ERCL BC-Recon 1

Nechako Reconnaissance Compilation

93F/7

B.M. Wright
September 1985

MEMORANDUM

85 10 10

TO: File

FROM: B. Wright

SUBJECT: NECHAKO AREA RECONNAISSANCE, SEPTEMBER 3 - SEPTEMBER 12, 1985

LOGISTICS

A reconnaissance mapping program was carried out in the Nechako Range area of north-central British Columbia in early September, 1985 (see figure 1). The crew consisted of myself and three seasonal geologists; Bob Tamaki, Susan Derby and Steve Charbonneau. Work was carried out by truck for 1 1/2 days and by helicopter for 1 day. Accommodation was at the Nechako Lodge, about 6 kilometres east of Kenny Dam.

PURPOSE

The major objective of this program was to assess the coal potential of Hazelton Group sediments in the Nechako Range area. An outcrop of coal was found last year by John Dunn (memo 1984-12-31) in supposedly non-coal bearing Hazelton sediments. This coal was not thought to be part of the Endako Group lignites due to its anthracitic rank.

MAPPING RESULTS

Cutoff Butte

- hard, quartzitic igneous rocks with feldspar phenocrysts
- no sediments encountered

Suscha Creek

- intermediate volcanics and lapillituff containing abundant lath-shaped phenocrysts

West Road (Blackwater) River

- basalt

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Tatelkuz Mountain

- green, hard, aphanitic volcanic with tiny feldspar phenocrysts

Nechako Range (high point)

- silty, phyllitic mudstone and sandstone grit
- dips are about 50° to the southwest
- grit displays platey cleavage and is conglomeratic in places (up to 2 cm. diameter clasts)

Nechako Range (north and south of high point)

- chert pebble conglomerate with platey cleavage

Big Paw Creek

- interbeds of fine grained sandstone and chert pebble conglomerate
- dips are southwest at 40°

Clearcut (east side of Nechako Range)

- chert pebble conglomerate, shale and fine grained sandstone
- dips are northwest at 50°

South Kluskus Road

- granite

Outcrop NC01 (J. Dunn)

- 45 cm. coal in 60 cm. interval
- steeply dipping (54°) to the southwest
- surrounding sediments are carbonaceous mudstones and well indurated fine to coarse grained sandstones
- other outcrops near this coal seam consist of chert pebble conglomerate and schist

.../3

Clearcut (northwest side of Nechako Range)

- outcrop NR005
- chert pebble conglomerate with aligned pebbles (strain fabric)
- 12 metres thick conglomerate unit
- further south along clearcut is an exposure of phaneritic, green intrusive (looks to be interbedded with the conglomerate)

CONCLUSIONS

1. Coal has been found within what is probably Hazelton Group sediments at one locality (NC01 - J. Dunn). Its thickness is 45 cm. over a 60 cm. interval.
2. Most of the other sediments encountered are coarse clastics (conglomerates) with no indication of carbonaceous material.

RECOMMENDATIONS

With the exception of one outcrop, the Nechako Range is barren of Hazelton Group coal. No further work is recommended for this region. We should not, however, discount the possibility of better coal occurrences within Hazelton Group sediments in other areas.

Brenda

BMW:jlb
Attachment
0057k:42-44

xc: G.J. Ockert
J. Horgan

COST STATEMENT

Salaries, Wages and Benefits	$11,000
Helicopter	7,250
Travel	2,360
Vehicle Rental	1,200
Accommodation and Meals	1,200
Fuel	750
Analyses	100
Field Equipment	55
Maps and Reports	45
TOTAL	$23,960

0057k:45
85.10.11

FIGURE 1

NECHAKO RECONNAISSANCE 1985

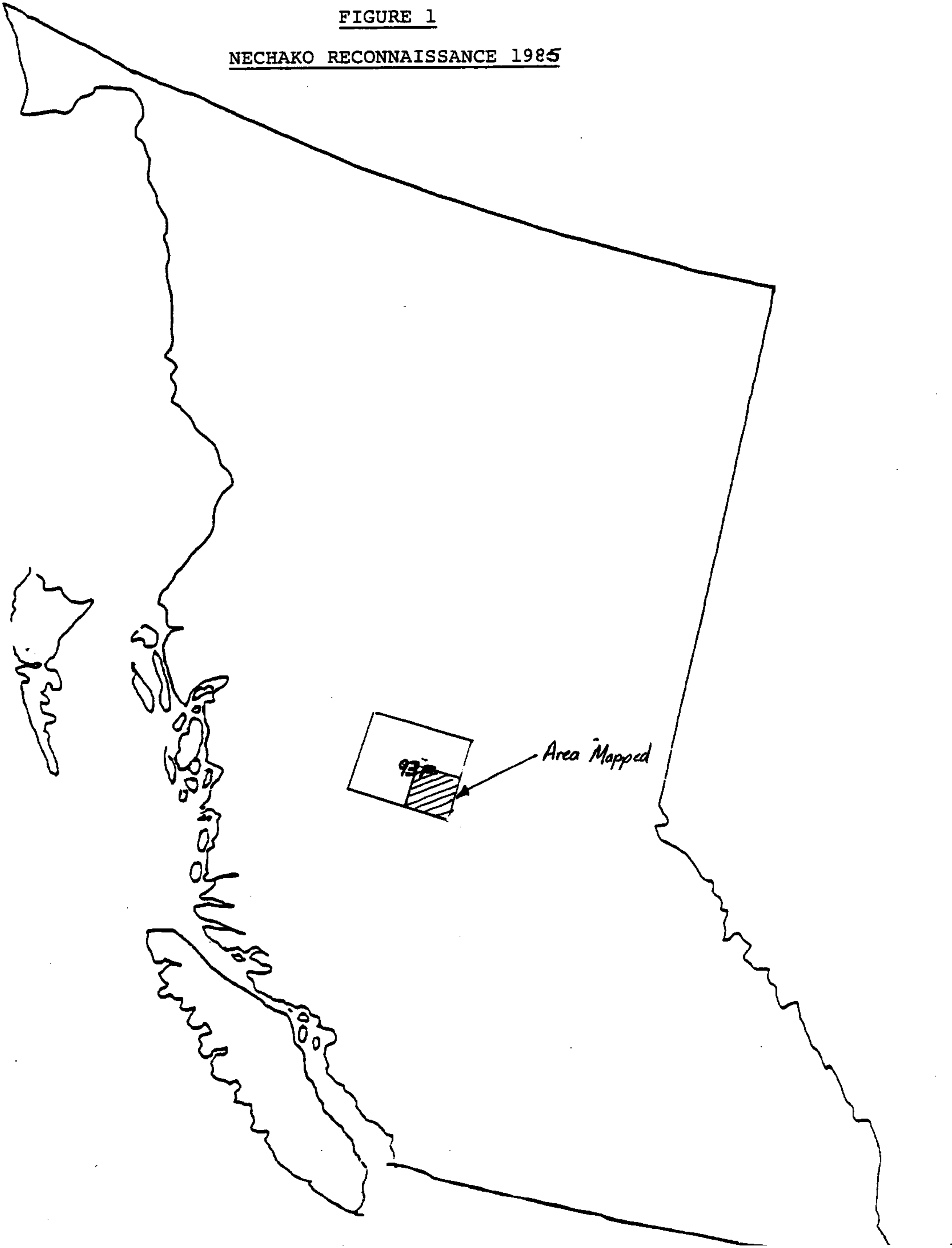
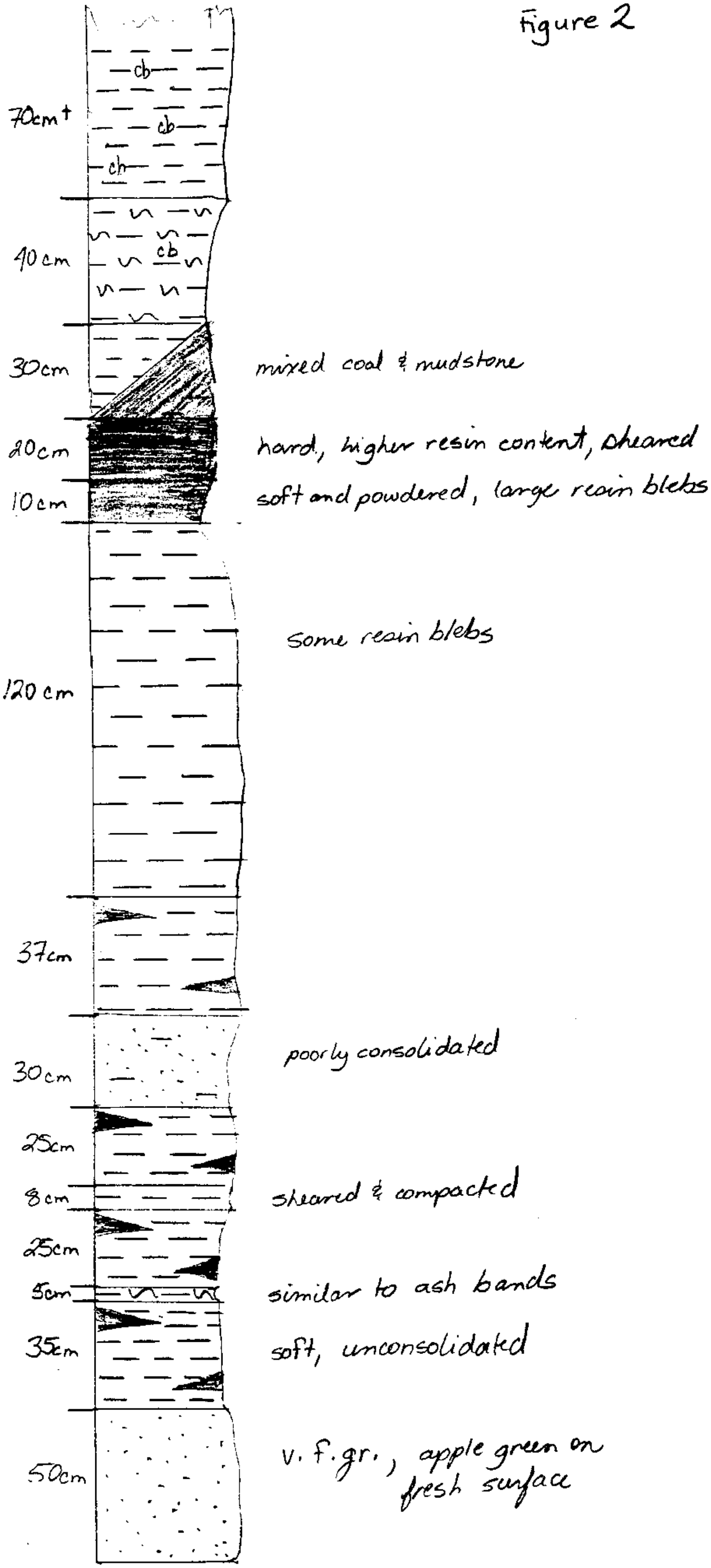


Figure 2

OUTCROP NC01 (J. Dunn)

Along west road below Nechako Range.

Scale 20:1



M E M O R A N D U M

ESSO MINERALS CANADA
COAL DEPARTMENT

80 11 24

TO: File

FROM: A. Hugh M. Jones

SUBJECT: Record of Phone Call to Ernie Shaw, Esso Resources Exploration

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Obtaining Data Regarding Esso Wells Drilling or about to Drill

Contact Chuck Jamieson who is a technologist working for Jim Todd in the Operations Group.

For Geological Background to Recent Holes

~~In Alberta, phone~~ phone Peter Byers and in British Columbia district phone Doug Menzies. 11-5047 not available til Monday

The Canadian Hunter Deal

Esso apparently has an optionable 17½% interest in Canadian Hunter plays. In the case of the Enchako Basin, they have sold 50% of this automatic-in to BCRIC and retain somewhat over 5%. Esso Resources has access to the data and Ernie saw no reason why we could not use the data for coal exploration. Please comment on the potential in the Enchako Basin if you have any opinion, and on the risks involved in a direct approach to Hunter which might alert BCRIC or some other partner more interested in coal than is Hunter.

I have a hint from a personal friend at Hunter that there is coal. Please phone Menzies and see if he has access to seismic or drill data which would aid in coal expl. + if he could monitor data as drilling progresses with us in mind

A. Hugh M. Jones

AHMJ/cyg

cc: B.D. Vincent
J.R. Yurko
G.J. Ockert

File: EXP 10
Nechako Basin 93F,G

MEMORANDUM

ESSO MINERALS CANADA

COAL DEPARTMENT

80 12 9

TO: A. Hugh M. Jones

FROM: G. Ockert

SUBJECT: NECHAKO BASIN 93-F,G

I spoke to Doug Menzies, Esso Resources Exploration, regarding the availability of data from oil and gas exploration on the Nechako Basin area in central B.C. The area is being explored by Canadian Hunter at present, and Esso has an optional 17½ percent interest (50% sold to BCRIC).

Menzies informed me that the only previous exploration in the area is 2 drill holes in the early 60's. Canadian Hunter is at present drilling a twin to one of these wells. Seismic data available is poor due to volcanic cover of about 30 metres. Canadian Hunter has extensive exploration planned for the basin over the next 5 years.

We have access to all data from the drilling operation (sample logs from Canadian Hunter, if requested). The geophysical logs from the earlier exploration wells should be sought out, and any published geologic data on the area reviewed.

Yes / Please have done

G. Ockert.

GO/kjs
File: 93-F,G

MEMORANDUM

ESSO MINERALS CANADA

COAL DEPARTMENT

Sandman

SG3-8131 => 1/13 => 38 results

20 hours

80 12 15

TO: File 93-F, G 10 hrs

FROM: [redacted]

SUBJECT: Nechako River Map Area, B.C.
from Tipper (1963); GSC Memoir 324

Although no good exposures of coal were seen, float was viewed in many places in the map area. The coal is believed to be Tertiary in age and belong to the Endako Group (Miocene and ? later). This group is composed of vesicular and amygdaloidal basalt and andesite; flow breccia; tuff; conglomerate; greywacke; and lignite.

The occurrences cited by Tipper are:

1) North of Cheslatta Lake - 5 miles east of Tyee Butte large blocks of carbonized wood, dull lignite and a bright, light weight, waxy coal were found in a creek bottom.

2) Along the Nechako River north of Kenny dam large blocks of lignite are strewn along the exposed river bottom (Tipper did not locate the seam).

3) Dawson (1878, p. 82) reported a 4 foot seam along the Nechako River near Mtn. Greer (not seen by Tipper). The seam is probably interbasalt or from the base of a plateau basalt unit.

4) Along Tsacha Lake, in the Batnuni Valley, and along the Chedakuz Valley small fragments of lignite and fossil wood were noted. The source was not viewed. Possibly (as above) these too are derived from concealed lignite beds or beneath the Endako Group.

Tipper claims the area has poor exposure and the sedimentary part of the Endako Group is at the base of the group; it is usually exposed where stream courses cut below the basalt.

G.O.
G. Ockert

GO/kjs

M E M O R A N D U M

ESSO RESOURCES CANADA LIMITED
RESEARCH DEPARTMENT

RECEIVED
APR - 3 1984
EMC-COAL
RESOURCES GROUP

84 04 02
File: 2647
Letter No. 44518

TO: LH. E. Hopkins
Coal - #695 EPE

FROM: J. Allan

RE: Nechako Basin Coal Samples

I have completed the petrographic examination of your four coal samples, as follows:

Sample NDOC-A

Composition (% Vol.): Huminite - 87.4% (Syn. vitrinite of bituminous coals)
Liptinite - 0.6
Inertinite - 0.2
Minerals - 11.8
Reflectance of Huminite: 0.31%
Rank: Lignite

Comments: The virtual absence of inertinite, good cellular preservation of huminites, evidence of fungal bodies and presence of resinite all suggest that the coal is derived from coniferous forest material, deposited in possibly acidic, fresh water with minimal transport of plant debris. Mineral matter is intergrown clays.

Sample NDOC-B

Composition (% Vol.) Huminite - 77.2%
Liptinite - 0.9
Inertinite - 0.2
Minerals - 21.7
Reflectance of Huminite: 0.33%
Rank: Lignite

Comments: This is generally similar to Sample A, except for a higher clay content, and a similar origin and depositional environment is interpreted.

Sample NDOC-C

Composition (% Vol.): Huminite - 85.3%
Liptinite - 4.1
Inertinite - 0
Minerals - 10.6

Reflectance of Huminite: 0.30%

Rank: Lignite

Comments: This sample contains a mix of huminite types which suggest that it is derived from a mixture of coniferous-forest and reed-moor peats. It is moderately pyritic, and richer in liptinites (spores, cuticle and resin), than Samples A and B. Absence of inertinites suggests little or no transport of plant debris. A brackish, open to partly forested swamp is the inferred depositional environment.

Sample NDOC-E

This sample is a carbonaceous mudstone and was not analyzed in detail. The high proportion of minerals, the presence of pyrite and the presence of thin vitrinitic stringers suggest deposition in a brackish environment marginal to the original peat swamps.

JA/mpa

MEMORANDUM

DATE: 1984 08 22

TO: A.R. Peach

FROM: J. Dunn

SUBJECT: 1984 Nechako Pre-Reconnaissance Report

The Nechako reconnaissance area was visited July 25-26, 1984 by Bob Tamaki and myself. Our objectives as outlined in Nechako memo 1984 07 19 were:

1) to check outcrop potential and to delineate the area where work should be concentrated.

2) to check topography and terrain for future access.

Conclusions made from the July 1984 pre-reconnaissance are outlined below. However, a brief but necessary review of Nechako Basin geology, known coal occurrences and exploration history is presented first.

GEOLOGY OVERVIEW

The Nechako reconnaissance area is centered in NTS map sheet 93/F and also includes parts of NTS map sheets 93B/C/G. The boundaries of the reconnaissance program are generally defined by the boundaries of the large Nechako Basin, one of three major intermontaine strike basins* of British Columbia (McCrossan and Porter, 1973). The Nechako Basin is situated between the Pinchi Geanticline on the east and the Tyaughton Trough on the west and is about 400 km long and 120 km wide (see Figure 1).

The rocks in the Nechako River (93/F) Prince George (93/G) and the Quesnel (93/B) map sheets as mapped by Tipper (1949-1953, 1958-1960, 1957) range in age from Late Palaeozoic to Miocene. Two tables of formations, one by Tipper 1963 and the other by Koch 1973 are provided below (see Figures 2 and 3).

*The other two major intermontaine strike basins being the Whitehorse Basin and Bowser Basin (see Figure 1).

