement with Nippon Mining to provide further financing.

At this time the company had in excess of 600,000 tons of 4.7% copper. Work to November, 1968 has indicated approximately 1,000,000 tons of 5% copper. The company is considering establishing a 750 to 1,250 tons per day mill and a townsite.

References:

Canadian Mining Journal, November, 1968, pp. 11-12.

British Columbia Minister of Mines and Petroleum Resources,
Annual Report 1958, page 13.
Annual Report 1959, page 21.
Annual Report 1965, page 12.
Annual Report 1966, page 18.

The Mining Industry of British Columbia and the Yukon, Third Edition (Revised), January, 1968, page 25.

Area 2 Toad River (Fort Reliance Minerals Limited).

The Toad River property is situated 18 miles south of Mile 442, Alaska Highway, on the west side of the Toad River at about 4,200 feet elevation.

In 1958 and 1959, a total of 30 claims were held by Fort Reliance Minerals. Twelve of these were held by option, eighteen by location.

The area in which the showings are located is underlain by gray slate and silty argillite of late Precambrian or early Paleozoic age. These rocks are part of a succession of metamorphic rocks which occupy an area south of the Alaska Highway and extend from Toad River east to Mount Churchill and Mount Stalin. Numerous diabase dykes intrude these strata parallel to the regional cleavage. On the property, the rocks strike north and dip 12 degrees west; axial plane cleavage strikes north 30 degrees west and dips 35 degrees southwest.

Copper mineralization is localized in a shear zone which cuts, but does not offset a diabase dyke. The dyke is intruded parallel to the cleavage and the shear zone strikes north 10 degrees east and dips 70 degrees west. The mineralized part of the shear zone ranges in width from 3 to 14 feet. South of the dyke, mineralization was explored for about 600 feet, while north of the dyke the shear zone apparently dies out, and the amount of copper mineralization is small.

In the two years the property was actively explored, 3,000 feet of drilling was completed and 650 feet of the shear zone south of the dyke was explored by trenching. The results of surface work indicated that the exposed part of the shear zone south of the dyke contained 6% copper across a width of nearly 8 feet. It was discovered that up to one-half of the copper was in the form of secondary malachite. Diamond drilling, however, indicated that although the shear zone persisted at depth and maintained its width, there was little secondary malachite and less chalcopyrite than in the surface exposures.

The property has apparently been idle since 1959.

References:

British Columbia Minister of Mines and Petroleum Resources,
Annual Report 1958, page 13.
Annual Report 1959, page 19.

Holland, S.S., 1947, Lode Gold Deposits, Northeastern British Columbia and Cariboo and Hobson Creek Areas: B.C. Dept. of Mines Bull. 20, Part VI, Revised, page 10.

Area 3 Davis Keays Mining Company Ltd.

The Davis Keays copper property is located approximately three miles west of Churchill Coppers' Magnum deposit. The company controls 127 contiguous claims covering their showings.

Although little information has been published regarding the property, it appears that copper is associated with a series of quartz-carbonate veins in a geologic setting similar to that on Churchill Coppers' adjoining property. Altogether, seven veins have been discovered; six of these are parallel to one another, and have total length of one and one-half miles.

To date, work has consisted of road construction, prospecting, surface sampling, bulldozer trenching and diamond drilling. Proposed work includes driving two drifts on the Eagle vein with a view to developing most of the tonnage required for a 1,000 tons per day mill. A twenty-four man camp has been established on the property.

No published information regarding tonnage exists, but one might infer from promotional literature, the existence of 350,000 tons of 6.38% copper, and possibly 1,180,000 tons of 6.38% copper.

References:

Industrial Progress of the North, Vol. 1, no. 5, page 14, July 1968.
Vol. 1, no. 8, page 5, October, 1968.

The Northern Miner, Annual Review Number, 1968, page 101.

Area 4 Mineralization is reported in this area as follows: -

a. Mapping by the Geological Survey of Canada has disclosed minor copper mineralization associated with basic dykes cutting a Precambrian succession of carbonates, shales and quartzites south of Summit Lake.

Reference: G.S.C. Map 28-1963, MacDonald Creek.

b. Pelletier (1959) reported small showings of copper had been found southwest of Tetsa River map area.

Reference: G.S.C. Map 29-1959 - Tetsa River.

c. Bell (1968) refers to an unpublished thesis on the geology and mineralogy of a copper prospect near the Tetsa River.

Reference: Bell, R.T., 1968, Proterozoic Stratigraphy of Northeastern British Columbia, G.S.C. Paper 67-68, page 1.

Area 5

Holland (1947) stated that copper mineralization has been found near the mouth of Gataga River.

Reference: Holland, S.S., 1947, Lode Gold Deposits, Northeastern British Columbia and Cariboo and Hobson Creek Areas, British Columbia Department of Mines, Bulletin 20, Part VI, Revised, page 10.

Area 6

Chalcopyrite float and vein quartz were found by Gabrielse (1962) in Lower Paleozoic carbonates about 10 miles northwest of Mount Winston. In the same area, fluorite is found in a similar type rock.

Area 7

Gabrielse (1962) reported minor chalcopyrite in veinlets cutting Lower Cambrian limestone on the east shore of Dall Lake. This showing has been staked, but claim maps covering the area indicate they have been allowed to lapse.

Area 8

Minor copper stains are found in a north-northwesterly trending shear zone in granitic rocks near the headwaters of Jackstone Creek (Gabrielse, 1962).

Reference for Area 6, Area 7 and Area 8

Gabrielse, H., 1962, Kechika Map-Area, G.S.C. Map 42-1962.

Area 9 West Group

This property, consisting of 32 claims held by record, is located on a tributary of the Frog River, between Jackstone Creek and Frog River.

Conwest Exploration Company Limited held the property in 1959 and carried out some trenching and trail cutting. The showing is reported to have consisted of massive galena float in an area underlain by Lower Paleozoic/Precambrian schists. Gabrielse (1962) refers to the prospect as a lead-silver-copper showing.

All but three of the original claims have lapsed.

References:

Minister of Mines, Province of British Columbia, Annual Report 1959, page 18.

Gabrielse, H., 1962, Kechika Map Area, G.S.C. Map 42-1962.