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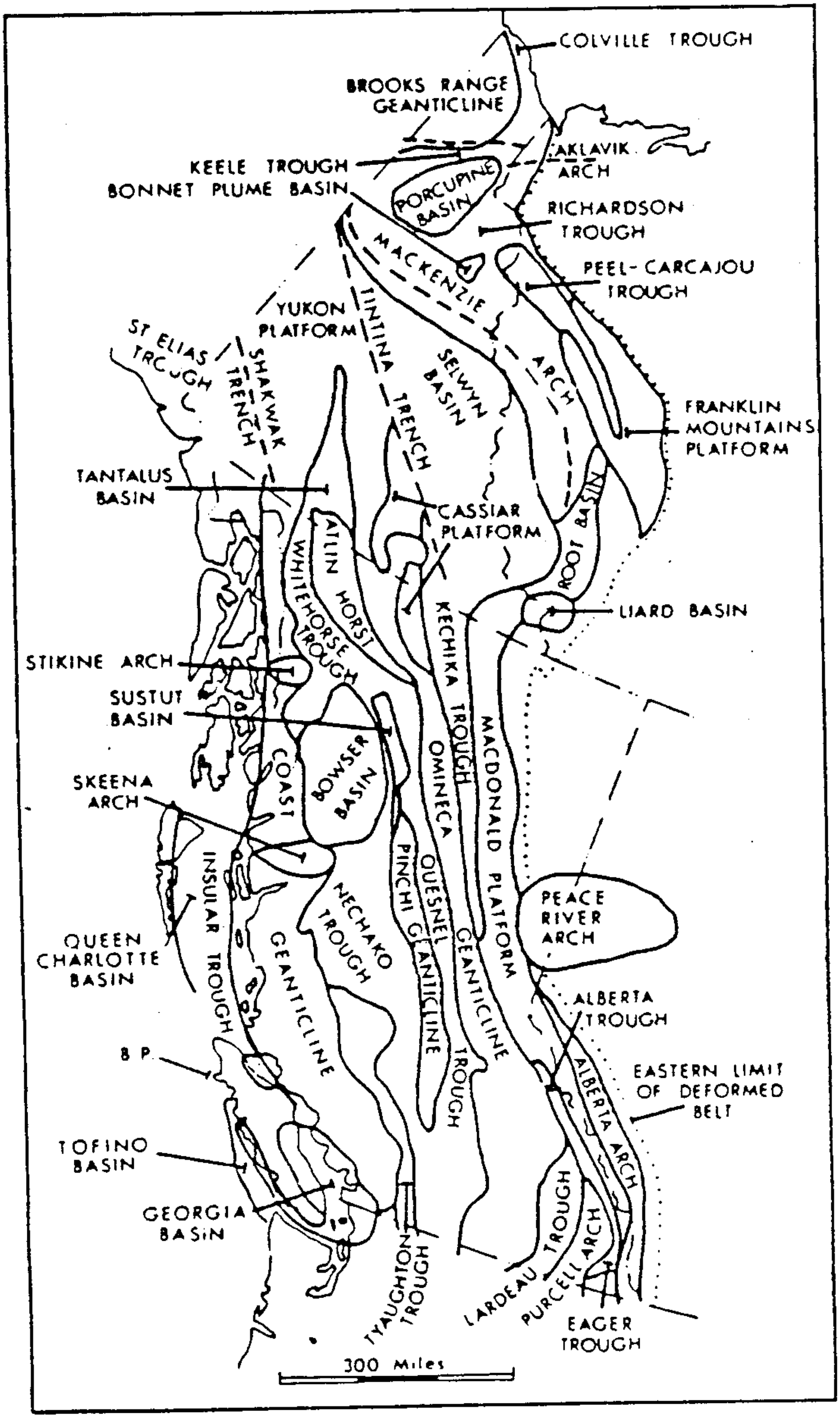
COLVILLE TROUGH
BROOKS RANGE GEANTICLINE
KEELE TROUGH
BONNET PLUME BASIN
AKLAVIK ARCH
PORCUPINE BASIN
RICHARDSON TROUGH
MACKENZIE ARCH
PEEL-CARCAJOU TROUGH
YUKON PLATFORM
TINTINA TRENCH
SELWYN BASIN
ST ELIAS TROUGH
SHAKWAK TRENCH
FRANKLIN MOUNTAINS PLATFORM
TANTALUS BASIN
CASSIAR PLATFORM
ATLIN HORST
WHITEHORSE TROUGH
ROOT BASIN
LIARD BASIN
KECHIKA TROUGH
STIKINE ARCH
SUSTUT BASIN
BOWSER BASIN
COAST
OMINECA
MACDONALD PLATFORM
SKEENA ARCH
INSULAR TROUGH
PINCHI GEANTICLINE
QUESNEL TROUGH
GEANTICLINE
NECHAKO TROUGH
PEACE RIVER ARCH
QUEEN CHARLOTTE BASIN
GEANTICLINE
ALBERTA TROUGH
B P.
ALBERTA ARCH
EASTERN LIMIT OF DEFORMED BELT
TOFINO BASIN
GEORGIA BASIN
TYAUGHTON TROUGH
LARDEAU TROUGH
PURCELL ARCH
EAGER TROUGH
300 Miles

FIGURE 1

The oldest rocks exposed in the Nechako Basin are those of the Permian Cache Creek Group. These rocks occur along the eastern margins of the Nechako Basin but pinch out to the west underneath the Basin (Koch 1973). They consist of massive shallow water limestones and deeper water shales, cherts, volcanics and their metamorphic equivalents. It has a probable thickness of 1800 metres (Duffell and McTaggart, 1952 in Koch 1973).

The Triassic Takla Group rests unconformably on the Cache Creek Group in the northern part of the Nechako Basin and is described as a sequence of marine and non-marine interlayered flow, breccias and sedimentary rocks including red beds. Tipper (1963) describes the Takla Group as typically eugeosynclinal; practically all the rocks are volcanic flows and breccias, or rocks derived directly or indirectly from active volcanism. Well-bedded black argillite, argillaceous tuff and argillaceous limestone are the more important sediments. In outcrop, the sequence has a combined total thickness of 1500 metres.

The main lower unit Takla Group rocks are intruded by the Topley Batholith. In the northern part of the Nechako Basin, the Topley intrusions lie between the Takla Group and the overlying Hazelton Group. Elsewhere the Takla Group is overlain unconformably by the Hazelton Group.

The Hazelton Group includes Middle Jurassic and, in some cases, Lower Jurassic rocks. Tipper (1963) divides the Group into a lower chert-pebble conglomerate unit and an Upper Middle Jurassic unit. The lower chert pebble unit includes conglomeratic sedimentary rocks, volcanic flows and pyroclastics. Some conglomerates are poorly cemented with limonite or calcite and the rock is very porous and permeable where weathered. Shales and argillites form an important part of the sedimentary section of the chert-pebble conglomerate unit. These rocks are invariably dark grey or black, banded or massive and are commonly sheared, contorted or drawn out (excerpted from Koch 1973). Thickness of the Lower Hazelton Unit is estimated to be greater than 2100 metres. The Middle Jurassic unit is primarily a sedimentary unit with some interlayered flows, breccias and tuffs. The rock types are conglomerate, greywacke, arkose, shale, tuff and breccia. Green andesitic greywacke with abundant wood fragments and carbonaceous imprints were found by Tipper (1963) along Taiuk Creek in the northern portion of the Nechako Basin. The Middle Jurassic unit is thought to have been laid down under marine or near shore conditions and has an estimated thickness in excess of 1500 metres.

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Table of Formations

Era	Period or epoch	Formation	Lithology
Cenozoic	Recent		Stream and lake deposits, talus, soil
	Pleistocene		Glacial and glacio-fluvial deposits
	Erosion interval		
	Miocene and (?) later	Endako Group	Basalt, andesite; related tuff and breccia; minor shale and greywacke
Angular unconformity			
Mesozoic and Cenozoic	Upper Cretaceous to Lower Miocene	Ootsa Lake Group	Rhyolitic and dacitic tuff and breccia; shale, sandstone, conglomerate
			Rhyolite, dacite, trachyte, andesite; minor basalt; related tuff and breccia
			Basalt, andesite; minor rhyolite, sandstone, and conglomerate
Erosion interval			
Mesozoic	Post-Middle Jurassic-pre-Upper Cretaceous		Biotite granite, granodiorite, quartz diorite, diorite; minor gabbro
	Not in contact		
	Upper Jurassic (Callovian)		Argillite, argillaceous limestone
	Relations not known; intrusive contact with younger granitic rocks		
	Middle Jurassic (Bajocian)	Hazelton Group	Greywacke, argillite, conglomerate tuff, breccia, andesite, and arkose; minor rhyolite
			Andesite, related tuffs and breccias, chert-pebble conglomerate, shale, and sandstone
	Unconformity; erosional interval		
Mesozoic cont.	Lower Jurassic mainly or entirely	Topley Intrusions	Granite, granodiorite, diorite, and quartz diorite
	Intrusive contact with lower part of Takla Group		
	Upper Triassic and Lower Jurassic	Takla Group	Red and brown shale, conglomerate, and greywacke
			Andesitic and basaltic flows, tuffs, and breccias interbedded argillites and minor limestone
	Not in contact; intrusive contact with Topley Intrusions		
	Post-Upper Permian-pre-Lower Jurassic		Serpentinized peridotite, talc schists, anthophyllite schists
Not in contact; intrusive contact between Topley Intrusions and Cache Creek Group			
Palaeozoic	Pennsylvanian (?) and Permian	Cache Creek Group	Limestone

FIGURE 2 (TIPPER, 1963)

FORMATIONS TYAUGHTON - NECHAKO BASINS

AGE	FORMATION	LITHOLOGY	THICKNESS	COMMENTS
tiary Jpper Cretaceous	Endako Group	Volcanics	2000' ±	Miocene and later Mainly basaltic.
	Ootsa Lake Group	Volcanics	1000' – 3000'	Eocene and later Mainly rhyolitic.
		GRANITIC INTRUSIONS		
per Cretaceous	Kingsvale Group	Volcanics	6000' +	Breccias and tuff. Restricted to Tyaughton
		Siltstone, Sandstone and Conglomerate	5400' +	Non marine clastics. Restricted to Tyaughton
e Lower Cretaceous	Jackass Mtn. Group / Taylor Creek Group	Sandstone, Siltstone and Conglomerate. Shale to Chert pebble Conglomerate.	10000' – 15000' (maximum)	Fraser Grp EB: Non marine clastics / Marine clastics
wer Cretaceous Jpper Jurassic	Relay Mountain Group	Fine Clastics	3290 – 9000' +	Fraser Grp EB: Marine arkosic clastics in Tyaughton Region
		GRANITIC INTRUSIONS		
ddle and Lower Jurassic	Hazelton Group	Shale, Sandstone Conglomerate	3000' – 7000'	Marine Clastics
ower Jurassic?) per [illegible] ic	Takla Group	Clastics & Limestone	5000' ±	Marine sequence. Main reservoir potential.
		Volcanics	7000' +	Effective basement to West.
		ANGULAR UNCONFORMITY		
mian and Penn?	Cache Creek Group	Limestone, Shale, Chert, Volcanics	6000' ±	Shelf Carbonates. Not known in Tyaughton region.
		ANGULAR UNCONFORMITY		
cambrian and Younger	Kaza and Cariboo Groups	Metasediments		Basement to east

FIGURE 3 (McCrossan and Porter, 1973)

In the Tyaughton Basin, the Upper Jurassic - Lower Cretaceous Relay Mountain Group unconformably overlies the Hazelton Group. The Relay Mountain Group consists of a thick sequence of predominantly argillaceous clastic sediments containing many interbeds of fine to coarse greywacke and relatively few interbeds of grit and pebble conglomerate. Insignificant interbeds, bands or concretions of impure limestone and intercalated beds of volcanic rock occur locally (Koch 1973). The Relay Mountain Group is overlain, probably disconformably, by a thick sequence of Upper Lower Cretaceous clastics known as the Jackass Mountain/Taylor Creek Groups. The two groups are believed by Tipper (in Koch 1973) to have been formed semicontemperaneously in the same basin; the Taylor Creek Group in a marine part of the basin and the Jackass Mountain in a non-marine part, with the Jackass Mountain sedimentation beginning earlier--(possibly because the sediments prograded into the marine condition).

Both Relay Mountain Group and Jackass Mountain Group equivalents are believed to be present in at least the east-central part of the Nechako Basin. In the Honolulu Nazko well 93 B11 A 4 L (discussed later) drilled in 1960 the Relay Mountain Group is estimated to reach 1/3 to 1/2 the estimated maximum thickness that it reaches in the Tyaughton Basin. The sequence can generally be described as being composed of red, green, grey and brown shale, tuff, chert and minor amounts of sandstone of non-marine origin. The 1600 metres of section in the well lying above the Relay Mountain Group is correlated with the Jackass Mountain Group. The sequence can generally be described as a sequence of marine and non-marine sandstones and shales with minor conglomerate.

Tipper (1963) on the other hand, has mapped argillite and argillaceous limestone of Upper Jurassic age as overlying the Hazelton Group in the northern portion of the Nechako Basin. Tipper (1963) initially mapped these rocks as an Upper Jurassic part of the Hazelton Group but he notes since Hazelton Group rocks are now considered to be pre-Upper Jurassic, they are considered to be a separate unit. He notes that it would seem logical therefore, to map these rocks as Bowser Group but as there is no known direct connection with the Bowser Basin and little information on the extent, thickness and lithology of these Upper Jurassic rocks, it seems better to map them as an unnamed unit. In the central part of the Nechako Basin however, Tipper (1959) has mapped a unit of at least 200 metres thickness of conglomerate, greywacke and argillite. No fossils were reported in the unit. Very possibly this could represent Jackass Mountain equivalent sediments.

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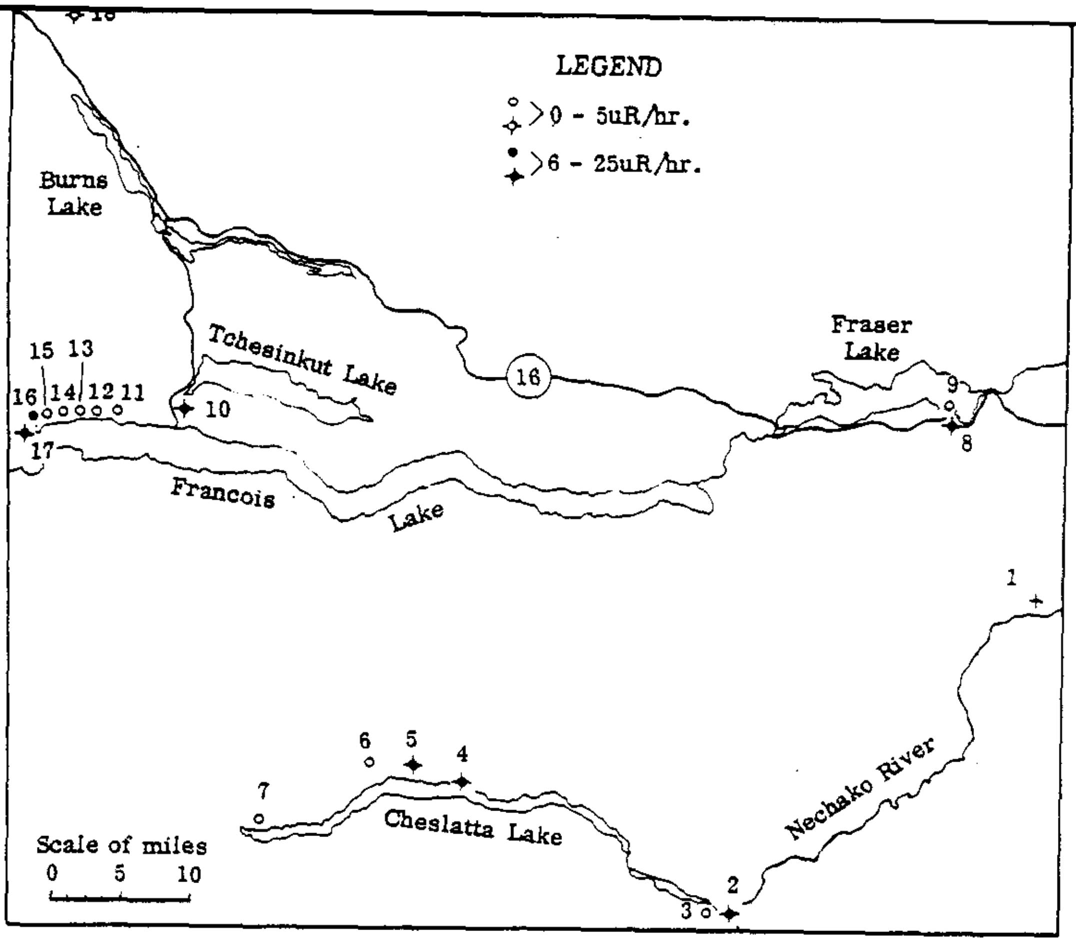
The Upper Jurassic - Lower Cretaceous time period of the Nechako Basin then is poorly understood. This period is of obvious interest for if the Nechako Basin developed in a similar fashion during this time as the Bowser Basin to the north and the Tyaughton Basin to the south, it may include facies favourable to or indicative of coal development. However, analysis of Relay Mountain Group equivalent rocks in the Honolulu Nazko well indicate an Early Cretaceous age. Koch (1673) suggests that this may be indicative of sea development during the Late Jurassic being restricted to the deeper Tyaughton Basin and becoming more widespread to the Nechako Basin in the Early Cretaceous. This seems to reinforce Al Peach's idea of uplift of a portion or all of the Nechako Basin with the regional affect of the Pacific Orogen advance creating a residual high; conceivably during Late Jurassic time the Nechako Basin was peneplained with likely transport of sediment to the Tyaughton Trough.

The Ootsa Lake Group, of Early Tertiary age, rests with angular unconformity on the Mesozoic rocks. A lower mafic volcanic and pyroclastic unit is succeeded by acid volcanics and tuffs, many members of which are characterized by a creamy or chalky colour (excerpted from Marr 1973). It is probable that the uppermost volcanic rocks of the Upper Cretaceous Kingsvale Group of the Tyaughton Basin are in part equivalent to, or at least merge with, the Ootsa Lake Group (Koch 1973). However, the lower part of the Kingsvale Group which is described as a thick sedimentary section of non-marine siltstone, sandstone and conglomerate and is described as one of the most predominant coal-bearig units in south-central British Columbia (Hopkins 1984), does not appear to have an equivalent in the Nechako Basin (Koch 1973).

The Endako Group of Miocene-Pliocene age overlies the erosional surface at the top of the Ootsa Lake Group. The Endako lavas were poured out upon a relatively flat surface above which hills projected and in which a few valleys were entrenched (Koch 1973). Sedimentary rocks are found associated with the volcanic rocks particularly while streams have cut through lavas that filled pre-Miocene valleys. Tipper (1960) notes that these sediments were observed to lie at the base of the group. He describes the sediments as consisting of poorly consolidated coarse sandstone and conglomerate, minor siltstone and lignite.

KNOWN COAL OCCURRENCES

Known coal occurrences in the Nechako Basin are referred to in Tipper (1957, 1960), Cameron and Birmingham (1970), Flynn and Swarsburgson (1982) and Hopkins (1984). All reported coals are lignitic to subbituminous C in rank. A map and corresponding table by Cameron and Birmingham (1970) which documents all the known coal occurrences in the northern part of the Nechako Basin is reproduced below.



Francois Lake - Cheslatta Lake area, British Columbia.

Stn.	Sample	Location		Remarks
		NTS Map	UTM Grid	
1	CQ 150	93 F	DQ 01 73	Lignite float collected along Nechako River
2	CQ 138	93 F	CQ 72 46	Five seamlets of lignite exposed in 30 feet of section at east end of Murray Lake. Second from bottom was sampled (CQ 138); in ascending order above this bed rusty siltstone (CQ 139), greenish clay (CQ 140) and coaly clay (CQ 141) were sampled. Top seam (CQ 142) and bottom seam (CQ 144) also sampled. In addition coal and clay below top seam was sampled (CQ 143).
2	CQ 139	93 F	CQ 72 46	
2	CQ 140	93 F	CQ 72 46	
2	CQ 141	93 F	CQ 72 46	
2	CQ 142	93 F	CQ 72 46	
2	CQ 143	93 F	CQ 72 46	
2	CQ 144	93 F	CQ 72 46	
4	CQ 145	93 F	CQ 45 58	Light coloured amygdoloidal volcanics on shore of lake
5	CQ 146	93 F	CQ 42 60	Two beds of lignite exposed along creek, lower one sampled (CQ 146), coaly fragments from fossilized stump (CQ 147) and two samples of lignite float (CQ 148 and 149) along creek were collected.
5	CQ 147	93 F	CQ 42 60	
5	CQ 148	93 F	CQ 42 60	
5	CQ 149	93 F	CQ 42 60	
8	CQ 137	93K/2E	928 913	Rusty agglomerate exposed in railway cut
10	CQ 128	93K/4W	200 947	Ten or 12 coaly layers in road cut, best one sampled (CQ 128), sandy layer below it (CQ 129) dark shale above (CQ 130); Tuff layer over shale (CQ 131). Coaly material from fossilized tree trunk (CQ 133 and 134). Second tuff layer lower down in section (CQ 132).
10	CQ 129	93K/4W	200 947	
10	CQ 130	93K/4W	200 947	
10	CQ 131	93K/4W	200 947	
10	CQ 132	93K/4W	200 947	
10	CQ 133	93K/4W	200 947	
10	CQ 134	93K/4W	200 947	
17	CQ 136	93K/4W	067 924	Coarse tuffaceous rock with carbonaceous(?) blebs
18	CQ 126	93K/5W	115 318	Coaly lenses in conglomerate and shale along creek
19	CQ 127	93K/5W	116 324	Black shale exposed along same creek as CQ 126

COAL EXPLORATION HISTORY

G.M. Dawson of the Geologic Survey of Canada first reported coal in the Nechako area in 1878. He made brief mention of a four foot seam along the Nechako River bank near Mt. Greer. H.W. Tipper, also of the G.S.C., mapped the region in the early 1950's and produced the only geologic map of the area to date. The Dawson seam was not delineated though large lignitic boulders were recorded along the Nechako River (excerpted from Gulf Canada Resources, Mt. Greer Coal Project Geological Report, 1981).

The only known coal exploration in the area has been conducted by Gulf Canada Resources and this was concentrated around Mt. Greer in the northern portion of the Nechako Basin. Field mapping of the Endako Group verified the existance of lignite. A follow-up drilling program on their Mt. Greer license consisted of one 300m rotary hole. The location of the hole was immediately beside a 308 m drill hole (EN-1) drilled by E&B Exploration in 1978 which reported 9.8 m of coal at a depth of 218.2 m. Gulf cored the interval reported by E&B to contain the coal and found no coal. Gulf concluded that the hole had either been erroneously logged or that they had intersected a local washout. Of the two possibilities, Gulf considered the former more likely and therefore did not pursue further drilling and dropped their licenses. One coal zone 0.8 m thick was intersected at a depth of 246.3 m and was analyzed to be lignitic in rank. The coal outcrop at Cheslatta Falls (see Hopkins 1984 Nechako memo), 10 km to the S.W. of the Gulf Mt. Greer property, may repesent an equivalent group of sediments.

OTHER EXPLORATION

The Nechako Basin has been explored fairly extensively by most major Canadian mineral companies. A lack of outcrop and the extensive nature of the Miocene volcanics which obscures much of the underlying rocks is quoted as one of the major reasons why few major economic prospects have been found in the area. Esso conducted a regional exploration program in 1971 for Late Jurassic-Tertiary porphry type (Mo) ore deposits and massive sulphide type mineralization (Cu). Also extensive exploration for Endako Group uranium placer deposits was conducted in the 1970's by a number of companies.

Hydrocarbon exploration in the Nechako Basin was attempted by Honolulu Oils and Hudson Bay Oil & Gas in the late 1950's/early 1960's with the Lower Cretaceous being the primary target formation. Lows in the Honolulu Nazko well showed black pyrobitumen or graphite in the Lower Cretaceous. The only available information found to date on these two wells and two previously drilled wells, Kersley #1 and #2 (1951, 1953), is found in Koch 1973 and McCrossan and Porter, 1973.

The largest hydrocarbon exploration program to date was initiated in 1979 by CanHunter, with B.C.R.I.C. and Imperial Oil as minor joint venture partners. Four dry holes were drilled, three of which are known to have penetrated down to the Cache Creek Group. Two zones in the Hazelton and 4 zones in the Jackass Mountain Group are known to have been tested in CanHunter et al Nazko, so these very likely represent the targets in the other 3 wells. A further memo on this work will be forthcoming once more information is acquired. Extensive gravity surveys and mini-sosie seismic ~~was~~ also carried out as part of the oil and gas exploration program. were

PRELIMINARY EXPLORATION PRIORITIES

As a result of the brief July 1984 reconnaissance and office investigation, a number of recommendations are outlined below. A map showing area covered in July 1984 reconnaissance is forthcoming.

(1) Delineation of Cheslatta Falls Endako Group coal outcrop. This includes investigation of the possibility of there being more than one package of coal-bearing sediments in the Cheslatta Falls-Mt. Greer area Endako Group sediments. Perhaps we can establish how persistant the coals are—was their development very local, perhaps controlled by to local volcanic activity?

Endako Group areas recommended in a first pass of the area are listed below:
(1) Nechako Canyon--Nechako River--Mt. Greer.
(2) Big Bend--Finger Lake area.
(3) Fraser Lake area.
(4) Tyee Butte--Francois Lake area.

Investigation of these areas will probably be road intensive and probably will take 1 1/2 to 2 weeks field work.

(2) Investigation of post-Hazelton/pre-Ootsa Lake Group sediments. The Upper Jurassic-Middle Cretaceous period in the Nechako Basin is poorly understood and some Bowser Group-Jackass Mountain Group equivalent sediments may be present. Areas of possible interest on the 93/F map sheet include: (1) Taiuk Creek,
(2) Chedakuz Creek/Valley,
(3) Tsacha Lake.

Investigation of these areas and follow-up areas in map sheet 93/B in the central part of the Nechako Basin will probably be helicopter intensive and initially will take 1 to 1 1/2 weeks.

Field work is tentatively scheduled to run from September 5 through 25.

(3) Further literature search - mineral exploration reports and CanHunter program information should be more thoroughly reviewed.

PROJECTED RECONNAISSANCE COST BREAKDOWN

Anticipated expenditures of the Nechako reconnaissance from September 5, 1984 to September 25, 1984.

GASOLINE	$ 500.00
ACCOMMODATION	800.00
FOOD	350.00
FIELD PURCHASES	300.00
HELICOPTER @ $395/hr	9,875.00
HELICOPTER FUEL @ 56¢/litre and 65¢/litre	1,650.00
TRUCK RENTAL @ $40/day	840.00
CHARGE-OUTS: 21 days follow-up @ $463/day	9,723.00
ANTICIPATED 10 days follow-up @ $463/day	4,630.00
MISCELLANEOUS	250.00
TOTAL EXPENDITURES	$28,918.00

JD/cyg
2632K

NECHAKO RECONNAISSANCE 1984 MAP LIST

TOPOGRAPHIC MAPS - 1:50,000

1. 93B/12,13,14
2. 93C/1-16 and 93C/5-16
3. 93D/9,16
4. 93E/1,2,3,6,7,8,9,10,11,14,15,16
5. 2 sets of 93F/1-16 and 2 sets of 93F/1-16 reproductions
   1 set of 93F/5-8 & 1 set of 93F/9,11,13 & 1 set of 93F/1,3,4
6. 93G/11,12,13,14 and 2 sets of 93G/3,4,5,6,10 reproductions
   93G/3,4,5,6 and 2 sets of 93G/11,12,13E,14 reproductions
   3 sets of 93G/11 & 2 sets of 93G/6 & 3 sets of 93G/14
   2 sets of 93G/13E & 1 set of 93G/13W
7. 93J/3,4,5
8. 93K/1,2,3,4,5,6,7,8 and 93K/1,2,3,4
9. 93L/1,2,8

TOPOGRAPHIC MAPS - 1:250,000

4 copies of 93B
3 copies of 93L
2 copies of 93F & 93G
1 copy of 93D, 93E, 93K, 93J and 93C

GEOLOGY MAPS - 1:253,440

1 copy of 93B and 3 reproductions
1 copy of 93C and 3 reproductions
1 copy of 93F and 3 reproductions
2 copies of 93G and 3 reproductions
1 copy of 93E, 93J and 93K/East

GEOLOGY MAP - 1:250,000

1 copy of 93D

GEOLOGY MAP - 1:380,160

1 copy of 93K

ROAD ACCESS MAPS

2 copies of 93F/SE,SW,NW and NE   1:100,000
2 copies of 93G/SE   1:100,000
2 copies of 93G/SW   1:125,000
2 copies of 93G/NE   1:125,000
1 copy of 93G/SW and 93G/NW   1:125,000
1 copy of 93F,93K,93C and 93A/SW   1:250,000

MEMORANDUM

ESSO RESOURCES CANADA LIMITED
RESEARCH DEPARTMENT

RECEIVED
OCT - 2 1984
EMC-COAL
RESOURCES GROUP

84 10 01
File: 2647

93 F, 3

Letter No. 45139

TO: A. R. Peach

FROM: J. Allan

RE: Nechako Sample NC01

The sample labelled NC01 is a high-rank anthracite, with a mean reflectance of 5.64%. At this high rank, I would expect the sample to be in a metamorphosed section. Petrographically, the sample is fairly homogeneous, as many macerals have similar reflectances - only occasional fusinite fragments are recognisably distinct in the uniform groundmass.

Disseminated clays are still visible, and seem to be regularly distributed through much of the coal. These are possibly the source of the 'volatiles' determined in your proximate analysis. True coal volatiles for a coal with a reflectance of 5.64% should be only about 2-4%.

JA/mpa

M E M O R A N D U M

EXPLORATION DEPARTMENT

RECEIVED
DEC 11 1984
EMC-COAL
RESOURCES GROUP

Mr. J. DUNN
OS, C. & M., Coal,
Room 681, West Tower Esso Plaza.

11 December 1984

Sample NC01 - NECHAKO BASIN, B.C..

A coal and a shale sample from the above locality which were supplied for age and environment determination have now been processed and examined with the following results:

Spl. 1. Shale

The organic matter in this sample comprised highly altered wood fragments and little else. A thermal alteration index of about 4.0 indicates a relatively high degree of thermal alteration. No fossils were seen in the sample, but the presence of recognisable wood fragments suggests that their absence is due to non-deposition, rather than subsequent metamorphism. In the absence of fossils no dating can be made on this sample. With regard to environment of deposition, the dominance of wood fragments in the organic residue suggests deposition in a non-marine, oxidising, moderately high energy environment, possibly in connection with a stream in the a lower delta plain setting.

Spl. 2, Coal

The organic matter in this sample is similar to that from the shale, being dominantly woody and relatively highly altered. A little collinite was observed in the residue. As with the previous sample, no fossils were seen and, therefore, no dating is possible. The material appears to have been deposited in the form of drifted wood in a lower delta plain setting.

Stanley A.J. Pocock

John

I have been nosing around and read this memo

Please note all samples we have sent from Lwr Cret i.e. Falling Cr and elsewhere have received similar results. Few spores & pollen which are hard to separate and lots of woody + fusinous material!

NC01	Nechako Basin, B.C.
a. Shale	
	No Fossils. Highly thermally altered. T.I. 4+
b. Coal	
	High rank coal No fossils.

M E M O R A N D U M

DATE: 1984 12 31

TO: A.R. Peach

FROM: J. Dunn

SUBJECT: Nechako Reconnaissance Summary (Sept.5 - Sept.14/84)

PURPOSE

The purpose of the program as stated in my memo of 1984 08 07 was as follows:

A) Delineation of Endako Group coal outcrops for coal-bearing sediments in the following areas:
   1) Nechako Canyon-Nechako River-Mt. Greer
   2) Big Bend-Finger Lake area
   3) Fraser Lake area
   4) Tyee Butte-Francois Lake area

B) Investigation of post-Hazelton/pre-Ootsa Lake Group sediments for coal-bearing potential in the following areas:
   1) Taiuk Creek
   2) Chedakuz Creek/Valley
   3) Tsacha Lake

PROGRAM RESULTS

The reconnaissance program generally followed the objectives as outlined above although not all areas were visited and some areas not mentioned above were visited. Overall, it is felt that given the time constraints of the program, a larger and fairly representative reconnaissance of the Nechako River mapsheet was achieved. Observations and conclusions made in various areas are listed below:

1) Dawson (1878) reported that a Mr. Broman ascended the Nechako River from Cheslatta Lake northward. He reported that the basalts are underlain by an extensive sedimentary formation, including lignites, of which one bed was found to be four feet in thickness. Dawson reported that the basaltic and other igneous rocks seem to have flowed out into pools containing earlier Tertiary deposits. He also reported that no coal exposures occur in the reach of the Nechako flowing due north toward Fraser Lake but the underlying rocks are, in all probability, those of the Tertiary series.

. . ./2

2) Tipper (1963) noted large blocks of lignite strewn along the exposed Nechako River bottom north of the Kenny Dam but was unable to locate their source. However, he concludes that in all probability the lignite is inter-basalt.

3) Cameron and Birmingham (1970) reported the area to be underlain by Tertiary rocks which "contain lenses and thin seams of lignite although exposures are rare and most of the lignite seen is in the form of float along rivers and creeks". They reported a lignite outcrop at the east end of Murray Lake (Cheslatta Falls area) where they reported five "seamlets" of lignite in 30 feet of section. Rusty siltstone, greenish clay and coaly clay were among the interseam lithologies quoted.

4) Gulf Canada Resources 1980-1981 Mt. Greer Exploration Program -- This program was based on a reported four foot seam along the Nechako riverbank near Mount Greer (Dawson, 1978) and a reported coal seam measuring 9.8 metres in a E and B Exploration uranium drill hole E.N.-1 drilled near Mt. Greer. Gulf twinned this hole with one of its own and only one coal zone was intersected at a depth of 246.3 metres and was analyzed to be lignitic in rank. A total of 275 m of Endako Group sediments comprised of siltstone, sandstone, mudstone, carbonaceous claystone, conglomerate, and thin lignite beds was encountered. Gulf concluded that the E and B hole had probably been erroneously logged and subsequently surrendered its licenses. Gulf also mapped its licenses and very probably the whole Nechako Canyon-Mt. Greer area and located coal-bearing Endako sediments outcropping near Cheslatta Falls.

5) Hal Hopkins (Nechako 1983 Reconnaissance memo) in a fairly broad helicopter reconnaissance of the area, noted seven coal float locations in the area from Mt. Greer to Cheslatta Falls. The only coal outcrop noted is the Cheslatta Falls outcrop. Hopkins noted a total of 3.4 m of interbedded coal (excluding seams less than 30 centimetres in thickness) within a 14.5 metre interval. The largest seam measured was slightly over a metre in thickness.

The Cheslatta Falls outcrop and the area around the falls was revisited in 1984 (see slide in back pocket). It was estimated that the total thickness of sediments observed was probably less than 25 metres and is underlain and overlain by basalt. One observation made that differs from Hopkins 1983 outcrop description is that much of the material in the outcrop appeared to be tuff or water-lain ash as opposed to sandstone and siltstone as previously described. Crippen Consultants in their December 1982 report entitled "Kenny Dam, Cold Water Release Facility - Geotechnical Report" note that the bedrock material at the Kenny Dam site 7 km due south of the Cheslatta Falls outcrop consists of a series of Tertiary volcanic strata which are nearly horizontal.

. . ./3

They go on to note:

> Although some interlayering occurs, the series comprises four distinctive formations. The lowest consists essentially of relatively weak tuffs and other ash rocks and lies about 50 m below the river. This formation is overlain by a formation of volcanic breccia up to about 50 m thick consisting of fragments of volcanic rock welded in a matrix of tuff. Overlying this is a formation of vesicular basalt. Results of the 1981 drill holes in the northeast bank indicate that this formation extends from about EL740 to at least EL859 m and that it consists of interlayered vesicular and non-vesicular basalt in roughly equal amounts. Above EL859 m, a formation of massive, generally non-vesicular basalt occurs. This formation is of unknown thickness extending far above the crest of the dam.

An examination of a topography map of the Kenny Dam-Cheslatta Falls area and a visit to the area strongly suggests that the material at the top of the dam site (previously the head of the Nechako Canyon) and the material at the top of Cheslatta Falls are correlatable. The drop in elevation below both of these points is the result of rapid downcutting through a recessive unit and it is suggested that the group of coal-bearing sediments at Cheslatta Falls is probably correlatable with the unit of relatively weak tuffs and other ash rocks mentioned above at Kenny Dam. The actual drop in elevation is about 30 m maximum suggesting that the maximum thickness of recessive sediments is about the same.

At this point, it is probably useful to very briefly review what is known about the Endako Group. Repeating what was said in the 1984 08 22 memo the Endako Group of Miocene-Pliocene age overlies the erosional surface at the top of the Upper Cretaceous Ootsa Lake Group. The Endako lavas were poured out upon a relatively flat surface above which hills projected and in which a few valleys were entrenched (Koch 1973). Sedimentary rocks are found associated with the volcanic rocks particularly where streams have cut through lavas that filled pre-Miocene valleys. Tipper (1960) notes that these sediments were observed to lie at the base of the group. It would seem then, accepting this type of model, that the type and thickness of sediments would vary widely. No doubt Gulf Canada did intersect 275 m of Endako Group sediments but we should not expect sediment package thicknesses as well as individual seams to remain consistent or predictable over the 40 km to Cheslatta Falls given the evidence of the conditions under which they were deposited.

. . ./4

To conclude, it would appear that the Nechako Canyon-Mt. Greer area has very little potential. It is very possible that very thick coal seams may have developed in the area but their development would be very localized. In addition, the sheath of Endako basalt which covers much of the area would make recognition of these areas extremely remote. This was the conclusion after visiting the area, therefore little time was further devoted to searching for Endako Group coals.

BIG BEND ROAD AREA

This area was originally considered to be of interest as Tipper (1963) mapped part of the area as being underlain by Endako Group rocks. The area discussed lies in the southern part of map sheet 93F/10 and is indicated on the 93F/10 forestry road map (see back pocket) as the area marked by outcrops NC01 through NC08.

A large part of this area (see Nechako River Geology Map, Tipper 1963, in back pocket) is blanketed with Quaternary till and gravel and consequently outcrop is generally limited to areas of higher relief such as the Jurassic rocks of the Nechako Range which bisect the central part of the Big Bend Road area in a northwesterly trend.