Area 10 Copper King and Extension

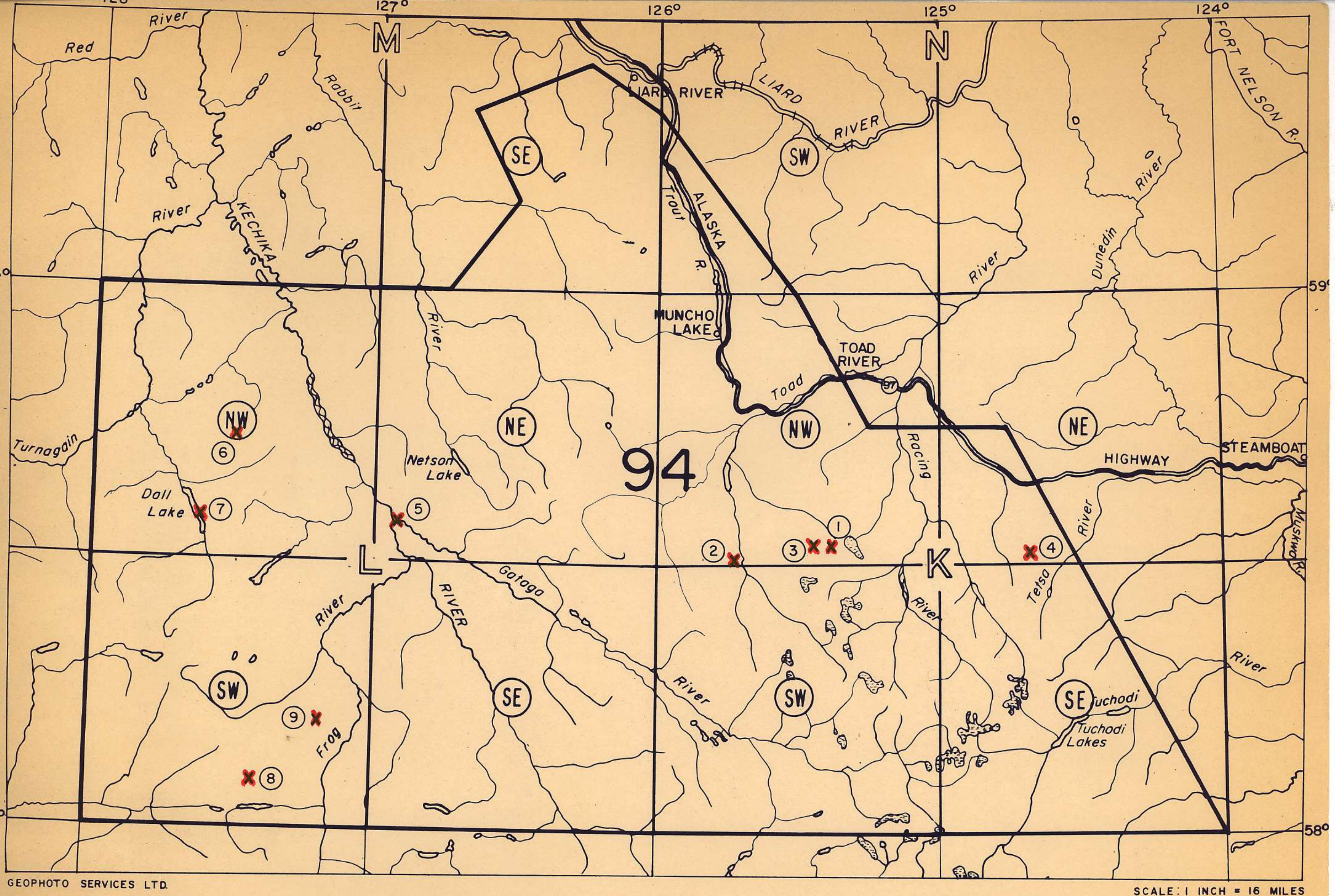
These old showings are located on the north side of Pesika Creek about 20 miles east of the Finlay River.

The showings consist of chalcopyrite, malachite and pyrite in a northwest trending quartz vein in calcareous slates and limestone. The quartz vein appears to be a zone of numerous narrow reticulating quartz veinlets which have partly or completely silicified the host rock. The vein is at least 5,000 feet long, and may be more than 100 feet wide in places. Mineralization consists of disseminated chalcopyrite, fracture fillings of chalcopyrite and massive(?) pyrite and chalcopyrite. Malachite is locally abundant.

The prospect was originally staked in the 1930's and some surface work and a small amount of underground exploration was done at that time. Unfortunately, there is no continuity of mineralization, neither is there a structural explanation for the localization of mineralization.

Reference:

Minister of Mines, Province of British Columbia, Annual Report 1951, page 118.



KECHIKA RIVER AREA, B.C.

✕ ⑤ Area of mineral occurrence

SCIENCE SERVICES DIVISION
TEXAS INSTRUMENTS
INCORPORATED

GEOPHOTO SERVICES, LTD.
world-wide natural resources evaluation

1969
PROPOSED MINERAL EXPLORATION PROGRAM
for the
KECHIKA RIVER AREA,
NORTHEASTERN BRITISH COLUMBIA.

Introduction

The purpose of the proposed exploration program is to locate and stake mineral claims utilizing a reconnaissance geochemical survey augmented by previously compiled detailed photogeologic maps.

The Kechika River area embraces an area of 9,500 square miles. It is envisaged that a sufficient number of samples will be collected during the survey to yield a statistical probability of outlining areas of economic interest.

Reconnaissance geochemical sampling of a large area is an effective method of prospecting which has been pioneered and developed by Geophoto geologists in previous programs of this type. Experience so gained has been applied to the planning of this program, so as to increase both efficiency and effectiveness.

Detailed photogeologic mapping has proved to be a most useful aid in the past. The comprehensive knowledge of geology and topography gained through the mapping is particularly valuable. In addition, the detailed drainage maps eompiled from the aerial photographs are indispensable in the field operations.

A helicopter will be chartered for approximately three months, beginning in early June. It will be used for the collection of stream sediment samples and later ground follow-up of anomalies. Fixed-wing aircraft will be used periodically for camp moves, personnel transport, supply trips and establishing gas caches.

Access and Topography

Easy access to the area is gained only by the Alaska Highway, which crosses the northeastern part of the area, some 120 miles west of Fort Nelson.

Topography within the area varies from moderately to extremely rugged. West of the Rocky Mountain Trench, the topography is relatively subdued, with mountain peaks reaching 7,900 feet elevation and a local relief of approximately 3,000 feet. This is in direct contrast with the extremely mountainous nature of the

706 Sixth Street S.W. Calgary, Alberta, Canada 403/266-8661

terrain east of the Trench. Here, relief approaches 6,000 feet and elevations in excess of 9,000 feet are common. For the most part, elevations within the area are between 3,000 and 6,500 feet. Much of the area lies above the timberline, which occurs at 4,500 to 5,000 feet. Small alpine glaciers are restricted to the higher ranges south of the Racing River and southwest of the Kechika River.

Geology

The Kechika River area includes parts of four major geologic units. From east to west, these are: an area of Paleozoic and older carbonates and clastics, the Rocky Mountain Trench, a belt of Precambrian metamorphic rocks, and part of the Cassiar Batholith.

The Rocky Mountain Trench is the singular major structural feature in the area. Physiographically, it separates the Cassiar Mountains on the west from the Rocky Mountains on the east. Mapping by the Geological Survey of Canada has shown that the trench is a locus of faulting which separates the complexly deformed sedimentary and metamorphic rocks of the Cassiar Mountains from the highly deformed, but more continuous, units in the Rocky Mountains. Except for marking the eastern boundary of large areas of igneous and metamorphic rocks, the Trench does not separate distinctive rock- or time-stratigraphic units. Neither does it interrupt structural grain inasmuch as a wide belt of Lower Paleozoic rocks crosses the Trench in the central and northern part of the area.

The Cassiar Batholith underlies the extreme southwestern part of the area, intruding a metamorphic assemblage of possible Precambrian age and a Paleozoic carbonate sequence.

The area east of the Trench is underlain by Lower Paleozoic clastics and carbonates which are, in part, an extension of similar rocks outcropping west of the Trench. Small areas of volcanic and igneous rock have been mapped immediately north of the proposed area, in the vicinity of Fishing Lake.

The area east of longitude 126°W is largely unmapped by the G.S.C. except for two small map sheets at a scale of 1 inch to 1 mile. Part of one of these map sheets lies within the proposed exploration area. It is known, however, that this region is underlain by Middle Devonian carbonates, undivided Paleozoic rocks which are an extension of similar units to the north and west, and Precambrian carbonates and shales. All of these units are highly folded and/or faulted.

The eastern boundary of the Kechika River area is more or less coincident with the boundary between the Foothills and the Rocky Mountains structural provinces.

Several mineral occurrences are known within the project area. These are mainly copper showings, although galena has been reported in the past. Deposits of barite and fluorite, in some instances associated with copper showings, are fairly common throughout the area.

In general, the proposed area has been less prospected than other areas to the west and north. This is the result of relative inaccessibility and a long standing, but false, belief that the Cordillera east of the Rocky Mountain Trench is generally barren of economic mineral deposits due to a lack of intrusions. However, there are in excess is forty reported mineral occurrences east of the Trench. Several of these are within the project area; two are in or near the advanced development stage.

For example, Churchill Copper Corporation has announced that it is considering a 750 to 1,250 tons per day production unit on its Magnum property, 100 miles west of Fort Nelson, British Columbia. Development work to the end of 1967 had indicated reserves of one million tons of 5% copper.

The diversity of geologic conditions, coupled with known mineral occurrences, indicates a highly favourable area for the type of exploration program proposed.

Photogeology

Approximately 3,000 air photos will be used in a photogeologic study to supplement information from published geologic maps and extend geologic coverage to presently unmapped areas. At the same time, detailed drainage maps will be compiled at a scale of 1 inch to 1 mile to serve as bases for plotting geochemical field data. A composite photogeologic map at a scale of 1 inch to 4 miles will be made from the individual 1 mile geologic maps.

In addition, a complete survey of available literature will be made with attention given to all reported mineral occurrences. Combined with the photogeology, this will result in delineating areas of specific interest which will receive particular attention in the field operations.

Field Work

It is proposed to carry out a field program commencing in mid-June, 1969. The party will include three Geophoto geologists, a helicopter pilot, flight engineer and a cook. A Bell G3-B1 helicopter and a truck will be used for transportation during field operations. Additional support will be rendered by fixed-wing aircraft when necessary. Gas caches will be established at appropriate locations to increase the efficiency of the helicopter operations.

The technique to be used for locating areas of economic interest is reconnaissance geochemical surveying which involves landing at or near streams for the collection of stream sediment samples. Accessible main streams and tributaries will be sampled at the rate of one hundred to one hundred and fifty samples per day, depending on weather and terrain conditions. The samples are tested at the base camp using cold extraction techniques. Bloom's Total Heavy Metal Test is performed on all samples, Holman's Copper Test on those that are high in the THM test. Streams which contain anomalously high amounts of metals are traversed on foot by a geologist to find the cause of the anomaly.

From previous programs, it is estimated that at least 5,000 samples will be collected during the field operations. Following analysis for cold extractable copper, lead and zinc, all samples will be dried and stored for possible further use.

In the event that areas of economic interest are located, they will be protected by a reasonable amount of staking. Subsequent work, in the form of detailed investigations and possible development, is considered to be a subsequent phase of this proposal and is therefore not included in the costs.

Costs

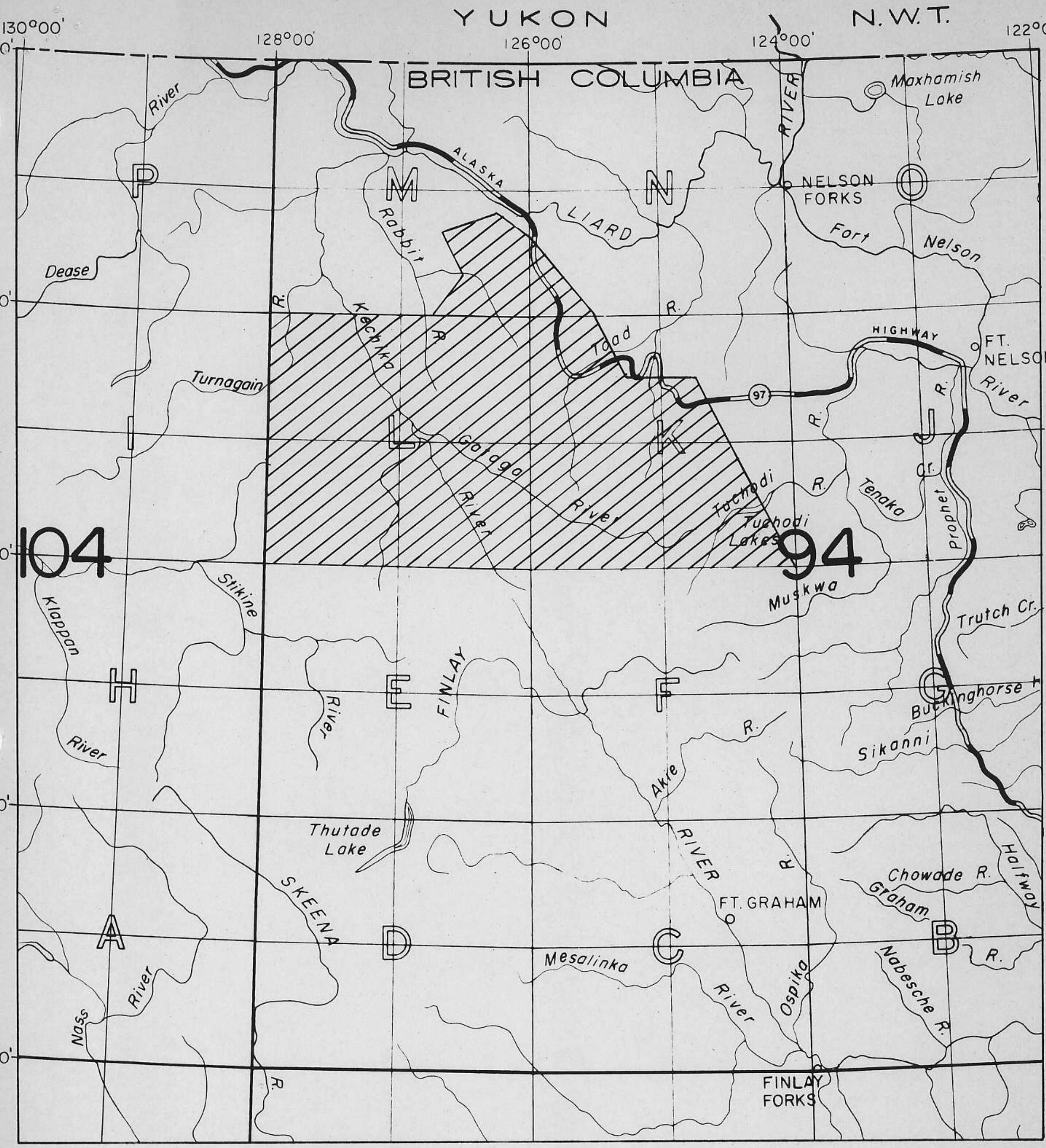
The estimated costs of the program are as follows:

1. Office

Pre-Field:	Photogeologic study, base map preparation and detailed research.	
Post - Field:	Map compilation and comprehensive report	$ 46,200.00

2. Field

Professional fees, helicopter and fixed-wing charter, chemicals, living expenses, etc.	119,800.00
	$ 166,000.00



INDEX MAP
OF
PHOTOGEOLOGIC & GEOCHEMICAL PROGRAM

KECHIKA RIVER AREA

N. CENTRAL BRITISH COLUMBIA

Project Area

GEOPHOTO SERVICES LTD.

SCALE: 1 INCH = 40 MILES

MINERAL EXPLORATION PROGRAM
GEOPHOTO SERVICES, LTD.

PHASE I (FIRST YEAR)
Geochemical Reconnaissance Exploration

PRE-FIELD

Mosaics
Drainage Maps
Photogeologic Evaluation

FIELD

Geochemical Sampling
- Cold Extraction Assays

Surface Examination
- Samples for Lab Assay

Claim Staking

POST-FIELD

Compilation of Data
- Hot Extraction Assays
- Spectrographic & Chemical Assays

Interpretation of Data
Report - Recommendations

PHASE II (SECOND YEAR)
Detailed Claim Evaluation

PRE-FIELD

Preparation of Topo Maps
- Scale 1" = 400'
- Contour Interval 50'

Mineral Studies
- Binocular Microscope
- Microchemical Tests
- Custom Assays

Petrographic Studies
- Petrological Microscope

FIELD

Detailed Surface Mapping
- Trenching & Sampling

Detailed Geochem Surveys
- Cold Extraction Assays

Geophysical Surveys
- Magnetometer
- Induced Polarization
- E.M.