Tipper (1963) states that this area was part of a northwesterly trending sedimentary basin. In this basin was deposited detritus derived from the erosion of the exposed Permian Cache Creek Group and Topley Intrusions on the northeast, detritus from volcanic islands on the southwest, and flow, tuffs and breccias of contemporaneous volcanism (Tipper, 1963). According to Tipper, in the earliest part of the Middle Jurassic chert pebbles accumulated along the shores of this basin. In later Middle Jurassic time, finer sediments accumulated that there was much admixing with volcanic tuffs and fine breccias. Volcanism continued intermittently in different parts of the basin. During Middle Jurassic time, the basin shifted to the east due to continuing uplift of a volcanic island arc on the southwest margin. During Late Jurassic time, basinal development continued with the deposition of limey shales. The whole area was then intruded, uplifted and eroded through to Late Cretaceous time.

Some concept of geological history in the area is important when we try to understand the relationship of lithologies observed in the field, particularly the coal described at outcrop NC01 which will be described later. At outcrops NC06 - NC08, Hazelton Group basalts and andescites of probable Middle Jurassic age were noted. At outcrop NC05 approximately 3.5 km to the N.W., fine-grained salt and pepper sandstone intermixed with volcanic was noted. This general area has been mapped as Upper Jurassic Hazelton Group argillaceous limestone by Tipper but it would seem this outcrop more probably represents near-shore Middle Jurassic deposition. What is believed to be marine shale was noted at outcrop NC03. Fossils were observed in this shale but unfortunately none were kept for identification purposes. Further west at outcrop NC02 fine grained large scale/rough bedded sandstone is in sharp contact with a chert pebble conglomerate. This conglomerate along with a similar one observed at NC04 may be indicative of a Middle Jurassic shoreline environment. The conglomerate closely matches a description of Hazelton chert pebble conglomerate on page 25 of his 1963 report. At outcrop NC01 a number of lithologies were described. The description of the outcrop is given below.

At the north end of the outcrop what appears to be a metamorphosed mudstone/schist was found. Chalcopyrite and an unidentified bronze mineral can be seen throughout. Beds oriented 120°/28°.

The rest of the outcrop appears to be unaffected by metamorphism. The northern part of the outcrop is characterized by abundant interbedded fine grained sandstone. The sandstone weathers to an iron color and is typically light olive grey fresh. The individual grains seem to be slightly stretched or elongated perhaps suggesting some degree of metamorphism. Quartz veining less the than .03 cm is abundant.

Interbedded with the sandstone is a black shale. What are believed to be stem imprints were occasionally observed. Towards the centre of the outcrop the sandstone appears to be even finer grained (very fine sandstone to siltstone) and is highly weathered. The sandstone is argillaeous and numerous concretions were observed.

At the southern part of the outcrop fine grained clastics and coal appear to be predominant. Black noncarbonaceous shale with hackly fracture is common. The coal appears to be interbedded with a greenish-dark grey rust weathering mudstone. The coal does not appear to be in-place so no orientation was recorded; however, it appears to be quite steeply dipping probably consistent with the rest of the outcrop (see photographs in back pocket).

Outcrop NC01 is very probably Hazelton Group and therefore, of Middle Jurassic or Upper Jurassic age. It would seem unlikely to be Endako Group as Tipper (1963) has mapped nearby.

Three points reinforce this conclusion:

1) The sediments do not resemble Endako Group sediments observed at Cheslatta Falls, 17 km to the northwest.

2) Endako Group sediments are generally flat-lying whereas outcrop NC01 is parallel to the local strike and is fairly steep dipping consistent with Hazelton Group sediments mapped by Tipper (1963).

. . ./6

3) Reflectance analysis of the coal and quality analysis indicated it to be high rank anthracite and has probably been metamorphosed. The only coals previously reported in the Nechako Basin have been unmetamorphosed Endako Group lignites (see appendices).

A sample of NC01 coal was also sent for palynological analysis in an attempt to provide an age date for the coals. However, the sample was barren of spore material, therefore the age of the coal could not be ascertained. Interestingly some of the woody material is well preserved. If spores were present they probably would have been preserved. Consequently, Stanley Pocock believes the coal may have formed in situ having been transported to its present location. If this is the case, the likelihood that the deposit is regionally extensive would be small. In any case further palynological analysis will be performed shortly to determine if there is any identifiable spore material in shale from the same outcrop.

Whatever the outcome, the outcrop is significant in that it is the only known occurrence of anthracite in the Nechako Basin. If the coal is of Middle or Upper Jurassic age it may have formed in swamps around a slowly retreating sea in the Nechako Range area. The close proximity of the coal at NC01 to Middle Jurassic conglomerates is persistent then perhaps these conglomerates could be used in locating coal around the margins of this ancient sea. Figure 2 illustrates the location of coal at NC01 and conglomerate at NC02 and NC04 with relation to the position of Middle Jurassic strand lines suggested by Tipper (1963).

OTHER AREAS

1) Chidakuz Creek

   This area proved to be Quaternary till and gravel and no outcrop was observed.

2) Finger Lakes - Tutuk Lake Area

   This area proved to be covered by Quaternary till and gravel and no outcrop was observed.

3) Jerryboy Hills - Sucha Lake - Sucha Lake Area

   No sediments observed. Outcrops observed were vesicular basalt, basalt, andesite and flow-banded volcanics.

4) Fawnie Range

No sediments observed.

5) Tatelkuz Lake - Kuakuz Lake - Euchiniko Lakes - Blackwater River

No sediments observed - helicopter traverse (see slides in Appendix)

6) Kluskoil Lake - Blackwater River - Redwater Creek - Nazko River - Enchiniko River - Batnuni Lake (S.W. portion of 93G)

No sediments observed - helicopter traverse. Checked old homestead at Redwater Creek for reported coal occurence by local resident.

7) Knewstubb Lake - Natalkuz Lake (N.W. portion of 93F)

Saw small exposure of quartzite and nearby flow-banded volcanics near Lucas Lake. Mapped as Ootsa Lake Group by Tipper.

Exposure of medium to coarse-grained sandstone with pebble conglomerate and some mudstone was examined in southern part of 93F/11 near Natulkuz Lake. The section was noncarbonaceous and no coal was observed. Mapped as Hazelton Group by Tipper.

The only other recognizable sediments were seen near False Hill in 93/F/12. The outcrop consists of a very dark, noncarbonaceous mudstone unit of probable marine origin (see picture in appendix). Mapped as Ootsa Lake Group by Tipper.

8) Tyee Butte - Holy Cross Lake - Target Creek

No sediments observed - helicopter traverse

CONCLUSIONS

No further work should be done in the Endako Group for the following reasons:

1) Poor quality low rank lignite.

2) Coals have not been identified to reach thicknesses of greater than one metre.

. . ./8

3) Coals are very probably only very localized and the existence of a regionally extensive seam or coal package is doubtful.

4) Exploration is strictly a hit and miss drilling proposition as Endako Group basalts and Quaternary tills and gravel covers much of the area.

One wildcat drill hole is recommended in the vicinity of outcrop NC01. It is probable that this outcrop represents a coal occurrence in the very thick Hazelton Group which previously was not thought to contain coal measures. If the coal could definitely be proved to be of Middle or Upper Jurassic age and thicknesses are favourable, a regional mapping program of Hazelton Group sediments might be warranted.

JD:cyg/pp John Dunn/PP

cc: G.J. Ockert
L. Klatzel Mudry
J. Horgan

4610K

M E M O R A N D U M

Minerals Research Division

1985 10 30

File # 2647.081

To: B. Wright
Coal Dept.

From: J. Allan

Re: **Coal Analyses - Nechako and Guess Creek Samples**

The analyses which you requested on five coal samples have been completed and the results are as follows:

Sample I.D.	H2O %	Ash %	Volatile Matter %	C.V. btu/lb	Total Sulphur %	Reflectance %
	air-dry basis					
Guess Creek:						
Sta#1,Spl#1	3.0	66.8	7.3	n.d.	n.d.	2.39
Sta#1,Spl#2	2.4	23.1	18.7	8297	0.87	1.39
Sta#1,Spl#3	4.9	32.1	20.8	10721	0.60	0.82
Nechako N001	6.0	53.7	11.9	n.d.	n.d.	5.42
Ashton Mullen #1	5.9	65.1	10.8	n.d.	n.d.	~0.75

Notes:

1. n.d. indicates that the analysis was not performed because of the high ash content of the samples.

2. Guess Creek. This is a series of samples which have been elevated in rank by localized heating. Samples #1 and #2 show virtually no anisotropy, which indicates that the pressure compression effects of normal burial coalification are absent. I would conclude that high geothermal gradients have been active, e.g. over an intrusive, and thus rapid and localized rank changes should be anticipated in this area. Furthermore, the technological properties of these coals might not be predictable from conventional analyses because their chemistry may be quite different from normally coalified coals of similar apparent rank.

3. Nechako N001. The rank at this collection site is confirmed as anthracite. The reflectance value quoted above is, for this sample only, mean maximum reflectance. The coal is strongly anisotropic.

4. Ashton Mullen#1. This is a carbonaceous shale. Almost all of the contained organic matter is detrital, reworked material of a variety of ranks and generally is poorly preserved. The true rank of the sample is probably in the high volatile bituminous range, based on the observation and measurement on only a couple of grains. Therefore treat the quoted value for reflectance as an approximation only.

J. Allan

JA:sb
cc: J.R. Rawling

0126-JA

8010 (1)

Sept. 8/84

Geologist : S Charbonneau & R. Tamaki
weather :- Sunny
General Area : ; Kluzkus Rd.
Project :- Nechako
Map :- 93F/7, 93F/10

Basic Purpose :- To check
Hazelton group sediment found
in a clear cut

intersection- Kluskus Rd and
Big Bend Rd 18518.2 Km

road after enormous bump
18525.0 Km

creek at 27.8
creek at 29.9

road intersection
18531.5
back 18540.6

LEVEL

KL 001

(2)

chert pebble conglomerate float

- shale
- dark gray (f)
- med. dark gray (w)
- poorly consolidated
- o/c thickness difficult to say
- very fissile
- very sharp pointed talus fragments
-

continuing down the road
- truck blocked by tree, we walked for several kilometer into Hazelton seds, saw no outcrop, but we saw abundant chert pebble conglomerate floats

①

KL 002   218/62 NW

conglomerate

A clast - 2-3mm
medium gray to very light gray (W)
chert pebbles 80%
volcanic " 20%
- well rounded
- poorly sorted
clast 70% } clast supported
matrix 30%
- thickness difficult to assess

B matrix

very coarse grain sst
med dark gray (F)
dark gray (W)
- poorly sorted
- well rounded
- well consolidated
- blocky talus fragments
- thickness ½ m for the conglomerate

LEVEL

KL002A

232

(2)

- ~~052~~ / 63° NW

- same chert pebble cong

- accuracy hard to assert

KL003

- conglomerate

- same as the previous conglomerate
- noticeable qtz veining cutting across the rock

KL004 233 / 55 NW

- sst
- med dark gray (f)
- light gray (w)
- fine grained
- poorly sorted
- well rounded
- well consolidated

appears to be about 1m thick

①

note: three different lithologies

sst / shale / congl / sst
moving up section
⟶

KL005

- similar sst to o/c
no. 004 - fine grain sst

Back at the main Kisuku 5 Rd

18 554.5

- intersection 18562.1

18566.0

- we walked towards
an large o/c

(2)

KC006

- ssf
- coarse grain
- medium bluish gray (f)
- moderate brown (w)
- poorly sorted
- subangular
- well consolidated
- ~~40~~ 40% spar, 30% RF, 30% qtz
- large o/c (4 m thick)
- no orientation possible

- chert pebble congl float

575.0

1

Sept. 9/84

Geologist: S. Charbonneau & R. Tamaki
weather :- sunny
General Area :- Kluskus Rd.
Project :- Nechako
Map :- 93F/7

Basic purpose :- to check Hazelton group sediments on a unknown creek

[007]   134/34 SW ???

- sst
- fine grained
- dark grey (f)
- med dark gray (w)
- well rounded
- poorly sorted
- well consolidated
- appears to be about 3m thick
- breaks into sharp pointed talus fragments
- good isolated exposure.

LEVEL

(2)

KL008 114/82 SW

- sst
- fine grained
- med. dark gray
- med. gray
- well rounded
- poorly sorted
- breaks into sharp talus fragments
- well consolidated
- has a metamorphic type weathering pattern (schistosity)

- below the sst
an area of chert pebble conglomerate

clast - 1-7cm.
clast colour - med dark gray to light gray
- well rounded
- poorly sorted
- clast supported

(1)

- Chert pebbles 70%
  volcanic pebbles 30%

- clasts ~~are~~ ~~appears~~ are aligned in one direction (similar to the dip)

- matrix

- very coarse sst
  - poorly sorted
  - well rounded
  - well consolidated
  - med dark gray (f)
  - brownish gray (w)

- the fine grained sst is overlying the conglomerate

walking ~~[illegible]~~ ~~meter~~ down section we observed the same fine grained sst followed by a thick section of conglomerate
112/58 SW
- this has more qtz veining

LEVEL

$10\frac{1}{2} - 7$

(2)

- followed by more fine grain sst (50 m)

KL009 120/39 SW

- sst
- fine grained
- med dark gray
- dark gray
- well rounded
- poorly sorted
- breaks into sharp tabus fragment
- similar to the other o/c

KL010 162/43 SW

- sst
- fine grained

1

- dark gray (f)
- med. dark gray w)
- breaks into small pointed talus fragments
- thickness appears to be around (1-2 m)

KLD 11

- sst
- fine grained
- dark gray (f)
- olive gray (w)
- poorly sorted
- breaks into sharp irregular shaped talus fragments
- no orientation
- poor isolated exposure

Sucha Creek

- from the beginning all the o/c are volcanics

LEVEL

(2)

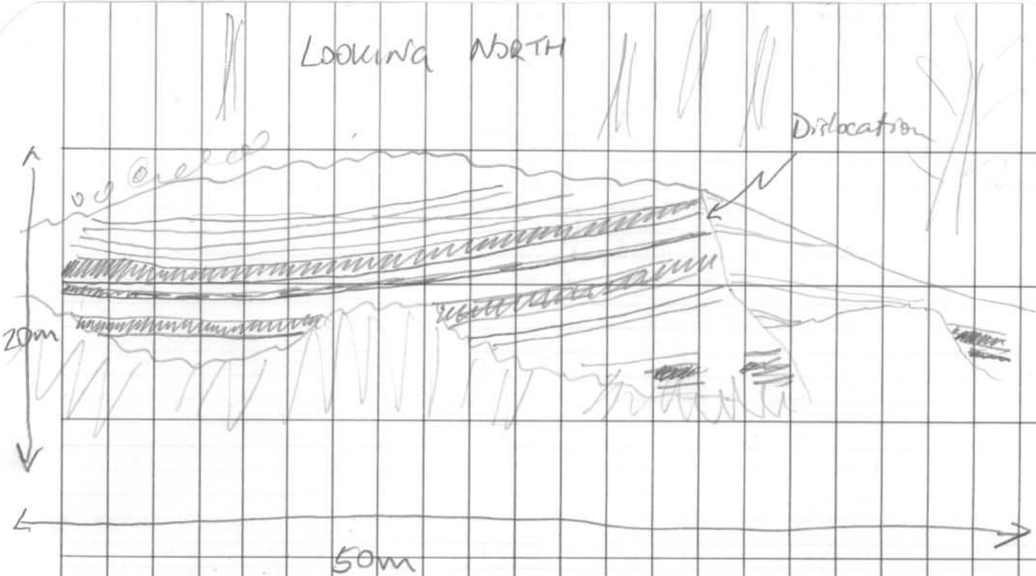
KL012

A) intermediate volcanics
- greenish colour (f)
- aphanitic
- greyish brown (w)

B) lapilli tuff
- feldspar phenocrysts abundant
- lath shaped 2mm - 5mm
- some rounded
- qtz eyes - well rounded
- greenish in colour
- weathers browny-gray + feldspar phenocrysts weather white
- lithic (black) fragments

No. Cheslatta Falls
Date 28 Aug 85 Page 801

COAL SEAMS IN DRY OVERFLOW



Dip into Bank @ 10-15°
Multiple seams Lignite in Creamy white tuff interbedded.
May be local dip.

No. NCO 1
Date 28 Aug '85 Page

NCO 1 Nechako

strike 120 dipping 60 - 70°
to the S.W.

Resampled seams
Appear to be multiple thin seams
in slate and highly cleaved
pebbly cong.

Further down section Greeny Pelites.

801 (1)

Sunday, September 8th.

Big Bend Ck.
Susan Derby & I on the (Wechako Ridge) Rd.

NR001

- @ km 17
- large rib of O/C.
- green colored rock with distinctive grains
- very well indurated
- weathers green & reddish
- white mineral veins shooting through it
- distinctive joint planes ⊥ to each other
- scratches easily, may be soft & chloritized volcanics ?
- 1st impression is that it was a cooked sed.
- light colored grains may be feldspar

165/48° ? bedding ?

- in one place, get an aphanitic, green lens that weathers orange and displays a vesicular nature
- perhaps this is some sort of sill ?

LEVEL

NR002

②

Conglomerate - rounded weathering
- chert pebbles
- appears to be about the same orientation as previous outcrop?
- clast size is quite large (2mm - 7cm)
- no other clast type seen
- matrix is dark grey, f → l.med grained sst
- clasts are subrounded in a variety of shapes
- clast supported
- weathers a speckled white

NR003

Schist - lineation of grains
- schistosity
- weathers grey → orange
- shiny
- contains dark fragments and orange blebs, & white frags
- blueish → gun metal grey
- has a blood-red mineralization in places
- almost like a sheared congl.
- has clast alignments

- high-up on rib, definitely looks like conglomerate
- 068/19°? may be just a cleavage plane
- due to schistocity as well as the presence of an iron-stained joint plane, it is difficult to tell the orientation

| JD'S outcrop N001 |

- coal exposure

143/35° ?

- taken on a sheared silty mudstone surface near where the coal is ?

131/54° @ top of outcrop ✱

↑ best reading

| NR004 | just above coal O/C

Sandstone - bluish green on fresh - wthrs lt grey

- well indurated - almost a quartzite
- v fine grained to v. med grained
- some dark cherty fragments
- 3 good cleavages at rt. angles to each other

- cont. 2 pages over →

LEVEL

Coal Thick.	Rock Thk	TOP Lith	Comments
	*		samples taken for vitrinite analysis
	70cm + Covered		Mdst - iron stained, sheared - carbonaceous, better consolidated
15	40cm		Clayey Mudst carbonaceous, ↳ poorly consolidated
3	30cm		Coaly Mudstone - very soft c̄ bright coal flecks, mixture of coal & mdst
20cm *			Coal ⇒ harder than unit below - orangy tinge to it (maybe higher resin content, sheared →
* 13cm			Coal - very soft, powdery, large resin blebs, no cleat, appears to be quite →
	1.2m		Mdst - relatively hard, brownish gray, - tiny orange resin blebs (1mm), →
	37cm		Coaly Mdst ⇒ as previously described
	30cm		SST - argillaceous, muddy, poorly consolidated, veinlets throughout, →
	25cm		Coaly Mud - as previously described
	8cm		Mudstone - yellow green colour, appears like it has been highly sheared, fler→
	25cm		Coaly Mud ⇒ no distinct coal bands (all mixed together
	5cm		Clayey Mud Med. light gray, similar to ash bands
	35cm		Coaly mud, soft, unconsolidated, rare bright sparkles, churned up c̄ overlying →
	50cm		apple green on fresh, weathers yellow brown, v.f.g. → SST

BASE

Comments cont'd ①

than below

has crispy sound to it as scrape it

sheared

becoming carbonaceous near the top

iron stained

compacted again => has little bits in it
- appears to be flattening out but only due to what's overlyin-

sediments, black in colour

LEVEL

(2)

NR004 continued

- appears to be fairly massive
- difficult to determine bedding
- followed rib down - ends up at north end of J.D.'s outcrop
- no orientation - could be same as N001 (JD's) but I sure wouldn't bet my career on it

NR005

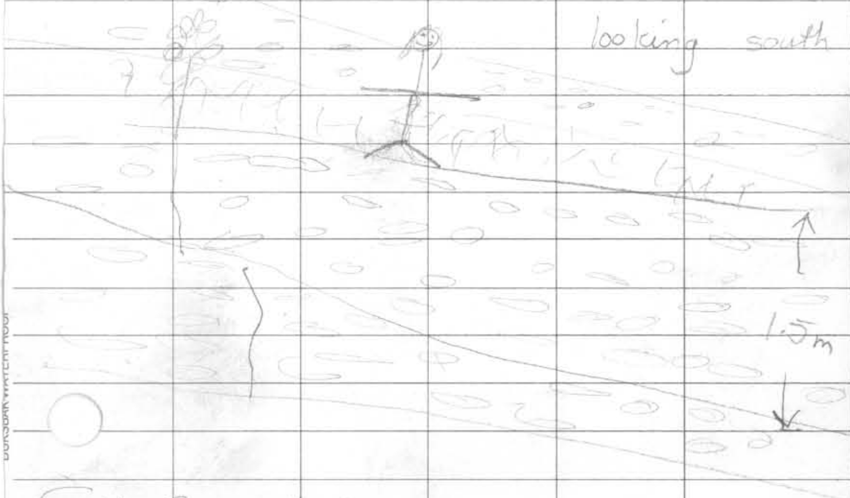
- in clear cut to the northeast of N001

Conglomerate - chert pebble (as before)
- pebbles are aligned
- definitely a strain fabric
- clast supported
- forms resistant ribs
- an overall med. lt. grey color
- looks fairly well-bedded
- parts of the outcrop look almost like a silty mudstone (lt grey) with floating pebbles here & there
- definite schistose fabric

137/15°   150/10°

140 / 11°

-may be channelling



- ~ 9 m thick
- outcrop extends for at least 70 meters
- Photos # 14 Frame - outcrop
  Frames 15 & 16 - detail of conglomerate & fabric
  BMW's Film
- outcrop continues for another 3m
  ~ 12m thick total
- further south along clearcut, get congl. w. v. f. gr sst interbeds, sst is off-white in color, hi in quartz content ~~...~~ in places
- some ssts look like they have a granitic source

LEVEL

(2)

- just north of this sst O/C is an intrusive, phaneritic, green color, lots of plagioclase, looks chloritized
- ~ halfway between this stuff & the original conglomerate is more conglomerate, looks like the same orientation

NR 006 Conglomerate - chert pebble
- as before
- some clast alig[illegible]ent but not as much as before
- ~ 1m thick
- resistant

185/32° ← not great

1

Monday, September 9th
Bob & Steve on creek on east side of Nechako Range.
BMW & Susan flying here & there.

NR007 Stopped at outcrop near lake behind Cutoff Butte

Volcanics - purple & green
- highly quartzitic & hard
- some portions of the outcrop display feldspar xtals
- weathers med. lt. grey
- distinctive joint pattern, but no discernable bedding

NR008 Outcrop in clearcut just below road near coal o/c

Conglomerate - chert pebble
- aligned and flattened clasts
- ~~6m~~ thickness ~~=~~ >10meters +
- 117/22°
180/50° - steepens to the south
174/49

LEVEL

NR 009 In top of clearcut on west side of Nechako Range where the black bear scared us yesterday.

Interbedded volcanics & seds.

Sandstone - crystalline
- quartzite?
- hard well bedded
- no distinct grains

Volcanic - greenish-grey
- 5mm long feldspar phenocrysts
- numerous calcite veins
- also contains block stringers of what appears to be mud.

160/35° 163/46°

- dip-slope
- 5m + thickness (if orientations are to be trusted)

NR010 Top of Nechako Range where repeaters are

Silty Phyllitic Mudstone - hard & cooked
- greenish grey
- dip ~ 50° SW

Grit - sst grit
- med grey
- platey cleavage
- conglomeratic in places (up to ½ cm clasts)
- 175/48°
- pebbles look sort of aligned
- clasts are chert,
- some clasts are 2cm in diameter
- 103/62°

NR011 Ridge top 1 km NW of high point

Conglomerate - chert pebbles
- as before
- aligned clasts
- platey cleavage

108/45° 100/55°

- resistant & cliff-forming
- at least 10m thick

7

NR012 Conglomerate - same go @ O/C oil
- below the conglomeratic unit, get a phyllitic sltst so at the top-most point of the range, greenish grey on fresh, displays a 2nd cleavage oblique (low angle) to bedding.
- at least 3m thick
- congl. is at least 5m thick
- 160/46°