Packsack Diamond Drilling
- Core for Assay

Additional Staking

POST-FIELD

Compilation of Data
- Hot Extraction Assays
- Spectrographic & Chemical Assays

Interpretation of Data
Report - Recommendations

PHASE III (THIRD YEAR)
Pre-Production Evaluation

PRE-FIELD

FIELD

Diamond Drilling
- Core for Assay

POST-FIELD

Compilation of Data
- Core Assays

Interpretation of Data
Services Studies
- Accessibility
- power, water, wastes
- plant location
- mining feasibility
- production economics

Report - Recommendations

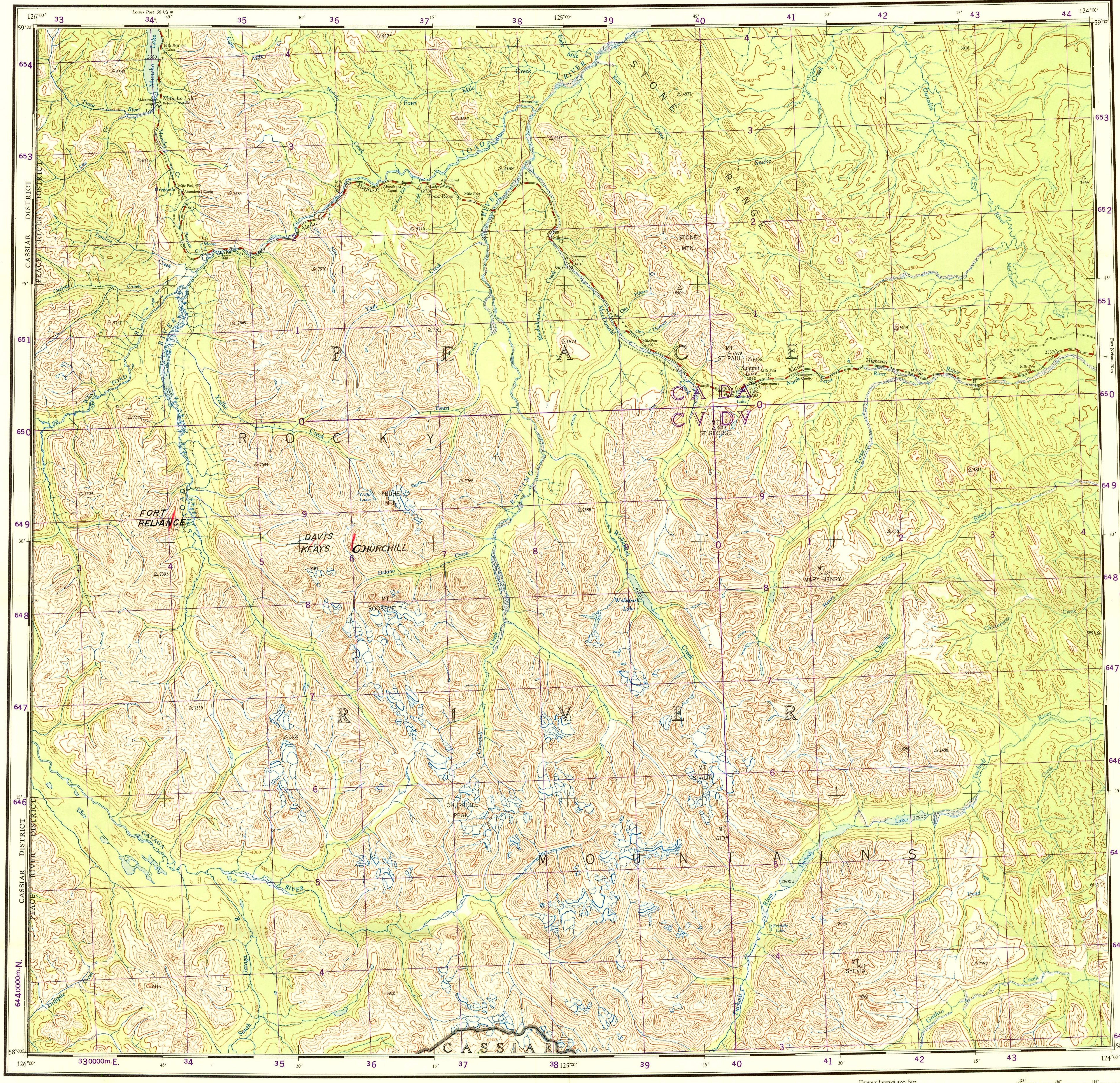
NATIONAL TOPOGRAPHIC SERIES

DEPARTMENT OF NATIONAL DEFENCE
ARMY SURVEY ESTABLISHMENT

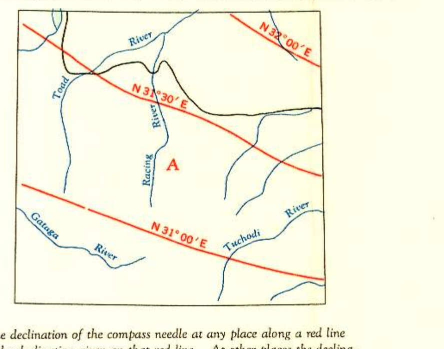
FIRST EDITION

Refer to this Map as :	94 K EDITION 1 ASE SERIES A 502

CANADA SHEET 94 K



THE DECLINATION OF THE COMPASS NEEDLE, 1954

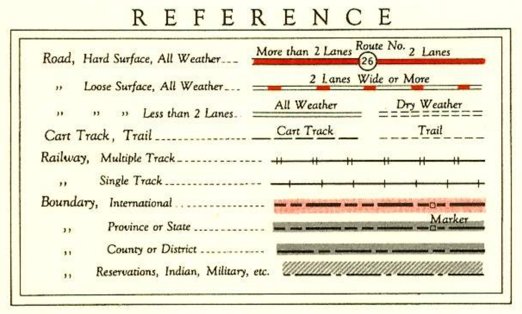


The declination of the compass needle at any place along a red line is the declination given on that red line. At other places the declination is between those given on the neighbouring red lines; thus at the place marked A, the declination is between N. 31°E. and N. 31°30′ E. The easterly declinations of the compass needle are decreasing 5 minutes annually.

Surveyed, compiled, drawn and printed by the ARMY SURVEY ESTABLISHMENT R.C.E., 1949-54
Aerial photography by the R.C.A.F. 1948

Universal Transverse Mercator Projection.

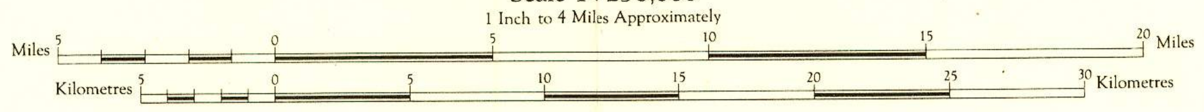
REFERENCE



TUCHODI LAKES

BRITISH COLUMBIA

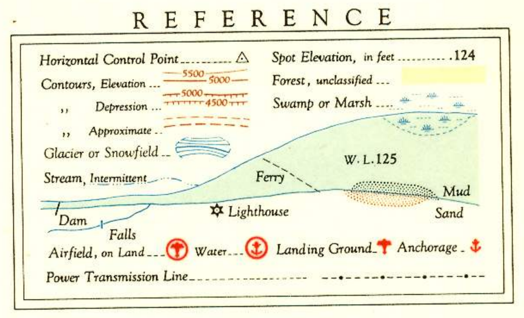
Scale 1 : 250,000
1 Inch to 4 Miles Approximately

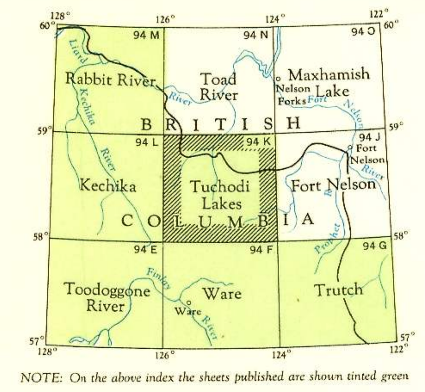


Contour Interval 500 Feet
All Elevations in Feet above Mean Sea Level.

North American Datum 1927
Preliminary 1951

REFERENCE

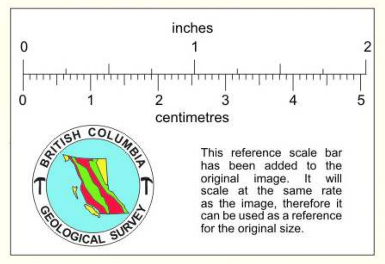




NOTE: *On the above index the sheets published are shown tinted green*

GRID ZONE DESIGNATION 10 V	TO GIVE A STANDARD REFERENCE ON THIS SHEET TO NEAREST 1,000 METERS			
100,000 M. SQUARE IDENTIFICATION	SAMPLE POINT: HORIZONTAL CONTROL			
CA DA / CV DV 650 40	1. Read letters identifying 100,000 meter square in which the point lies:	CV		
	2. Locate first VERTICAL grid line to LEFT of point and read LARGE figure labeling the line either in the top or bottom margin, or on the line itself:		8	
	Estimate tenths from grid line to point:		5	
	3. Locate first HORIZONTAL grid line BELOW point and read LARGE figure labeling the line either in the left or right margin, or on the line itself:			8
	Estimate tenths from grid line to point:			9
IGNORE the SMALLER figures of any grid number; these are for finding the full coordinates. Use ONLY the LARGER figures of the grid number; example: 330000m.E.	SAMPLE REFERENCE:	CV 85 89		
	If reporting beyond 18° in any direction, prefix Grid Zone Designation, as: 10VCV8589			

TEN THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 10



This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

TUCHODI LAKES
SHEET 94 K
FIRST EDITION

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PRELIMINARY SERIES

SHEET 94 M

LEGEND

CENOZOIC

QUATERNARY
13 Glacial till, gravel, sand, and silt; lake clay

TERTIARY
12 Coal and clay

PALAEOZOIC

MISSISSIPPIAN
LOWER MISSISSIPPIAN
11 Limestone, chert-nodule limestone, sandstone, siltstone; minor black, calcareous argillite, slate, and sandy limestone

DEVONIAN AND MISSISSIPPIAN
UPPER DEVONIAN AND MISSISSIPPIAN
10 10a, grey and black shale, slate, argillite, siltstone, sandstone; 10b, hard grey sandstone, siltstone, slate, and quartzite; grit, pebble conglomerate, greywacke, calcareous shale; may be in part older and correlative with 1b; 10c, black slate, grey slate, sandstone, limestone

DEVONIAN
MIDDLE DEVONIAN
8 Upper unit: grey and dark grey, fetid, fossiliferous limestone
Lower unit: grey and dark grey, fetid dolomite and calcareous dolomite; may locally include 6

LOWER DEVONIAN (?)
7 Buff, orange, and yellow limestone breccia and conglomerate; minor laminated, light grey dolomite

6 Well-bedded, dark and light grey dolomite; minor buff argillaceous and calcareous siltstone; may include some 5

SILURIAN
MIDDLE SILURIAN
5 Grey and black, fetid, fossiliferous dolomite; cherty dolomite, calcareous dolomite; minor limestone, sandstone

9 Undivided

CAMBRIAN AND (?) ORDOVICIAN
4 Thin-bedded, grey and buff, argillaceous limestone and calcareous phyllite; greenstone sills and dykes; mainly Upper Cambrian (?); may include some infolded younger rocks

CAMBRIAN
LOWER CAMBRIAN
3 3a, light grey, well-bedded to massive limestone; includes sandy and argillaceous beds near Gundahoo River; 3b, quartzite, minor slate and shale; 3c, quartzite-pebble and cobble conglomerate; buff and reddish brown sandstone, siltstone, and argillite

PRECAMBRIAN AND PALAEOZOIC

CAMBRIAN AND EARLIER
2 Quartzite-pebble and cobble conglomerate; dark-weathering, laminated argillite, siltstone, sandstone, and sandy limestone; buff, brown, and reddish sandy dolomite; crossbedded, dolomitic sandstone and pebble conglomerate; quartzite; argillaceous sandstone, siltstone, and limestone; black argillite

CAMBRIAN AND/OR EARLIER
1 1a, impure grey and green quartzite, siltstone, sandstone, and argillite; brown and black, laminated siltstone; quartz-pebble conglomerate; minor limestone conglomerate; gabbroic sills and dykes; 1b, may be younger and correlative to part of 9b

Geological boundary (defined, approximate or assumed)
Limit of geological mapping, unmapped area
Bedding (inclined, vertical, overturned)
Cleavage (inclined, vertical)
Fault (defined, approximate, assumed)
Fault (direction of dip, downthrown side)
Anticline (defined, approximate)
Syncline (defined, approximate)
Anticline, (overturned)
Glacial striae, drift ridge or rock groove (showing direction of ice-movement)
Fossil locality
Mineral occurrence (barite, ba(b); witherite, ba(w); fluorite, fl)

Geology by H. Gabrielse, 1958 and 1960

Cartography by the Geological Survey of Canada, 1961

Base-map prepared by the Surveys and Mapping Branch 1952, and partially revised 1960. Minor additions and alterations by the Geological Survey of Canada, 1961.

Air photographs covering this area may be obtained through the National Air Photographic Library, Topographical Survey, Ottawa

In response to public demand for earlier publication, Preliminary Series maps are issued in this simplified form and will be clearer to read if all or some of the map-units are hand-coloured

Adjoins Map 1954-10, "McDame"

Adjoins Map 57-1959, "Kechika"

PUBLISHED, 1961

PRINTED BY THE SURVEYS AND MAPPING BRANCH

DESCRIPTIVE NOTES

The Alaska Highway and Smith River Road provide access to the northern and eastern parts of the map-area. Good pack-train routes lead westerly from the Alaska Highway into Terminal Range. The southwestern part of the area can be reached by the Davie Trail which runs southeasterly from Lower Post, 37 miles to the northwest, or via the trail that runs from the mouth of Turnagain River to McDame Post on Dease River. Large burned areas make foot travel extremely difficult in many parts of Liard Plain. Liard River is easily navigated downstream from a point 3 miles southeast of the mouth of Coal River, but upstream from this point the river contains numerous dangerous rapids. Lower Kechika River includes several hazardous stretches that are best navigated during high water. Landings can be made by small float-equipped aircraft on parts of Liard, Kechika, and Coal Rivers and on numerous lakes throughout the area.

Cambrian and Precambrian rocks (2), more than 3,000 feet thick, outcrop in a northwesterly plunging anticlinorium in Terminal Range. The succession is dominantly clastic and includes a coarse conglomerate member as much as 700 feet thick. West of Gundahoo River a conspicuous Lower Cambrian limestone member (3a) is underlain by a thick succession of impure clastic rocks (1a) that are cut by numerous gabbroic sills and dykes. In the southwestern part of the map-area Lower Cambrian rocks (3a, 3b) include a lower quartzite member and an upper limestone member, each more than 1,000 feet thick. Clastic Lower Cambrian strata (3c) including coarse conglomerate are either overturned or are thrust easterly over Silurian dolomites (5) 4 miles southeast of Smith River airport. Similar rocks are overlain unconformably by Silurian beds (5) 7 miles southsouthwest of the airport. Impure clastic rocks (1b), including quartz-pebble conglomerate and phyllitic slate, east of Tatisno Creek in the northwestern part of the area have not been satisfactorily dated but are tentatively correlated with the Cambrian and/or Precambrian strata south and west of Gundahoo River.