NR013 Top end of creek on North side of Blackwater River

Basalt - reddish-brown
- ~~lum~~ lumpy weathering

NR014 - top of Tatelkuz Mtn.
Volcanic - aphanitic, green, hard, some tiny plag? phenocrysts
NOT COAL

```
OC1A       1985SEPT    NR001850908BMW BMW 379275.0 5932420.0 960.0125548 3
OC2A04010 02MJHZG              VOLCANIC          0               NNNN010 N
OC1A       1985SEPT    NR002850908BMW BMW 378875.0 5932260.0 945.01        9
OC2A04010 02MJHZG              CONGLOM.          0               NNNN010 N
OC3AMASSIVE
OC1A       1985SEPT    NR003850908BMW BMW 372125.0 5930040.0 975.0115819 3
OC2A04010 02MJHZG              SCHIST            0               NNNN010 N
OC1A       1985SEPT    NR004850908BMW BMW 377520.0 5929910.0 983.01        9
OC2A04010 02MJHZG              SST               0               NNNN010 N
OC3ANO GOOD BEDDING PLANES
OC1A       1985SEPT    NR005850908BMW BMW 378130.0 5930600.0 968.0123011
OC2A04010 02MJHZG              CONGL    VOLC     0               NNYY010 Y
OC3AINTERBED OF GREEN PHANERITIC VOLCANIC TO THESOUTHEAST
OC1A       1985SEPT    NR006850908BMW BMW 378500.0 5931430.0 939.0127532 3
OC2A04010 02MJHZG              CGL               0               NNNN010 N
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OC2A04010 02MJHZG              VOLC              0               NNNN010 N
OC3ANO ORIENTATION
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OC3ADIPS SHALLOW TO 22 TO THE NORTHWEST
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OC2A04010 0 MJHZG              VOLC              0               NNNN010 N
OC1A       1985SEPT    N001850908BMW BMW 377170.0 5929780.0 975.0123335 1
OC2A02010 02MJHZG                                                YNNY0604Y
OC3AOUTCROP IS FROM SEPT1984. J.DUNN MAPPED IT PREVIOUSLY
OC1A       1985SEPT    KL001850908BITBTNK 393600.0 5920050.01310.62
OC2A01010 0 MJHZG                                0               NNNN010 N
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OC2A01010 0 MJHZG              CONGLOM  CHERT PEB0               NNNN010 N
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OC2A01010 0 MJHZG              SANDSTONE         0               NNNN010 N
OC1A       1985SEPT    KL006850908BITBTNK 395055.0 5916155.0      2        9
OC2A01010 0 MJHZG              SANDSTONE         0               NNNN010 N
OC3ANO ORIENTATION POSSIBLE
OC1A       1985SEPT    KL007850909BITBTNK 389500.0 5920700.01310.6122534 0
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OC2A04010 0 MJHZG              SANDSTONECONGL    0               NNNN010 N
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OC2A02010 0 MJHZG              SANDSTONE         0               NNNN010 N
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OC2A01010 0 MJHZG              VOLCANICSTUFF     0               NNNN010 N
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From: File BMW, ODFILE, NECHAKO

GEOLOGICAL SURVEY
OF CANADA

MEMOIR 324

NECHAKO RIVER MAP-AREA, BRITISH COLUMBIA

By
H. W. Tipper

DEPARTMENT OF
MINES AND TECHNICAL SURVEYS
CANADA

PREFACE

The study of Nechako River map-area was begun in 1949 as part of the systematic program to map Canada geologically. The Aluminum Company of Canada constructed Kenney Dam on Nechako River as part of a development to supply power to their plant at Kitimat, British Columbia, and as a result, areas in this drainage system are flooded below 2,800 feet elevation. But these areas were mapped before the dam was completed.

This part of the Interior Plateau of British Columbia is underlain by Permian to late Tertiary sedimentary and volcanic rocks and by Jurassic to Cretaceous granitic rocks. A thick mantle of glacial drift obscures the bedrock and this may possibly be a major reason for failure to find important mineral deposits. In this report, the several rock-units are described, the geological history is outlined, and the economic geology is discussed.

J. M. HARRISON,
Director, Geological Survey of Canada

OTTAWA, December 22, 1960

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CHAPTER II

CHAPTER III

Illustrations

NECHAKO RIVER MAP-AREA, BRITISH COLUMBIA

Abstract

Nechako River map-area, in central British Columbia, is physiographically a part of the Interior Plateau, with low relief and few bedrock outcrops. The Upper Triassic and Lower Jurassic Takla Group, deposited in a northwest-trending eugeosyncline, is characterized by basic volcanic flows, breccias and tuffs with interbedded black argillite, fine greywacke, and minor limestone beds. The marine Middle Jurassic Hazelton Group rests unconformably on the Takla Group and similarly is made up of basic volcanic rocks but differs in that the interbedded sedimentary rocks are mainly chert-pebble conglomerate, greywacke, and minor shale or argillite. Upper Jurassic shale and argillite underlie a very small area. The non-marine, Upper Cretaceous to Oligocene, Ootsa Lake Group, resting with angular discordance on Jurassic or Triassic rocks, is divisible into two units—a lower andesite and an upper rhyolite. The Ootsa Lake Group is overlain unconformably by the non-marine, late Tertiary Endako Group, an essentially undeformed succession of basaltic and andesitic plateau lavas, breccias, and tuffs.

The area was overridden by Pleistocene glacier ice which, in its final phases, moved across the area in a direction varying from N40°E to east. Granitic, granodioritic, and dioritic rocks of the Topley Intrusions were emplaced in Early Jurassic time. Late Jurassic or early Cretaceous granitic rocks intrude rocks of the Hazelton and Takla Groups.

Lack of good rock exposures and the wide areas of barren Tertiary rocks have discouraged extensive prospecting. No large economic mineral occurrences are reported within the area.

Résumé

La région à l'étude se trouve au centre de la Colombie-Britannique. Du point de vue physiographique, elle fait partie du Plateau intérieur. Le relief y est peu marqué et on y trouve peu d'affleurements de la roche en place. Le groupe Takla, qui remonte au Trias supérieur et au Jurassique inférieur, s'est déposé dans un eugéosynclinal allongé suivant le nord-ouest; il est caractérisé par des roches volcaniques basiques, en forme de coulées, brèches et tufs et interstratifiées avec de l'argilite noire, du grauwacke fin, et quelques couches de calcaire. Le groupe marin Hazelton, qui remonte au Jurassique moyen, repose en discordance sur le groupe Takla et se compose également de roches volcaniques basiques, mais contrairement à l'autre groupe, les roches sédimentaires interstratifiées comprennent principalement un conglomérat à cailloux de chert, du grauwacke ainsi qu'une petite quantité de schiste ou d'argilite. De l'argilite et du schiste du Jurassique supérieur constituent une très petite étendue de la roche en place. Le groupe non marin Ootsa Lake, dont l'âge se situe entre le Crétacé supérieur et l'Oligocène, repose suivant une dis-

cordance angulaire sur des roches jurassiques ou triasiques, et on peut le diviser en deux unités, savoir une andésine au bas et une rhyolite au haut. Le groupe Ootsa Lake est recouvert en discordance par le groupe non marin Endako, qui remonte à la fin du Tertiaire et se compose d'une succession essentiellement non déformée de laves, brèches, et tufs tant basaltiques qu'andésitiques du type plateau.

La région a été recouverte par les glaciers du Pléistocène qui, à leur déclin, ont traversé la région suivant une direction qui variait de N40°E à franc est. Les roches granitiques, granodioritiques et dioritiques des intrusions Topley se sont déposées au début du Jurassique. Des roches granitiques de la fin du Jurassique ou du début du Crétacé font intrusion au sein des roches des groupes Hazelton et Takla.

L'absence d'affleurements rocheux convenables et les grandes étendues de roches tertiaires stériles ont nui à la mise en œuvre de travaux poussés de prospection. Aucun gîte étendu de minéraux d'importance économique n'a été rapporté dans la région.

Chapter I

INTRODUCTION

Nechako River map-area lies between latitudes 53 and 54 degrees and between longitudes 124 and 126 degrees, and comprises an area of about 5,800 square miles near the geographic centre of British Columbia.

Accessibility

The Canadian National Railways and the Northern Transprovincial Highway lie immediately to the north. Secondary roads and farm roads, negotiable by automobiles, form a connecting network in the northwestern and northeastern parts, and extend as far south as Kenney Dam and the outlet of Ootsa Lake. A passable car road extends from Batnuni Lake eastward to Quesnel, about 120 miles.

Travel by boat is practicable on most of the larger lakes and rivers in the west half of the area. Flooding of low country above Kenney Dam has not greatly impaired the value of water transport, and navigable waterways extend 70 miles westward from the area.

The numerous lakes afford many excellent landing places for float-equipped aircraft making almost any part of the area accessible. Aircraft for hire are based at Burns Lake and at Prince George.

Many excellent wagon roads, some sleigh roads, and pack-trails that are rapidly falling into disuse, reach into the more remote parts. In the south half of the area the wagon roads between the many Indian Reserves are kept in good repair. The forested areas are fairly clear of undergrowth and windfall and only in burned areas is travel greatly impeded. Swamps, although numerous, are mostly small and easily crossed or avoided. Back-packing is seldom necessary.

Settlement

The area is sparsely settled. In the northwestern quarter a few ranchers and farmers live in the vicinity of Grassy Plains, Danskin, Cheslatta, and Marilla—the local post offices. Small communities near the east end of François Lake, near Lily Lake, around Tachik and Nulki Lakes, and along Nechako River represent the outermost fringe of settlement spreading southward from the railway, and a few trappers and ranchers live at Tatuk Lake, at Batnuni Lake, and along the upper part of West Road River.

The Indian population is fairly large but widely scattered. The largest Indian community is the Stony Creek Reserve with thirty or more houses and a church.

Industries

Farming or ranching, trapping, lumbering, and guiding are the principal means of livelihood. Grain crops can be grown successfully near Tachick and Nulki Lakes, and to a lesser degree around Grassy Plains and Lily Lake. A few cattle are raised by most farmers and ranchers in the northern settled areas, and cattle ranches are operated in the lower Nechako Valley and Batnuni Valley. Distant markets and a severe climate with long winters make farming and ranching a marginal enterprise.

Trapping is carried on mainly as a supplement to farming, ranching, or guiding, and few depend entirely on this for a livelihood. In recent years with the decline of fur prices, less and less trapping has been done.

Lumbering is of importance in the northern part of the area. Spruce is cut for lumber and pine for ties. Although much of the area is burned or covered with scrub timber and second growth, many large stands of suitable timber remain; distance from the railway and accessibility are factors in deciding what timber is marketable.

In past years the tourist industry provided an income for several residents near Ootsa Lake. Guiding for fishing and big-game hunting was a profitable seasonal occupation but raising of lake levels at the head of Nechako River has disrupted the industry and forced many of the guides and outfitters to move. In the vicinity of François and Uncha Lakes several residents cater to hunters and fishermen.

The Indians of the area engage in trapping, a few raise cattle, some take summer employment on ranches south and east of the area, a few work as guides for hunting outfitters, some cut ties, but few are steadily employed at one occupation for any great length of time.

Climate

The climate of Nechako River area, like that of all the Nechako Plateau, is a continental type with warm summers and long cold winters. Annual temperatures range from a maximum of about 90 degrees to a minimum of below minus 40 degrees (Farstad and Laird, 1954, pp. 12-15)[1]. The annual precipitation at Vanderhoof is reported to be 13 inches, and a comparison of the vegetation near Vanderhoof with that of the area as a whole suggests a similar general precipitation; snowfall is light, particularly in the southern part.

Pronounced climatic variations occur from one summer to another. During the 1952 field season, while the author was working in the southeast quarter, except for thunder showers there were three rainy days from June 23 to September 21, but in 1953, in the northeast quarter, there were only nine days in July and August without rain. Frost is not uncommon above 3,000 feet elevation during any summer month.

[1] Names and/or dates in parentheses are those of references cited in Bibliography.

Flora and Fauna

Much of the map-area is forested and offers environment suited to the perpetuation of the many varied animal species.

Lodgepole pine is by far the most abundant tree, occurring at all elevations up to tree-line, 5,000 to 5,800 feet; black and white spruce, and aspen poplar are next in abundance. These four varieties make up well over 80 per cent of the trees in the area, and all other species are only locally abundant. Douglas fir occurs on the moist south shore of François Lake and near Batnuni Valley. White birch is restricted to the aspen poplar forests in the northern part; balsam occurs sparingly with spruce in the wetter parts and near tree-line; alpine fir occasionally occurs near tree-line. Stunted whitebark pine has been noted at several places, and cottonwood, although rare, occurs along the major waterways. Larch was found only in the swampy area north and east of Tatuk Lake.

Many open meadows and south-facing valley slopes produce a thick, luxuriant growth of several types of grasses mixed with pea vine, vetch, and other broad leaf plants. Such meadows and sparsely timbered areas provide the hay meadows and range land for ranching, and abundant feed for moose and deer.

Mammals noted during field work were: moose, deer, black and brown bear, grizzly bear, wolf, coyote, porcupine, skunk, rabbit, beaver, mink, muskrat, marmot, red squirrel, chipmunk, rock rabbit, and several types of mice. Other mammals reported include cougar, wolverine, marten, fisher, weasel, otter, red, silver and cross fox, and lynx. Goat and sheep are not known on any of the ranges; caribou were once present in the Fawnie Range as indicated by many very old antlers; wolves are not so abundant here as in other parts of British Columbia, probably the result of persistent efforts to exterminate them.

Birds of many species are abundant. Game birds include Franklin's grouse, blue and ruffed grouse, ptarmigan, prairie chicken, many types of duck, and Canada goose. A few Canada geese are known to nest within the area, particularly along Coglistiko River in the southeast quarter of the area. Pelican were seen on the lower Euchiniko River and on Entiako Lake. In 1949 one swan was seen on Murray Lake. Bald eagle, loon, and many types of small birds are familiar sights.

Rainbow trout are common to all major lakes and streams and attain their greatest size and importance as a game fish in the lakes drained by Nechako River. Char are present in all other lakes, some of the largest have been caught in Uncha and François Lakes; none occurs upstream from Nechako Canyon. Sockeye salmon ascend some streams but waterfalls prevent entrance to some of the larger lakes particularly above Nechako Canyon, Cheslatta Lake, Tsacha Lake, and Qualcho Lake (see Plate I). Salmon were noted in François Lake, West Road River, and lower Nechako River. Other fish caught or reported include kokanee, ling, suckers, squaw fish, and whitefish.

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History

Sir Alexander MacKenzie in 1793 crossed the southern part of the map-area on his journey overland to the Pacific Ocean. He followed the West Road (Blackwater) River through the area and continued westward roughly parallel with its southern boundary. In taking this route, MacKenzie probably chose the most direct and most easily travelled route possible through the interior of the province.

During the nineteenth century the main activity in Nechako River area was trapping, with trading at the various posts to the north, at Fort Fraser, Fort St. James, and Fort George. No serious attempt at settlement was undertaken until the twentieth century as the area was not on the main travel routes, did not offer opportunities for placer mining, did not appear interesting to prospectors, and did not contain much land suitable for agriculture.

A Hudson's Bay Company Post was established within the area on one of the Kluskus Lakes near West Road River about 1844, but it was soon abandoned (Morice, 1904, p. 244).

Near the end of the nineteenth century, settlement in the Bella Coola valley to the southwest opened a new port of entry to the interior of the province. About 1905, settlers began moving into the Ootsa Lake country over the Bella Coola trail, which runs in a northerly direction from Tsayakwacha Lake to Ootsa Lake, and most of the early settlers followed this route bringing with them their cattle, horses, and possessions. Over this route also moved the supplies needed in the Ootsa Lake valley.

The Prince Rupert Branch of the Canadian National Railways was completed in 1941, and settlement has gradually moved southward from Vanderhoof, Fraser Lake, and Burns Lake. With this new line of communication, the Bella Coola route fell into disuse.

Subsequent development of this area has been slow, with most of the activity concentrated in the north, whereas the south half of the area with few exceptions has remained virtually unchanged.

Alcan Project

After World War II the Aluminum Company of Canada investigated the possibility of damming the Nechako River, raising the level of the lakes of Tweedsmuir Park, and reversing the drainage direction through a tunnel. By this means electrical power could be developed near Kemano River on the Pacific side of the Coast Mountains, power that was to be used for an aluminum plant built at Kitimat.

The key to the project was the building of a suitable dam. In 1949 test drilling of some proposed dam sites near the head of Nechako River, near the outlet of Intata Lake, was undertaken without success. In 1950 the site at the head of the Nechako Canyon was investigated and found to be suitable. In 1951 a road was built to the site from Vanderhoof and preliminary work begun. The construction of the dam (the Kenney Dam) proceeded rapidly, and was completed in the autumn of 1952. The diversion tunnel was closed and the raising of the lake levels began.

The Kenney Dam is 317 feet high, 1,500 feet long at top, 40 feet wide at top and 1,170 feet at base. The materials used in its construction were all found locally. Quarries were opened in the late Tertiary basalt and massive to vesicular basalt was readily quarried within one half mile of the dam site. Suitable gravel was found along Nechako River about the dam, and suitable clay from the higher areas above the river valleys.

Previous Geological Work

In 1876, G. M. Dawson (1878, pp. 17-94) of the Geological Survey of Canada travelled through the area via Euchiniko River, Blackwater River, Qualcho Lake, and north to Nechako River and Fort Fraser; in 1905, W. F. Robertson, the Provincial Mineralogist (Robertson, 1906, pp. 87-139) crossed the northwest quarter of the area following Tahultzu and Cheslatta Valleys; and in 1916, J. D. Galloway of the British Columbia Department of Mines (Galloway, 1917, pp. 134-186) followed the Bella Coola trail south from Ootsa Lake. Aside from brief reports of these trips, there are no published geological reports on any part of the area. Work on which this report is based was done during the field seasons of 1949 to 1952.

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Chapter II

PHYSIOGRAPHY AND GLACIATION

Physical Features

The area is drained by streams flowing to the Pacific Ocean. Prior to the construction of Kenney Dam, Nechako and West Road Rivers and their tributaries drained most of the area eastward into the Fraser drainage system but now the area above Kenney Dam is drained to the Pacific Ocean through Kemano tunnel. Only a small part of the southwest quarter is drained westward directly to the ocean through Dean River drainage system.

Compared with most of British Columbia, the area is not mountainous (*see* Pl. II). Two distinct, though not rugged, ranges, Nechako and Fawnie, occur in the central part, but even these rise gradually and gently from broad valleys to mountain crests. Elsewhere in the area the topography is characterized by groups of rounded hills with no particular arrangement into distinct ranges. Elevations range between about 2,500 and 6,300 feet, but the local relief rarely exceeds 2,500 feet. The major valleys, such as Ootsa Lake, Entiako, Chedakuz, Nechako and West Road, are broad and uneven and merge imperceptibly into the flanking hills and mountains. The complex drainage pattern forms a disjointed network of shallow V-shaped valleys cut into the broad irregular valley bottoms.

The topography shows a marked relation to the underlying rocks. The northwest trend of Fawnie and Nechako Ranges reflects the northwest trend of the folded, Jurassic rocks. The rounded hills of the northern quarter of the area reflect the absence of pronounced trends in either the early Tertiary volcanic rocks or the Topley granitic rocks of the Nulki Hills. The flat, swampy areas are almost invariably underlain by flat-lying late Tertiary basalts.

Physiography

The physiography of the Canadian Cordillera north of latitude 55 degrees has been studied extensively by Bostock (1948). His system of physiographic subdivisions is here extended to include Nechako River area (*see* Table I, Fig. 2, Map 1131A).

Nechako River map-area is entirely within the Interior Plateau, which Bostock divided into two secondary subdivisions—Fraser and Nechako Plateaux—and placed the boundary "about the fifty-third parallel" (1948, p. 42). The impression gained is that the division was based on convenience rather than on a distinct difference in the two parts. However, if the boundary is more closely defined as West Road River to its source and thence westward to the Coast Mountains, the two areas are distinctly different both geologically and topo-

Table I

Systems	Areas	Subdivisions			
		Primary	Secondary	Tertiary	Quaternary
Interior System	Southern Plateau and Mountain area	Columbia Mountains			
		Interior Plateau	Fraser Plateau		
			Nechako Plain		
			Nechako Plateau	François Lake Highlands	Nulki Hills
					Chealatta Hills
					Tetachuck Hills
				Plateaux and Valleys	Entiako Plateau
					Chedakuz Valley
					Nechako Valley
					Euchiniko Plateau
				Interior Ranges	Fawnie Range
					Nechako Range
	Central Plateau and Mountain area				

graphically. Fraser Plateau is underlain mainly by Tertiary volcanic rocks whereas the Nechako Plateau is underlain mainly by pre-Tertiary volcanic, sedimentary, and granitic rocks. Nechako Plateau is more dissected than Fraser Plateau and is rougher in detail, with greater local relief.

The Nechako Plain, although extensively underlain by flat-lying volcanic rocks, more probably takes its relatively even surface from extensive erosion which truncated rocks of several ages, and from a deep covering of glacial till or silt and glacial lake clay (Armstrong, 1949, p. 8).

François Lake Highlands (*see* Pl. II) is a good descriptive name and its further subdivision into groups of hills is topographically correct. These hills are in no way oriented into ranges of mountains although some are referred to as mountains. Most of these hills are less than 5,000 feet in elevation with less than 1,500 feet relief, and although some may rise abruptly, most rise gradually to a rounded summit. The apparent uniformity of summit levels in this subdivision suggests a dessected erosion surface.

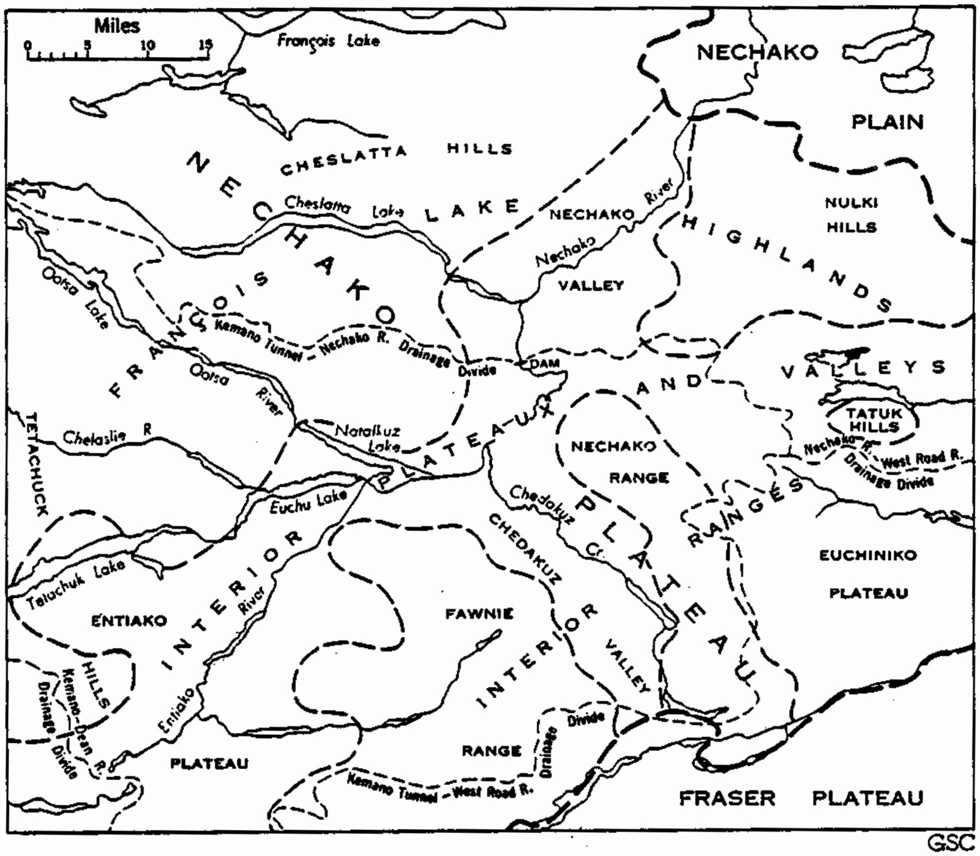

FIGURE 2. Physiographic subdivisions of the Nechako River map-area

Erosion Surface

Since Jurassic time, this positive area has been undergoing active erosion. How many cycles have occurred or the manner of erosion is not known. From a preliminary study, however, it is obvious that there is at least one erosion surface in this area—the one characteristic of the Interior Plateau (Bostock, 1957, p. 288)—at about 2,500 to 3,000 feet elevation. This corresponds to the broad flat areas in the south and to most of the major valley bottoms. These surfaces rise gradually to the south and, with several interruptions, merge with the more striking plateau features of the Chilcotin River country. In Nechako River area this erosion surface is more dissected than it is farther south.

A second erosion surface may be inferred from the accordance of summit levels. A great number of hilltops have elevations near 4,500 feet and even where prominences are higher the summit levels rise gradually; particularly in the northerly part, the hills merge into a fairly uniform horizon. The tentative conclusion is that this is a very old dissected surface, but no proof is available.

Glaciation

Nechako River map-area was completely covered by glacier ice whose movement, at its maximum, was seemingly unaffected by the bedrock surface. The suggested thickness of 6,000 feet (Prest, 1957, *p.* 460) for the ice-sheet is not unreasonable, as in order to cover all hills and mountains it must have been at least 3,500 feet thick but to move with the freedom suggested by the glacial features it must have been much thicker. South of the area evidence indicates ice thicknesses in excess of 5,000 feet.

Glacial features are prominent, and most of the glacial information available from air photos and ground observations has been plotted on Figure 2. Greater detail, however, could be obtained by further ground studies.

Glacial Striae, Drumlins, Rock Drumlins, and Till Grooves

These features are grouped together because they all originate from the movement of the ice and because they offer the most precise means of determining the direction of the last movement. Glacial striae are fairly abundant, the more clearly defined ones being developed on Mesozoic volcanic rocks and Tertiary rhyolite.

Numerous drumlins occur throughout the area and possess the usual inverted teaspoon-shape. They are best developed in thick glacial deposits and in areas underlain by flat-lying Miocene basalt, where they form large 'fields of drumlins'. Elsewhere they occur singly, surrounded by rock drumlins and bedrock hills. Commonly 50 to 200 feet high, about a mile long and up to one quarter of a mile wide, the drumlins rise gently to a crest near the stoss-end and taper gently to the lee end, merging with depressions that, although distinct, are less prominent than the hills. These drumlins are composed essentially of till, although a bedrock core may be present. Included under drumlins are the more elongate drumlinoid ridges which, although differing in shape, are believed to be similar in origin (*see* Pl. IV).