A thick sequence of incompetent calcareous and argillaceous strata of Cambro-Ordovician age (4) are well exposed in the Kechika Ranges and in the northern Rocky Mountains. These rocks also outcrop along Liard River near Leguil Creek and south of the mouth of Coal River, and, locally, along Coal River.

Silurian and Devonian strata (5-9) are widespread in the northern and eastern parts of the map-area. The Middle Silurian unit (5) and the upper member of the Middle Devonian unit (8) are highly fossiliferous, but the intervening beds (6, 7) contain few fossils. An early Devonian age for map-unit 6 is based on the presence of fish fragments. Although the base of the succession is marked by an unconformity the mutual relations between the four units are not known. Estimated thicknesses for the constituent map-units are as follows: Middle Silurian (5), 1,000-1,700 feet, including basal sandstone 10-150 feet; Lower Devonian(?) (6), 1,600-1,700 feet; Lower Devonian(?) (7), 500 feet; and Middle Devonian, 1,600+ feet.

Clastic Devono-Mississippian strata (10a) disconformably overlie Middle Devonian carbonate rocks (8) north of Liard Hotsprings, and are in fault contact with similar rocks southwest of Liard River in the same area. Greywacke and greywacke conglomerate (10b) of probable Devono-Mississippian age outcrop near the mouths of Rabbit and Kechika Rivers. Included with these rocks, however, are hard, arenaceous and argillaceous rocks that may be older. Highly contorted, locally calcareous, clastic rocks (10c) along lower Turnagain, Kechika, and Red Rivers, are tentatively dated as Devono-Mississippian. The relationship of black slate and argillite (10a) exposed along Coal River about 7 miles north-northwest of its mouth—to carbonate rocks exposed nearby—is not known.

Lower Mississippian strata (11), tightly infolded in Cambro-Ordovician strata (4) north of Turnagain River, include a basal unit of sandstone and siltstone as much as 300 feet thick, and an overlying carbonate unit more than 900 feet thick.

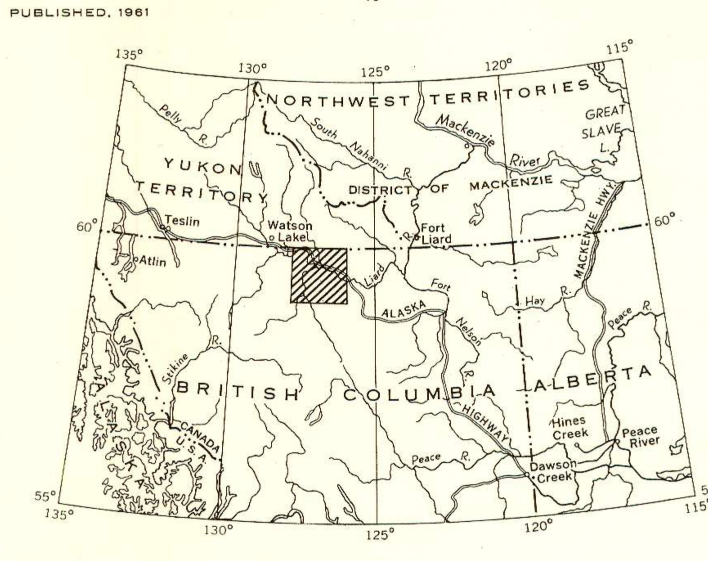
Coal and clay of Tertiary age (12) form small outcrops on the west bank of Coal River about 3 miles north of the bridge.

Much of Liard Plain is underlain by thick glacial, glacio-fluvial, and fluvial deposits.

During Pleistocene time an ice-sheet advanced northeasterly and easterly from the Cassiar Mountains across most of the map-area. No evidence was obtained to suggest that the ice covered the higher mountains south of Gundahoo River and those in Terminal Range south of latitude 59°20′. Glacial erratics occur on Mount Halkett at an elevation of about 5,000 feet. Drumlinoid ridges, glacial grooves, eskers, and kettles are abundant in Liard Plain. Glacial-lake silts are well exposed in the valley of Kechika River west of Gemini Lakes and in the valley of Rabbit River near the mouth of Gundahoo River. Easterly trending abandoned channels are deeply incised in bedrock east of Coal River. These and other less-spectacular channels in Liard Plain were apparently cut by streams that were diverted by ice occupying parts of the valleys of Kechika, Liard, lower Coal, and lower Smith Rivers.

In general, the structural trends south of Liard River are northwest whereas the trends north of the river are north to northeast. Major southwest-dipping thrust faults along Liard River southwest of Liard River bridge separate the two areas of different structural trends. Cambrian and/or Precambrian strata (1a) have been thrust northeasterly over Cambro-Ordovician strata (4) west and south of Long Mountain. Rocks immediately east of the fault have been deformed into a northwesterly plunging syncline, overturned to the northeast. Except near faults, the rocks north of Liard River occur in relatively simple, open folds. Strata in the northern Rocky Mountains, on the other hand, are more tightly folded and have been involved in overturning and thrusting to the northeast. Rocks of Cambrian and/or Precambrian age (1a, 1b) near Gundahoo River and east of Tatisno Creek have been tightly folded and the latter locally exhibit plunging folds overturned to the north. Most of the thin-bedded, incompetent rocks are tightly folded. In particular, strata along Kechika, Turnagain, and Red Rivers have been intensely contorted.

Placer gold has been obtained from bars along Liard River but most of this mining activity was carried on during the latter part of the nineteenth century. A barite, witherite, and fluorite deposit has been explored about 2 miles north of Liard River bridge. The mineralized zone occurs along and near a gently dipping contact between Middle Devonian carbonate rocks and overlying Devono-Mississippian clastic rocks.



INDEX MAP

MAP 2-1961
GEOLOGY
RABBIT RIVER
BRITISH COLUMBIA

Scale: One Inch to Four Miles = $\frac{1}{253,440}$

Miles

4 2 0 4 8 12

Geographical names subject to revision

COPIES OF THIS MAP MAY BE OBTAINED FROM THE DIRECTOR, GEOLOGICAL SURVEY OF CANADA, OTTAWA

inches
0 1 2
0 1 2 3 4 5
centimetres

BRITISH COLUMBIA GEOLOGICAL SURVEY

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

LEGEND

Highway	97
Road and buildings	
Trail	
District boundary	
Intermittent stream	
Marsh	
Fall and rapid	F. R.
Contours (interval 500 feet)	2500
Height in feet above mean sea-level	2454

Approximate magnetic declination, 31° 44′ East

MAP 2-1961
RABBIT RIVER
BRITISH COLUMBIA
SHEET 94 M

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PRELIMINARY SERIES

SHEET 94 L

LEGEND

CENOZOIC

QUATERNARY
PLEISTOCENE AND RECENT

13 — Glacial till; gravel, sand, and silt; lake clay

TERTIARY (?)

12 — Glassy, pisolitic, brecciated rhyolite

MESOZOIC

CRETACEOUS (?)

11 — Mainly biotite quartz monzonite and granodiorite

JURASSIC (?)

10 — Chert-pebble conglomerate, sandstone, argillite, vesicular lava, agglomerate

TRIASSIC (?)

9 — Massive greenstone; 9a, bleached and pyritized volcanic rocks; may include some sedimentary rocks

PALAEOZOIC

PERMIAN (?)

8 — Greenstone, limestone; minor hornfels

MISSISSIPPIAN
LOWER MISSISSIPPIAN

7 — Limestone, chert-nodule limestone, chert

DEVONIAN AND MISSISSIPPIAN
UPPER DEVONIAN AND LOWER MISSISSIPPIAN

6 — 6a, argillite, siliceous argillite, chert; 6b, agglomerate, vesicular greenstone, tuff; may be younger or older

SILURIAN
MIDDLE SILURIAN

5 — Dolomite, chert-nodule dolomite, sandstone, quartzite; 5a, may include some 4; 5b, impure siltstone, age not definitely established

CAMBRIAN AND ORDOVICIAN

4 — Limestone, phyllitic limestone, calcareous phyllite, phyllite, argillite, sandstone; slate, black shale; includes sills and dykes of greenstone; 4a, may include younger rocks; 4b, may include younger and older rocks

CAMBRIAN
LOWER CAMBRIAN

3 — Limestone, dolomite; minor slate and shale; 3a, may be Precambrian; 3b, limestone, limestone conglomerate, phyllitic limestone, calcareous phyllite; age not definitely established

PRECAMBRIAN

CAMBRIAN AND/OR PRECAMBRIAN

2 — 2a, quartzite, pebble conglomerate, siltstone, slate, shale; Lower Cambrian; 2b, sandstone, quartzite, argillite, slate, quartz-pebble conglomerate, limestone conglomerate

PRECAMBRIAN

1 — Limestone, quartzite, phyllite, schist, slate, argillite; includes small sills and dykes of greenstone; may include some Cambrian rocks

METAMORPHIC ROCKS

A — Calcareous phyllite, phyllite, micaceous quartzite, schist, granitic gneiss, crystalline limestone, limestone, greenstone, pegmatite, hornfels; may be Cambro-Ordovician and older

Geological boundary (defined, approximate, assumed)

Limit of geological mapping

Bedding (inclined, vertical, overturned)

Schistositv and gneissosity (inclined, vertical, dip unknown)

Fault (defined, approximate, assumed)

Fault (inclined, arrows indicate relative movement)

Anticline (defined, approximate)

Syncline (defined, approximate)

Anticline, syncline (overturned)

Glacial striae, drift ridge or rock groove (showing direction of ice movement)

Fossil locality . . . Ⓕ

Mineral prospect or occurrence . . . X Cu

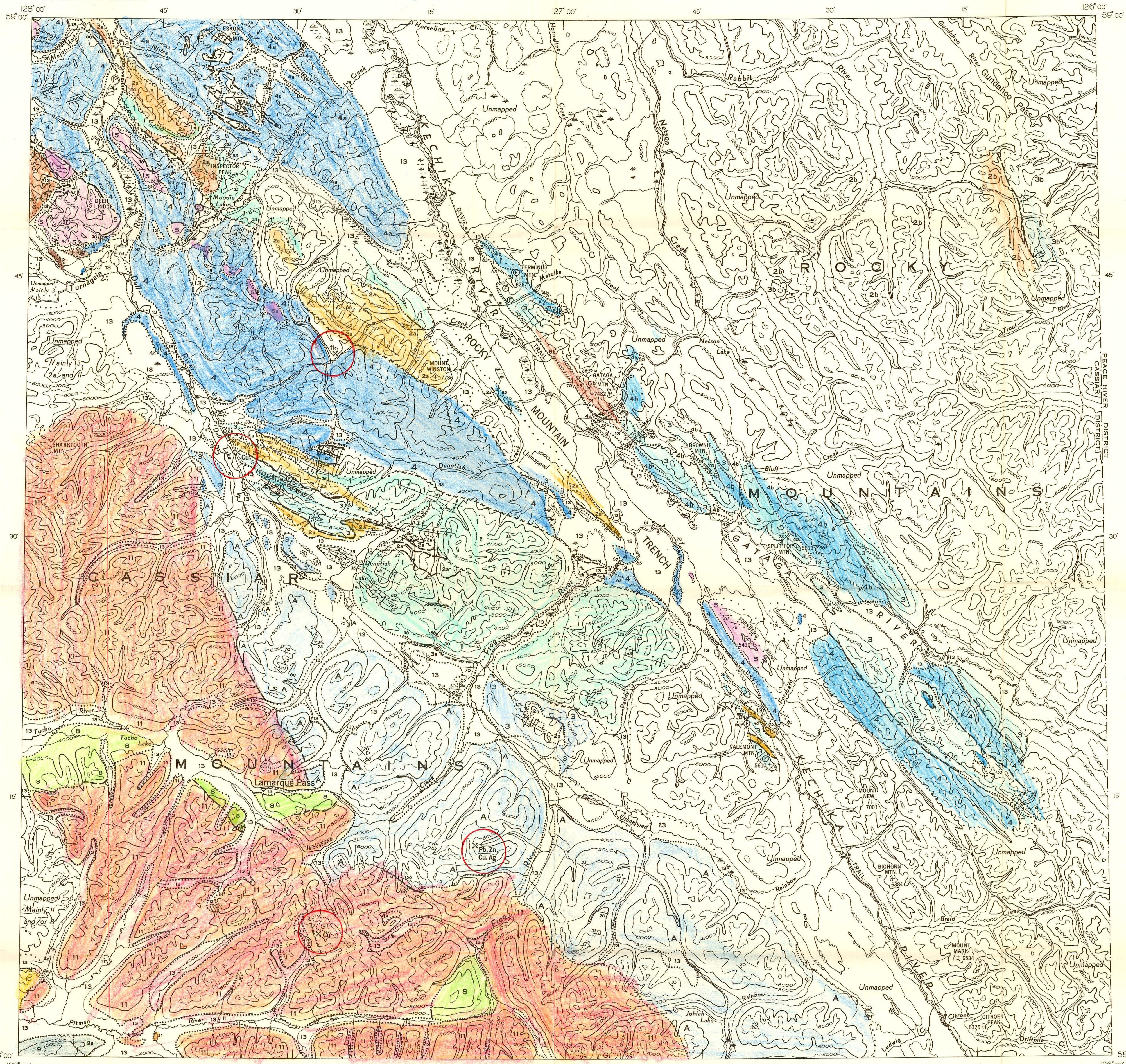
Mineral Symbols

Copper . . . . Cu	Lead . . . . . Pb
Fluorite . . . . fl	Silver . . . . . Ag

Geology by H. Gabrielse, 1957, 1958, 1959

In response to public demand for earlier publication, Preliminary Series maps are issued in this simplified form and will be clearer to read if all or some of the map-units are hand-coloured

Air photographs covering this area may be obtained through the National Air Photographic Library, Topographical Survey, Ottawa



PUBLISHED, 1960
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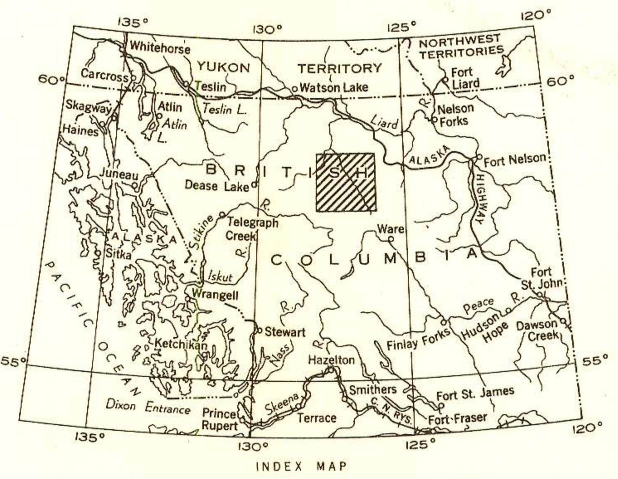
PRINTED BY THE SURVEYS AND MAPPING BRANCH



INDEX MAP

MAP 57-1959
GEOLOGY
KECHIKA
CASSIAR DISTRICT
BRITISH COLUMBIA

Scale: One Inch to Four Miles $= \frac{1}{253,440}$

Miles

4 2 0 4 8 12

inches 0 1 2

centimetres 0 1 2 3 4 5

BRITISH COLUMBIA GEOLOGICAL SURVEY

This reference scale bar has been added to the original image. It will scale at the same rate as the image, therefore it can be used as a reference for the original size.