Rock drumlins, commonly described as 'crag and tail', are similar in form and origin to the drumlins but differ in several aspects. Rock drumlins possess a bedrock 'crag', which forms the highest part of the feature, and a 'tail' that is moulded by ice on the lee of the 'crag'. They are strikingly linear features, with a much smaller width relative to length than the drumlins. The intervening grooves are narrow, sharply defined, and are as prominent as the 'crag and tail' features. Rock drumlins are best developed where glacial drift is thin and where the bedrock is hard and well jointed with an irregular surface. Areas of Tertiary rhyolites and Mesozoic volcanic rocks are well suited to their development.

The till grooves appear to be shallow linear grooves in an otherwise featureless till surface. They occur in areas of thick glacial debris or wherever the bedrock surface does not have a controlling influence on the developed glacial features. They are widely spaced and the intervening area bears no resemblance to drumlins. These grooves may be compared to scratches in a till surface formed by a few major irregularities in the base of the ice, which, for reasons unknown, were maintained during glacier flow, or they may be vestiges of drumlins or rock drumlin areas that have been almost obliterated by subsequent deposits.

All features mentioned point to a general ice movement in a direction varying from N40°E to east, and most drumlins, rock drumlins, and many glacial striae clearly indicate a southwestern source of ice. Air photographs of the area show that on some of the higher hills and in some protected areas another set of glacial grooves exists, indicating earlier ice movement quite different from that suggested for the last movement. On Uncha Mountain, near Grassy Plains, on Mount Hobson, on Tatelkuz Mountain, and at several other places in the area linear grooves vary in direction from N30°W to N10°E, but at no place is there conclusive evidence to show whether this ice moved northward or southward. A recent study by the writer of the distribution of erratics near Alexis Creek, southeast of Nechako River area, has shown that an earlier north-to-south movement of ice occurred in that area.

Eskers

Eskers are abundant throughout the area, more particularly in the southeastern half. For purposes of mapping they have been shown as two types: (1) single eskers, the typical sinuous gravel ridge; and (2) esker complexes, reticulate networks of ridges completely enclosing kettle-like depressions. The first type is not unusual, the second is similar in most respects to the 'compound eskers' of Carp Lake map-area to the northeast (Armstrong and Tipper, 1949). The term esker complex is however more descriptive than compound esker, suggesting not only complexity of pattern but also complexity of origin.

The only esker complex of importance extends from the east end of Natalkuz Lake along Nechako River for 6 to 7 miles (*see* Pl. III). This network of ridges is made up of porous and permeable gravel and sand, and rises as much as 275 to 300 feet above the river level, as it existed in 1950. The Aluminum Company reported a depth of about 300 feet of gravel and sand below the river level, which means a total thickness, in places, of 600 feet. However, the drilling may have penetrated relatively unconsolidated Tertiary gravel and sand similar to the materials of the eskers but unrelated to them. The sides of the esker ridges are steep, close to the maximum angle of repose for unconsolidated materials, and the crests of the ridges are sharp and narrow. The depressions are round or elongated parallel with the ridges, which in this instance parallel Nechako River. Although the complex is in the Nechako River valley it cannot be considered as confined by valley walls. The north side of the valley rises well above the highest ridge of the complex, but on the south side the valley wall attains a comparable elevation about 2 miles south of the most southerly esker ridge, and then only as the result of a gradual rise from the base of the esker complex toward Mount Swannell. Because of the lack of a confining bedrock wall on the south side, it can only be concluded that, at the time of formation of this esker complex, ice formed the southern valley wall.

The origin of this esker complex is not clear but certain features suggest some answers. The complex lies along one of the major meltwater channels and, as it is partly in this eroded channel, it must have been formed during the active period of meltwater run-off or later. Formation at a later date is unlikely because the presence of abundant ice in the vicinity is indicated by the many kettles and the probability of confining ice. It is suggested that this complex represents an ice jam that formed along the meltwater channel, the spaces between the ice-blocks being filled with sand and gravel. This feature was unquestionably the result of a local condition as it has no extension or counterpart elsewhere in the area.

Crevasse Fillings

Near the western boundary of the area, 6 miles southeast of Uduk Lake, a group of ridges are believed to be crevasse fillings. These are ridges which, although possessing the cross-sectional appearance of an esker, lack the characteristic sinuous shape. They are straight ridges with a slightly uneven top, composed of coarse, unsorted, and unstratified material giving the impression of a coarse till from which the fines have been washed. The arrangement in no way resembles the usual sorted and stratified material of an esker. These ridges are believed to have resulted from the filling of crevasses in a stagnant block of ice, the material being washed into the crevasses without further sorting or reworking. They occur in an area topographically suited to the existence of such a stagnant mass of ice, and their haphazard arrangement—some at right angles to one another—precludes the possibility of their being formed by moving ice.

Cirques

Cirques occur in the Fawnie and Nechako Ranges but, as they have been overridden by glacier ice, they must have formed before the last glaciation. Only in the Fawnie range is there evidence of renewed activity since that time, and even this does not seem to have been extensive. There is no active glacier ice in the area today.

Meltwater Channels

Two types of meltwater channels are shown on the map: (1) large channels with well-formed terraces; and (2) small or abandoned channels. The small channels were formed mainly by streams following the lateral margins of glaciers or by those forced from their normal channels by ice or glacial debris that blocked their course. Many of these channels are the erosional part of a subglacial stream, an esker representing its depositional part. It will be noted on the map that many eskers lead directly to one of these gullies or channels.

The large meltwater channels are the most outstanding glacial features. Along their course stretch the major rivers and most of the long, narrow lakes characteristic of this area. These channels were formed by meltwater streams pouring off a rapidly wasting and disintegrating glacier. The streams followed pre-existing depressions that were virtually clear of active ice and contained only disconnected fields of almost stagnant ice, and they formed the steep cut-banks and terraces that border, in part, all these drainage channels. Where no cut-banks or terraces occur to-day—thus leaving a gap in the channel wall—it is assumed that these gaps were then filled with ice. This is a reasonable assumption as such bordering areas commonly have a knob-and-kettle topography suggestive of stagnant ice.

The main channels were the François Lake, the Ootsa Lake, the Tetachuck, and the Entiako. Apparently the last two adequately handled all the water in their systems, but the first two at times carried more water than they could contain, so that the François Lake channel overflowed southward to Cheslatta Lake and eastward from its east end—neither course is followed by the present drainage.

The Ootsa Lake channel is probably the most spectacular drainage system in the area. It overflowed its channel via three outlets northward from the Ootsa Lake valley into the Cheslatta Lake valley and one southward into the Chelaslie Lake valley. It is interesting to note that two of these north-flowing channels were cut sufficiently low to require the erection of small dams across them to ensure the necessary flooding for the Alcan Project. The volume of water entering the upper Nechako River valley was immense, so much so that the Nechako Canyon either was unable to handle the flow or was blocked. Whatever the reason water was forced to turn eastward through Big Bend Creek and into the Euchiniko River valley and northward via several small channels to the lower Nechako River valley. Prominent cut-banks occur along its course, particularly along Intata and Natalkuz Lakes and terraces are prominent along its entire course. Through most of its course, this meltwater stream was actively eroding and the deposition that did occur was coarse sand and gravel. Silt or clay was however deposited along the lower part of Big Bend Creek, possibly because the flow of the stream slowed as the topographic divides were crossed. Banks and terraces occur along most of the course but there are many places where obvious confining features are lacking and the stream in these places does not appear to have spread out over low ground—probably was confined by stagnant ice.

Vanderhoof Lake Silt and Clay

The only important lake deposits are those laid down in the part of the Vanderhoof Lake basin occurring in the northeast part of the area. These deposits and their extent in Carp Lake area have been briefly described (Armstrong and

Tipper, 1949). In Nechako River area, silt and clay are the most common deposits, occurring as thin varves one quarter inch to 8 inches with an average thickness of about 2 inches. They are grey to buff, compact, relatively impermeable, and turn into a greasy, gumbo-like substance when wet. Considerable contortion occurs in the beds, particularly near the top of most sections. Pebbles common near the top of the deposits were previously considered to have been ice-rafted, but are now believed to have been deposited by ice. The surface of the deposits is undulating and frequently grooved parallel with the known direction of ice movement.

Because of the distortion of the upper beds and their contained pebbles, and the grooving of the surface, it is thought that these deposits were overridden by ice. These contorted upper beds presumably represent one poorly developed till sheet with an older till below the lake beds. The period of recession during which the lake deposits were laid down may have been very brief. The lacustrine deposits around Lily Lake do not appear to have been overridden by ice, suggesting either that these are later deposits or that the ice did not re-advance in this sector. The latter explanation is preferred.

Ablation Moraine and Pitted Outwash

Several outlined areas are characterized by deposits believed to be ablation moraine and pitted outwash, and include numerous eskers, kettles, and abandoned channels and gullies. These areas have poorly organized drainage systems and swampy conditions are common. No relation to bedrock is apparent to explain the chaotic arrangement of these deposits and the writer believes these areas to be sites of decay of large masses of stagnant ice.

The ablation moraine has an irregular, hummocky topography with low relief and no obvious arrangement. In some areas the surface is gently undulating. The material suggests a till from which the fine sand, silt, and clay have been washed. The resulting coarse gravel may be stratified but slump features are common. Little or no clay-rich till is present although it should be exposed below the ablation moraine if any valleys are cut sufficiently deep.

Pitted outwash occurs as small isolated patches, not as extensive areas. These patches apparently were a result of local conditions and no general explanation pertains to all areas. The kettles are 20 to 30 feet deep, rarely deeper, with swamps or meadows in the bottoms.

Eskers are numerous within these areas and leading away from their edges. They are thought to have been deposited in crevasses in the ice, or in tunnels under the ice while the ice was melting.

Drumlins, where present, are poorly formed and indistinct, rock drumlins are not present, and till grooves are irregular and indistinct. Presumably these features have been masked by the ablation moraine and outwash.

These areas where ice is believed to have stagnated are almost entirely restricted to the southeast half of the area and within this region most of the areas are on the northeast slopes of hills and mountains and cover the adjacent valley bottoms. They commonly lie with their long axes at right angles to the last direction of ice movement. The valleys and low areas generally have a low gradient, or a constriction or obstruction that would impede the easy flow of ice. Without the pressure of an ice-cap or the influence of a steep gradient and in areas less exposed to the sun the ice melted in situ.

The northwest half of the map-area is in sharp contrast. Sharply defined drumlins and rock drumlins are common, eskers and kettles are less common and smaller, and little topography characteristic of ablation moraine exists. Apparently no large mass of ice stagnated there.

Glacial History

The glacial cycle of a mountainous region according to Kerr (1934, p. 22) is believed to go through four stages: (1) alpine, (2) intense alpine, (3) mountain ice-sheet, and (4) continental ice-sheet. Nechako River map-area, although mountainous in part, is more typically a plateau area, and is therefore an area into which ice moved rather than one in which it initially accumulated. Although there are a few cirques that have been overridden by ice, it is unlikely that the Pleistocene ice-cap had its beginnings within the area. Indeed there are so few cirques, either preglacial or post-glacial, that the writer believes that little ice accumulated within the area while any hills or mountains remained above the ice-sheet, but rather that it accumulated in the Coast, Omineca, Cariboo, and Rocky Mountains and flowed into the Interior Plateau as piedmont glaciers that coalesced to form an ice-cap. As the topographic features of Nechako River area were covered, accumulation on the ice-cap itself began, reaching thicknesses probably well in excess of 6,000 feet. The direction of flow at the glacial maximum is not clearly indicated but it is possible that the ice flowed in general outward from the centre of the province and that many shifts in the position of the ice divide occurred. In Nechako River map-area the north-south grooves on some higher hills indicate that the ice moved from north to south or south to north. Whether this was at a time of maximum ice thickness is unknown; it was earlier than the last movement.

The last movement of ice across the area was from the southwest and west, and apparently at that time the ice was still thick enough to flow over all or nearly all topographic features, although it was thinning rapidly and the topographic features were exerting greater control on the manner of flow. Ice flowed around some hills and mountains such as Fawnie Range, but elsewhere, such as around Nechako Range, it thinned, broke into separate masses, stagnated, and melted in situ.

In most major valleys not parallel to the direction of ice movement, such as Chedakuz, Euchiniko, and Blackwater, there is no evidence of ice moving along the valleys; in other valleys, parallel with the direction of ice movement, there is no evidence to suggest valley glaciation. In the southeast half of the area, apparently much stagnant ice occupied the low areas but in the northwest half ice retreated in the usual manner.

The final break-up and melting of the glacier is thought to have been rapid. Gigantic meltwater channels—far greater than the streams now occupying them—suggest torrential floods of meltwater rushing through any avenue of escape. The hundreds of eskers and thousands of small channels trending in all directions suggest rapid melting, short-lived streams, and no organized drainage system. The course of many meltwater channels can only be explained by the presence of ice and in most places this ice is considered to have been stagnant.

Whether there were any complete withdrawals of ice followed by re-advances is a question that cannot be answered as yet, but there is evidence that ice withdrew briefly from the northeast quarter, lake deposits were laid down, and ice re-advanced over part of these lake deposits. The fact that this lake basin was not a second time completely covered by ice, points to a brief re-advance only.

Chapter III

GENERAL GEOLOGY

The rocks in the Nechako River map-area range in age from late Palæozoic to Recent. The most widespread sedimentary and volcanic formations are of Upper Triassic and Lower Jurassic, Middle Jurassic, and Tertiary age; the principal intrusive rocks are those of the Lower Jurassic Topley Intrusions and intrusions of post-Middle Jurassic age.

Table of Formations

Era	Period or epoch	Formation	Lithology
Cenozoic	Recent		Stream and lake deposits, talus, soil
	Pleistocene		Glacial and glacio-fluvial deposits
	Erosion interval		
	Miocene and (?) later	Endako Group	Basalt, andesite; related tuff and breccia; minor shale and greywacke
Angular unconformity			
Mesozoic and Cenozoic	Upper Cretaceous to Lower Miocene	Ootsa Lake Group	Rhyolitic and dacitic tuff and breccia; shale, sandstone, conglomerate
			Rhyolite, dacite, trachyte, andesite; minor basalt; related tuff and breccia
			Basalt, andesite; minor rhyolite, sandstone, and conglomerate
Erosion interval			
Mesozoic	Post-Middle Jurassic-pre-Upper Cretaceous		Biotite granite, granodiorite, quartz diorite, diorite; minor gabbro
	Not in contact		
	Upper Jurassic (Callovian)		Argillite, argillaceous limestone

Table of Formations (cont.)

Era	Period or epoch	Formation	Lithology
	Relations not known; intrusive contact with younger granitic rocks		
	Middle Jurassic (Bajocian)	*Hazelton Group*	Greywacke, argillite, conglomerate tuff, breccia, andesite, and arkose; minor rhyolite
			Andesite, related tuffs and breccias, chert-pebble conglomerate, shale, and sandstone
	Unconformity; erosional interval		
Mesozoic *cont.*	Lower Jurassic mainly or entirely	*Topley Intrusions*	Granite, granodiorite, diorite, and quartz diorite
	Intrusive contact with lower part of Takla Group		
	Upper Triassic and Lower Jurassic	Takla Group	Red and brown shale, conglomerate, and greywacke
			Andesitic and basaltic flows, tuffs, and breccias; interbedded argillite and minor limestone
	Not in contact; intrusive contact with Topley Intrusions		
	Post-Upper Permian-pre-Lower Jurassic		Serpentinized peridotite, talc schists, anthophyllite schists
Not in contact; intrusive contact between Topley Intrusions and Cache Creek Group			
Palæozoic	Pennsylvanian (?) and Permian	Cache Creek Group	Limestone

Sedimentary and Volcanic Rocks

Cache Creek Group

Rocks assigned to the Cache Creek Group occur in the southeast quarter of the area, south of Kluskoil Lake. They consist of massive grey limestone and banded grey limestone; contact with younger rocks is not exposed. These rocks

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were only briefly examined as they underlie such a small part of the map-area; for a full discussion *see* Armstrong's report (1949, pp. 32-51).

Takla Group

The Takla Group was named by Armstrong (1949, p. 51) from its occurrence in the vicinity of Takla Lake and was defined as "an apparently conformable succession of interbedded volcanic and lesser sedimentary rocks ranging in age from Upper Triassic to Upper Jurassic". Although rocks of this age and general description occur within Nechako River map-area, they have not been assigned to the Takla Group and a revision of the Mesozoic Hazelton and Takla Groups has been made (Tipper, 1959a). Briefly, the reasons for this revision are: (a) the age assigned to the Takla Group overlapped the age of the Hazelton Group, (b) evidence of unconformities within the Mesozoic rocks exists, (c) there was a marked change from fine clastic sediments in the Upper Triassic to coarse conglomerates and sandstones of the Middle Jurassic, a situation with several parallels elsewhere, and (d) the Topley Intrusions had cut the Upper Triassic rocks but were undergoing erosion by Middle Jurassic time.

In the type area of the Takla Group the fossils collected were of Upper Triassic and Lower Jurassic age only. No strata with Middle or Upper Jurassic fossils were found in Takla map-area. To the northwest, in McConnell Creek map-area, Lord found such younger rocks (Lord, 1948, pp. 15-28), and extended the Takla Group to include them, although this was not apparently justified from fossil evidence or from a comparison of estimated thicknesses in the type area.

In summary, the Talka Group was re-defined as an Upper Triassic and Lower Jurassic marine assemblage of grey to green andesite, basalt, and associated tuffs and breccias, with interbedded argillite, shale, limestone, minor greywacke, and rarely conglomerate. The group rests unconformably on the Cache Creek Group and is overlain unconformably by the Hazelton Group. Its greatest thickness is more than 10,000 feet in Aiken Lake map-area (Roots, 1954, p. 159), and considerably less in Nechako River map-area. The Takla Group occurs mainly in the eastern part of British Columbia although unnamed Upper Triassic rocks are distributed along the eastern margin of the Coast Mountains. For the present it is well to restrict the geographic distribution of this group.

The Takla Group is typically eugeosynclinal; that is to say it was formed in an eugeosyncline which is defined as "a surface that has subsided deeply in a belt having active volcanism . . ." (Kay, 1951, p. 4). Practically all the rocks are volcanic flows and breccias, or rocks derived directly or indirectly from active volcanism. Only locally are important sections derived wholly or mainly from the erosion of earlier groups; the Red Bed Unit of the Takla Group in the Nechako River area is one such local unit. Typically the rocks are dark green to dark grey or black, andesitic and basaltic flows and breccias occurring in thick sections interlayered with lesser amounts of fine-grained, water-lain tuff, argillite, and greywacke. Non-marine rocks are rare.

Within Nechako River map-area a group of rocks typical of the Takla Group, here mapped as the main unit, are exposed, as well as a red bed sequence that interfingers with rocks of the main unit and apparently represents the same time span. The writer has mapped two sequences as distinct units, fully realizing that the red bed sequence is not typical and should perhaps be mapped as a separate local group or formation. For the present, however, it is considered as part of the Takla Group.

Main Takla Unit

Distribution

This unit occurs as two disconnected belts, one forming the core of the Fawnie Range and the Tetachuck Hills, the other occurring along the western margin of the Topley Intrusions. These belts form the approximate northeasterly and southwesterly rims of a northwesterly trending Middle Jurassic trough or basin. Later folding, faulting, and erosion brought Takla rocks to the surface at a few places within this basin.

Lithology

No complete section of this part of the Takla Group is exposed in Nechako River area, only two or three separate sections believed to represent different parts of the group with little time overlap indicate at least 5,000 feet of interlayered volcanic and sedimentary rocks. Andesitic and basaltic pyroclastic rocks and lavas make up by far the greater part of the group unless repetition or omission of parts have given an erroneous impression. Well-bedded black argillite, argillaceous tuff, and argillaceous limestone are the more important sediments.

The lavas are black to dark green, porphyritic, basic andesites and basalts, which are best exposed in the Naglico Hills near the southern margin of the map-area, on Tutiai Mountain, and on the west end of Fawnie Nose Mountain. Tatuk Hills is made up of similar flows but also includes some purplish andesites.

The flows consist mainly of dark green porphyritic andesite with phenocrysts of grey plagioclase or dark green to black augite; the phenocrysts are seldom prominent, and are generally less than a quarter of an inch in any dimension. The groundmass is a fine-grained aggregate of andesine or labradorite, augite, chlorite, and magnetite. Saussuritization of feldspars and alteration of augite to hornblende and chlorite have occurred, but alteration and metamorphism is not a pronounced feature except near some plutonic masses. Some fine-grained, dark grey to black basalt, made up of a cryptocrystalline aggregate of plagioclase, magnetite, and

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mafic minerals, occurs as a minor part of the lava assemblages. Some so-called porphyritic andesites should be more properly called basalts on the basis of feldspar composition but as yet sufficient information is not available to estimate the proportion. At present it is believed that the bulk of the lavas in the Takla Group are andesites.

The lavas occur in flows 25 to 100 feet thick but large structureless masses occur that may be very thick flows, or possibly necks or stocks that were the feeders for the flows. Pillow lavas were seen only south of Skins Lake. Vesicular and amygdaloidal flows rarely occur, and columnar flows were not seen.

Associated with the lavas, and generally in lesser amounts, are volcanic breccias and tuffs that commonly are well bedded, poorly to well sorted, and graded. The fragments are derived almost entirely from contemporaneous volcanism but occasionally chert, limestone, or quartzite fragments from the Permian strata are incorporated either by erosion of the older rocks or by eruption through the older strata. Most of the coarse breccias are unsorted and show no water action, but finer breccias and tuffs show various degrees of sorting, stratification, grading, and water-working. Many tuffs should be called argillaceous tuffs, indicating that an important fraction of their constituent material is derived from normal erosion. The well-bedded tuffs commonly grade into well-bedded, black argillite.