LEGEND

Cabin

Trail

Intermittent stream

Marsh

Glacier

Contours (interval 1,000 feet) . . . 5000

Height in feet above mean sea-level . . . + 6375

Cartography by the Geological Survey of Canada, 1960

Approximate magnetic declination, 30° 50' East

MAP 57-1959
KECHIKA
BRITISH COLUMBIA
SHEET 94 L

DESCRIPTIVE NOTES

Long pack-train routes lead to the map-area from the Alaska Highway, McDame Post, Dease Lake, and Fort Ware. Good horse-trails are abundant except southwest of the Dall Lake-Ludwig Creek valley. Kechika River, Gataga River up to the rapids about $2\frac{1}{2}$ miles below Through Creek, and Frog River up to Jackstone Creek are all navigable. Boats brought upstream from mile 539.3, Alaska Highway, however, must pass hazardous stretches on Liard River and lower Kechika River. Numerous lakes and parts of Kechika and Gataga Rivers can be used by float-equipped aircraft based at Watson Lake, Yukon Territory, and wheel-equipped aircraft have landed in a large meadow in the Rocky Mountain Trench west of Terminus Mountain.

The Rocky Mountain Trench separates the Cassiar Mountains to the southwest from the Rocky Mountains to the northeast. The divide between Pacific and Arctic drainage winds irregularly through the southwest part of the map-area.

A metamorphic terrain (A), lying between the Dall Lake-Ludwig Creek valley and the Cassiar batholith (11), includes three units of lithologically contrasting rocks. Southwesterly from a point about 10 miles south of the upper end of Dall Lake, a band of granitic gneiss as much as 2 miles wide flanks the eastern contact of the Cassiar batholith. The granitic gneiss is bordered to the northeast by a belt of gneissic feldspathic quartzite, quartzite, schist, and crystalline limestone that attains a maximum width of about 8 miles north and south of Rainbow River. These rocks grade easterly into calcareous phyllites, phyllitic limestones, and limestones forming a belt as much as 6 miles wide along Jackstone Creek. The phyllitic rocks contain some greenstone bodies, and in general resemble rocks of Cambrian and Ordovician age to the northwest in Cry Lake map-area.

Well-bedded Precambrian strata (1), probably more than 3,500 feet thick, outcrop in two southeasterly trending belts between the Rocky Mountain Trench and the Dall Lake-Ludwig Creek valley. Limestone predominates in the exposures along Frog River, whereas schist, phyllite, and impure quartzite are the most abundant rocks near Moodie Lakes.

A thick sequence of well-bedded, clastic sedimentary rocks (2b), underlying an extensive area northeast of Netson Lake, may be of Cambrian and/or Precambrian age.

Lower Cambrian strata (2a, 3) east and southeast of Dall Lake comprise a lower quartzite unit (2a) as much as 2,000 feet thick and an upper, fossiliferous limestone unit (3) at least 1,000 feet thick. These rocks are apparently conformable with underlying Precambrian rocks and the boundary has been drawn arbitrarily at the top of a conspicuous red and green slate and shale sequence. Near Hizaza Creek the upper part of the quartzite unit contains much argillite and impure, dark-weathering quartzite, whereas the lower part consists essentially of white, vitreous quartzite.

Prominent limestone ribs (3) east of Kechika River and along Gataga River are believed to be of Lower Cambrian age although fossils have been found only on Terminus Mountain. These rocks include minor amounts of sandstone, quartzite, and argillite. Calcareous rocks on the limbs of the anticlinorium northeast of Netson Lake may be of Cambrian age but conclusive evidence has not been obtained.

Thin-bedded, incompetent strata of Cambrian and Ordovician age (4), at least 2,500 feet thick and possibly more than 5,000 feet thick, are widespread in the northwestern and eastern parts of the map-area. Both older and younger rocks may be included in this unit in the structurally complex area between Kechika and Gataga Rivers and the Netson Lake valley.

Near Turnagain River Middle Silurian rocks (5), more than 1,500 feet thick, overlie disconformably Cambrian and Ordovician strata (4). Well-bedded, impure siltstones underlying part of Forsberg Ridge may be of the same age but conclusive evidence for this is lacking.

Devonian and Mississippian rocks (6) overlie unconformably Silurian rocks northwest of Turnagain River. Volcanic rocks (6b) of possible Devonian and/or Mississippian age are preserved in a northeasterly overturned syncline on Gataga Mountain.

Northwest of Moodie Creek fossiliferous carbonate rocks of Mississippian age (7) occur as tight infolds in the underlying strata (4a).

Greenstone and hornfels of Permian (?) age (8) form a belt of rocks that trends easterly through the Cassiar batholith (11) south of Tucho Lake and Lamarque Pass. Greenstone and minor limestone outcrop in the southern part of the map-area west of Frog River.

In the southwesternmost part of the map-area two small areas are underlain by Mesozoic volcanic and sedimentary rocks (9, 10)

Cretaceous (?) granitic rocks (11) of the Cassiar batholith occupy much of the southwestern part of the area.

Small bodies of Tertiary (?) volcanic rocks (12) outcrop northwest of Turnagain River near the mouth of Dall River.

Glacial, glacio-fluvial, and fluvial deposits (13) locally form thick overburden in the major valleys.

During Pleistocene time an ice-sheet advanced northeasterly in the Cassiar Mountains and deposited glacial erratics to an elevation of at least 7,200 feet between Denetiah Lake and Frog River. Apparently, ice reaching the Kechika valley south of Terminus Mountain was deflected to the northwest by the barrier of the Rocky Mountains. North of Terminus Mountain the movement of ice was again northeasterly. Within the map-area the Rocky Mountains were affected only by local alpine and valley glaciation except for the relatively low-lying terrain north of Terminus Mountain.

Asymmetrical and overturned folds, whose axial planes dip steeply to the southwest, are prominent in both the Rocky and Cassiar Mountains. Plunging, overturned and asymmetrical folds are particularly evident in the Lower Cambrian and Precambrian rocks between Dall Lake and the Rocky Mountain Trench. Tight, northeasterly overturned folds, possibly complicated by thrusting, are inferred from the rock distribution in the range between Kechika River and the Netson Lake valley and in the range between Kechika and Gataga Rivers. East of Netson Lake the major structure appears to be an anticlinorium, the northeast limb of which is overturned to the northeast.

Northwesterly trending faults appear to be abundant in the Cassiar Mountains. Strata and structures in the Cassiar and Rocky Mountains are truncated at acute angles by the Rocky Mountain Trench. The general trend of strata in the Rocky Mountains is more northerly than that in the Cassiar Mountains.

Exploration work has been carried out on a lead-silver-copper showing in calcareous phyllite and phyllitic limestone 9.6 miles south of the confluence of Jackstone Creek and Frog River. Fluorite was noted in a greenstone body about 10 miles east-northeast up a creek that flows into Dall River 2 miles north of Dall Lake. Greenstones and associated metamorphosed sedimentary rocks southwest of Tucho Lake have been bleached and pyritized as have greenstones south of Pitman River. Minor copper stain occurs in a north-northwesterly trending shear zone in granitic rocks on the west side of a peak, elevation 7,950 feet, near the headwaters of Jackstone Creek. Minor chalcopyrite was noted in veinlets cutting silicified limestone on the east shore of Dall Lake about 3 miles from the south end of the lake. Copper minerals have been found in the mountains immediately northeast of the mouth of Gataga River. Minor tremolitic asbestos forms veinlets in greenstone on Gataga Mountain.