The tuffs are evenly bedded and commonly graded. The thickness of individual beds ranges from a fraction of an inch to 18 inches, and commonly decreases upward in any one section. Sections totalling more than 300 feet have not been observed. The breccias seem to be more abundant than the tuffs, but this may not actually be so, as the tuffs are softer and more likely to be covered. At several places the tuffs become coarser downward and pass into fine breccias; upward they grade into argillites. This relation was common but not everywhere apparent or invariable.

Argillites and shales occur associated with the tuffs or as distinct sedimentary units interlayered with flows. Limestone and greywacke are rare.

The argillites are black, hard, siliceous and fine grained, and display excellent bedding, but crossbedding is rare and ripple-marks were not observed. Some of the beds are limy and a weathered surface has a ribbed appearance caused by alternating resistant and non-resistant beds. Although some of these beds may be chert, none was definitely recognized as such. Graded bedding is common and is abundantly visible in hand specimens and commonly in thin-section. Even the coarsest component however would probably be classed as fine sand.

Limestone or limy beds are rare, but as mentioned in the previous paragraph, some argillites are limy. Presumably, in some beds the lime content predominates, but such rocks are uncommon. A shell limestone bed 15 feet thick is interbedded with argillites on Tetachuck Lake near Bryan Arm, but is only of local extent.

Red Bed Unit

Distribution

This unit occurs in several disconnected areas south of François Lake, east of Uncha Mountain, along both sides of Ootsa Lake, along Chelaslie River, and near the east end of Cheslatta Lake. The Chelaslie River occurrence is the most southerly, and all are confined to the northwest quarter of the area. No comparable strata are reported in adjoining areas to the west and north.

Lithology

The Red Bed Unit is an assemblage of sedimentary rocks consisting primarily of red and brown shales and interbedded conglomerate and lesser amounts of green and grey shales, orthoquartzite, greywacke, and black limestone. It is distinguished from the main unit by its red colour and its coarse clastic components. In this respect it bears a closer lithologic relation to the type Hazelton Group but, because it underlies Middle Jurassic strata and is in part interbedded with typical Takla rocks, it is preferable to map it as a local, non-typical part of the Takla Group. The red beds are non-marine, except for a part at or near the base.

Shales form the most important part of the unit. They are fine grained, poorly to moderately well sorted, and lack graded bedding and distinct stratification lines. Ill-defined conglomerate beds or conglomeratic lenses are commonly interbedded with the shales. Shale beds, where distinguishable, are 2 to 3 feet thick but may be as much as 50 feet thick. A red, brown, or reddish brown coloration, due to disseminated hematite, is a dominant feature but a few green or grey shales are interbedded with the red shales and are identical in all respects except colour.

The conglomerates of the Red Bed Unit vary in composition, colour, and physical characteristics. They are interbedded with the shales of the unit wherever they occur but are more common along François Lake and southward decrease in pebble-size, thickness of beds, and amount. The conglomerate beds vary in thickness from 6 inches to 150 feet. They have sharp, distinct contacts with shale beds and rarely grade into them. Although channelling and erosion of shales before deposition of the conglomerates was deduced from the evidence at several places, generally the conglomerate appeared to have been spread sheet-like over the shale with little intermixing at the contacts.

The conglomerates are, in general, moderately to well sorted, generally distinctly stratified, and in places are crossbedded; many beds, however, are poorly sorted and unstratified. The pebbles of the conglomerate vary from sand size to 18 inches across, but the usual size is one half inch to 2 inches. Where fine conglomerates occur, greywackes may form beds or lenses. The greywackes apparently are similar in all respects to the conglomerates, differing only in grain size. Pebbles are subrounded to well rounded and are made up of fine-grained andesite, porphyritic andesite, quartz, and grey chert in order of abundance. The matrix may contain much hematite or chlorite, a calcite or a siliceous cement. The make-up of the cement determines the compactness and colour of the rock—green, grey, red or reddish brown.

Along François Lake a unique section, at least 100 to 200 feet thick of well-bedded red shales, white to greenish orthoquartzites, fine reddish pebble-conglomerate, and black limestone, forms what is believed to be the base of the Red Bed Unit. Individual beds are 6 inches to a foot thick, well bedded, and without crossbedding or graded bedding. One bed of black limestone carries indeterminate marine shells and this, coupled with the complete dissimilarity of this section with the rest of the unit, leads to the conclusion that this whole section was laid down under marine conditions.

Origin

The red beds and their origin have been described and discussed more fully elsewhere (Tipper, 1959a, pp. 18-19). Briefly stated, there is ample evidence to indicate a non-marine environment of deposition. Largely on negative evidence and physical dissimilarities they are considered to be primary red beds that have been eroded and transported from a deeply weathered regolith of an old land area to the north. It is suggested that late Permian or Triassic red soils were produced on a land area north of François Lake and these were rapidly eroded, transported, and dumped on a marginal area, possibly a coastal plain, and rapidly buried to preserve the red coloration (Krynine, 1949, p. 61; Van Houten, 1948, pp. 2083-2126).

Structural Relations of Takla Group

Little is known of the internal structural relations of the Takla Group as no complete controlled section was studied. The red beds are interbedded with the main unit, and many flows are mapped with the red beds. The nature of two units in Nechako River area suggests very strongly that the group is not a conformable succession—certainly a short distance north of the area erosion was apparently active while deposition was occurring within the area.

The relation of the Takla Group to the Cache Creek Group is not known in the area, but in Fort St. James area Armstrong stated "that the Takla group lies unconformably above the Cache Creek group [Permian] and that the period between Middle Permian and Upper Triassic was apparently one of igneous intrusion, uplift, erosion, and probable deformation" (Armstrong, 1949, p. 56).

The chert-pebble conglomerate unit of the Hazelton Group overlies the Takla Group unconformably.

The Topley Intrusions cut the main unit of the Takla Group and the marine part of the red beds, but not the non-marine. The intrusions are therefore younger than at least part of the group.

Age and Correlation

Fossils, as in the type area, are not abundant in the Takla Group of the Nechako River area. Only three collections were made, two from the main unit and one, consisting of indeterminate forms, from the marine part of the Red Beds Unit. From tuffaceous argillites on Verdun Ridge, about 4 miles west of Spencha Lake in the northwest quarter of the area, pelecypods were collected. They were identified as *Halobia* sp. by F. H. McLearn, Geological Survey of Canada, and are indicative of a Late Triassic age. Another collection of fossils from the south side of Tetachuck Lake near Bryan Arm contained pelecypods most of which are indeterminate. Included in this collection was a new species of *Trigonia* which McLearn believed to be of Jurassic age, most probably Early Jurassic.

Upper Triassic and Lower Jurassic rocks are widespread in British Columbia but as they were laid down under eugeosynclinal conditions lithological variations are numerous, making correlation of the Takla with other groups difficult. The Nicola Group of Ashcroft and Nicola areas (Duffell and McTaggart, 1952, pp. 29-31) closely resembles the Takla in lithology but is only known to be of Upper Triassic age. Lithologically similar but non-fossiliferous rock occurs in Anahim Lake map-area (Tipper, 1957) and in Whitesail Lake map-area (Duffell, 1959, p. 33). In the latter area the rocks were mapped as Takla Group. A strict correlation with other well-known groups in northwestern British Columbia and in southern British Columbia would be unwise and impractical at present.

Hazelton Group

Hazelton Group was the name proposed by Leach (1910, p. 62) for a thick section of pyroclastic sedimentary rocks near Hazelton, British Columbia. After further work he decided to include a succession of lavas, then known as the Porphyrite Group, as part of the Hazelton Group (Leach, 1911, p. 93). The group as a whole may be rather broadly defined as pyroclastic sediments and porphyritic andesites and basalts of Jurassic age. Later work leads to some modifications, but the Hazelton Group was never rigidly defined. (*See* p. 18, and Tipper, 1959a.)

This group is characteristically variegated, red to green bedded tuffs and breccias with red, brown, purple, or green andesite and basalt. Sedimentary rocks include conglomerate, greywacke, and some argillite. The group was laid down mainly under marine or near-shore conditions. Non-marine strata although present are not abundant.

The Hazelton Group was originally thought to be Middle Jurassic, Late Jurassic, and Early Cretaceous, but more recent information suggests that this range is too broad (Tipper, 1959a, p. 40). Mapping in Bowser Lake area of northwest British Columbia, Roots (1957) outlined an extensive area of sedimentary rocks presumably of Late Jurassic to Early Cretaceous age. For the following reasons[1] these rocks were not mapped as Hazelton Group (1) the group is entirely sedimentary, unlike the Hazelton Group which includes volcanic rocks; (2) the sediments occur in a distinct basin whose boundaries can be drawn precisely; and (3) in Terrace area the group rests unconformably on Hazelton Group volcanic rocks (Duffell and Souther, 1956).

The rocks were therefore named the Bowser Group, and comprise a sedimentary succession of Late Jurassic and Lower Cretaceous age. This group includes rocks formerly mapped as Skeena Formation and some rocks formerly mapped as Hazelton Group. The Hazelton Group is therefore restricted to Middle Jurassic, probably early Middle Jurassic (Bajocian) strata, but in so restricting the age, the areal extent is only slightly lessened.

Within Nechako River map-area the Hazelton Group is mapped as two units, the chert-pebble conglomerate and the Middle Jurassic. These units may with further study be designated as formations. They are more fully described elsewhere (Tipper, 1959a).

Chert-Pebble Conglomerate Unit

This unit is characterized by chert-pebble conglomerate, but volcanic rocks —both flows and pyroclastic—comprise well over 50 per cent. Conglomerate is present in all sections studied, but in places is of minor importance. Shale and greywacke are commonly interbedded with the conglomerate and in places predominate, but limestone was never observed.

The lavas of this unit are characteristically green, dark grey, black, and reddish brown andesite and basalt not unlike those of the Takla Group volcanics but commonly fresher. Characteristically the flows have numerous white or grey lath-shaped phenocrysts of plagioclase one sixteenth to one quarter inch long, in a finely crystalline, felted groundmass of plagioclase, magnetite, chlorite, and epidote. Amygdules, vesicles, and pillow structures are characteristically absent from these rocks in this area. Some of the lavas are massive, consisting of a rock with a microcrystalline texture and a mineral content similar to that of the porphyritic lavas. Individual flows are difficult to distinguish but are believed to be from 15 to 100 feet thick. The best exposures of the lavas are on Cutoff Butte and in Nechako Range.

The tuffs and breccias of this unit are more easily recognized than those of the Takla Group. They are interbedded and each contains angular fragments. They show a fairly distinct sorting but are generally ungraded. The fragmental rocks appear to be slightly reworked and sorted into distinct beds of similarly sized fragments. The fragments consist of broken feldspar crystals and volcanic rock similar in most respects to the contemporaneous volcanic flows. Generally they

[1]Roddick, J. A. Personal communication.

are easily visible on either a fresh or a weathered surface, suggesting differences in composition between fragments and matrix. Individual beds vary in thickness from ¼-inch beds of tuff to 5-to-25-foot beds of breccia. These are interlayered with the flows and with sedimentary rocks.

The sedimentary rocks of the chert-pebble conglomerate unit are the conglomerates for which it was named—orthoquartzites, shales, and greywackes. Because of the high chert and quartz content, most of the rocks fit into the quartzite series of Krynine's classification (1948, pp. 149-152); but with an increase in chlorite, mica, and volcanic rock fragments, some members of the greywacke series are present. In general, the conglomerates, orthoquartzites, and shales are similar to one another in composition but differ in grain size.

The chert-pebble conglomerate beds are distributed around the margin of the sedimentary basin and were deposited under both marine and non-marine conditions. They are exposed in the northwest quarter of the area, along Chelaslie Lake and in isolated patches southeast from there to the southern boundary of the area, and in Nechako Range. These conglomerates are interbedded not only with the volcanic strata of the unit but also with the finer clastic sedimentary rocks. Individual conglomerate beds vary in thickness from 2 inches to more than 25 feet, but show many irregularities with abrupt thickening or thinning and lensing out. Laterally the conglomerate beds may pass gradually into finer clastic rocks, but despite the variable thicknesses, they are fairly persistent. Pebbles in the conglomerates are well rounded and vary in shape from tabular to almost perfect spheres. The conglomerates are moderately to well sorted and rarely display graded bedding; in finer phases, coarse crossbedding is common. Pebbles vary in size from one sixteenth of an inch to 3 feet in diameter but most are from one half inch to 2 inches. Most of the conglomerate includes more than 90 per cent quartz and chert pebbles with about 10 per cent argillite, andesite, greenstone, and rarely pebbles of limestone, granite, gneiss, and schist. Almost all the pebbles are similar to rock types of the Permian Cache Creek Group, which outcrops north and east of the area. The granite pebbles, locally abundant near François Lake, are derived from the Topley Intrusions outcropping nearby. The matrix is mainly sand-sized particles of the material contained in the pebbles. The cementing material of the well-indurated beds is always siliceous, forming an impermeable rock. Poorly cemented conglomerates mostly have limonite or calcite cement and the whole rock is very porous and permeable, and commonly friable. The chert pebbles are mainly of two kinds, black chert and grey chert, and the proportion of these one to the other varies from 100 per cent black chert to over 90 per cent grey chert. Black chert pebbles are characteristic of these conglomerates. With increased distance from the source area of the Cache Creek strata, the percentage of andesite pebbles increases substantially to produce a greywacke conglomerate. Thus in the southwestern part of the area conglomerates consist of as much as 50 per cent green andesite pebbles, derived presumably from Takla Group andesite or the erosion of penecontemporaneous volcanic flows.

Orthoquartzites and low-rank greywackes are interbedded with the conglomerates and differ from them only in grain size. They are of coarse sand size and have a 'salt and pepper' appearance. Well-stratified, crossbedded or ripple-marked beds are common. Individual beds vary in thickness from 2 inches to 12 feet, most being between 2 and 3 feet. The appearance of the orthoquartzites is deceptive; the black chert grains suggest at first a greywacke, but a microscopic examination shows a very high chert and quartz content, commonly 90 per cent. Whereas the conglomerates are both marine and non-marine, the orthoquartzites and greywackes everywhere suggest marine or near-shore features and the common presence of belemnite moulds confirms their marine origin. These rocks are more abundant near the centre of the sedimentary basin and outcrop in the Fawnie Range, north of Chelaslie Lake, and north of Euchiniko Lake.

Shales and argillites form an important part of the sedimentary section of the chert-pebble conglomerate unit. These rocks are invariably dark grey or black, fine grained, banded or massive, well sorted, and, because they are the least competent rocks in this unit, are commonly sheared, contorted, and drawn out. In composition many of the shales and argillites are merely finer equivalents of the orthoquartzites and conglomerates and some may be referred to as quartzose or siliceous shales and argillites. However, such purity is rare, and carbonaceous, chloritic, and micaceous shales are more abundant, though all have a high quartz or chert content. The shales become tuffaceous when interbedded with pyroclastic strata. Calcareous shales and limestone are not known in the unit. The shales are interbedded with conglomerates, orthoquartzites, greywackes, tuffs, breccias, and flows and occur in marine and non-marine sections as indicated by the presence of both non-marine flora and marine fauna. Although widespread, the shales form thicker sections near the centre of the basin of sedimentation.

Middle Jurassic Unit

This unit is characteristic of the Hazelton Group both in lithology and age. It is primarily a sedimentary unit with some interlayered flows, breccias, and tuffs. The sedimentary rocks are commonly tuffaceous, mostly marine, but show by the type of fragments that land areas were nearby. Many rock types are present but none can be said to be typical, although the rocks of the unit are, on the whole, less siliceous than those of the chert-pebble conglomerate unit. This characteristic may be used to a limited extent to define the unit, but for positive identification, palæontological evidence and knowledge of its relation to the underlying unit are necessary. The rock types are andesite, rhyolite, related tuffs and breccias, greywacke, conglomerate, shale, argillite, and arkose; no one type is widespread or particularly predominant in sections examined. The unit is exposed in three parts of the area, as a syncline trending along Big Bend Creek and Euchiniko River, as a syncline forming the crest of Kuyakuz Mountain, and as a syncline on the crest of Fawnie Range. No other strata referable to this unit are known in Nechako area.

The volcanic flows and pyroclastic rocks are mainly reddish brown, purplish red, brown, green, and grey. The flows are mainly andesite, rhyolite, and basalt. A fine-grained rhyolite, mainly a cryptocrystalline mass of quartz, occurs on Fawnie Nose Mountain and rhyolite breccia on Kuyakuz Mountain. Andesite is common to all areas of outcrop but andesitic and basaltic tuffs and breccias are more abundant, particularly on Kuyakuz Mountain. The andesitic and basaltic rocks are not appreciably different from those of the chert-pebble conglomerate unit except that red, brown, and purplish types are more abundant.

The sedimentary rocks comprise conglomerate, greywacke, shale, and arkose, commonly derived from erosion of contemporaneous volcanic rocks, but also include some debris from older rocks. Conglomerates are uncommon in this unit but grey to brown conglomerate is prominent in the Fawnie Range section. Black shales, green tuffaceous shales, and brownish shales occur as numerous but discontinuous beds in all sections. Green andesitic greywacke with abundant wood fragments and carbonaceous imprints occurs along Taiuk Creek. Arkose and arkosic conglomerate occur along Euchiniko Creek.

The arkose that occurs in this unit is an interesting rock type consisting of euhedral grains of feldspar in a greenish chlorite, biotite, and quartz matrix. Sorting is poor and on first glance the rock appears to be igneous. However, the rounding of the quartz grains, crude stratification, and interlayering with fossiliferous marine shales point to a marine sedimentary environment. The beds of arkose are from 2 to 50 feet thick but most are about 3 feet. The lack of sorting and the fresh, unbroken appearance of the feldspar grains point to rapid transportation for a short distance and rapid burial. An arkosic conglomerate occurs in one place with irregular pebbles (2 inches in diameter) of granodiorite embedded in an arkosic matrix. The outline of the pebbles is lost on a fresh surface; only on a weathered surface is it distinguishable. The granodiorite pebbles and feldspar grains in hand specimen are seen to bear a close resemblance to the rocks and feldspars of the Topley Intrusions. The proximity of the Topley Intrusions, which were undergoing erosion at the time, suggests the obvious source of the arkoses. Furthermore, the short distance over which the material was transported as indicated by the arkoses, as well as the carbonaceous imprints and coarse clastic fragments present, suggests that the rock formed near the northeast margin of the sedimentary basin.

The lithology of the rocks in the different sections of this unit varies greatly but the strata in each are considered to be correlative in time, and deposited in a single unstable sedimentary basin, hence they should be considered as a single mapping unit. A lithological characteristic of the unit would be its heterogeneity rather than homogeneity. It is not known to contain sedimentary strata identical with or even similar to those of the underlying chert-pebble conglomerate unit.

Structural and Stratigraphic Relations

The strata of the Hazelton Group accumulated in a central northwest-trending basin. The shape of this basin cannot be drawn precisely; it probably was changing rapidly as the group was being deposited. Although there is no apparent widespread break in deposition between that of the chert-pebble conglomerate unit and that of the Middle Jurassic unit, there was a broad tilting or shifting of the basin from west to east, so that in Fawnie Range non-marine sediments rest on marine, on Kuyakuz Mountain marine sediments rest on marine, and east of Nechako Range, marine sedimentary strata rest on non-marine and apparently overlap onto the exposed Topley Intrustions.

The Hazelton Group rests with angular discordance on the Takla Group in Fawnie Range but elsewhere may be conformable. The change in the nature of the sediments from the fine clastic rocks of the Takla Group to the coarse clastic rocks of the Hazelton Group suggests a change in sedimentary environment. Both units of the Hazelton Group received debris from the Topley Intrusions, and there is no doubt that the Hazelton Group rests unconformably on older strata. Whether this unconformity is an angular discordance, a disconformity, or an erosional interval cannot be stated with certainty. All three possibilities may be true with the added possibility that in some deeper part of the basin, not within Nechako map-area, there is no unconformity at all. There is no evidence to indicate an appreciable time gap—possibly there was none.

Age of the Hazelton Group

The age of the Hazelton Group can be defined fairly closely from fossil evidence within the group and from relations with other stratigraphic units. Of the twenty fossil localities found in the two units of the group, only two yielded diagnostic fossils. The other localities yielded collections of pelecypods, gastropods, brachiopods, and belemnites that either were of no stratigraphic significance or were unidentifiable.

The Middle Jurassic unit is dated closely by two collections of ammonites, one from south slope of Kuyakuz Mountain, the other from Euchiniko River, a mile west of the mouth of Taiuk Creek. These collections were examined by H. Frebold, Geological Survey of Canada, who comments as follows (*see also* Frebold, 1957, p. 16):

1. Collections from Kuyakuz Mountain.

This collection contains poorly preserved ammonites, probably belonging to the genera *Sonninia* and *Witchellia*, and some pelecypods (*Trigonia* sp., *Pleuromya* sp.). This fauna is of early middle Bajocian (early Middle Jurassic) age. Its stratigraphic position is probably between the somewhat older *Tmetoceras* and the younger *Stephanoceras* beds in the adjacent Whitesail area. Beds with *Sonninia* that form part of the Hazelton Group near Hazelton, British Columbia, and some beds of the Takla Group in McConnell Creek area that contain *Witchellia* are probably of the same age.

2. Collections from Euchiniko River.
   Most of the many poorly preserved and not accurately determinable ammonites in this collection have affinities to *Sonninia* and *Witchellia*. The age of this fauna is probably early middle Bajocian (early Middle Jurassic). Its stratigraphic position is probably the same as that of the Kuyakuz Mountain fauna.

These two Bajocian collections occur near the top of their respective sections. As pointed out by Frebold, the fauna is probably younger than the *Tmetoceras* bed, which is considered to be the oldest of the Middle Jurassic (Frebold, 1951, pp. 18-21).

The chert-pebble conglomerate unit yielded several collections of fossils, both fauna and flora, but no index fossils were present. There is no significant stratigraphic break between it and the overlying Middle Jurassic unit, and for this reason it is believed that the chert-pebble conglomerate unit represents the earliest Middle Jurassic strata and is correlative with the sedimentary strata of the Whitesail Lake map-area that contain the *Tmetoceras* fauna. However, an Early Jurassic age must be considered possible until a more exact dating of the unit is obtained.

In summary, as now restricted, the Hazelton Group in Nechako area contains Middle Jurassic strata only, mainly early Middle Jurassic.

Several other fossil collections were made but none contained diagnostic fossils. Only a broad age, Jurassic or Cretaceous, can be suggested. The following identifications were all by H. Frebold except No. 6 which was by W. L. Fry, formerly of the Geological Survey of Canada. The first séven collections were from the chert-pebble conglomerate unit and the eighth from the Middle Jurassic unit. These collections are mentioned as they suggest the best localities for future, more intensive search.

1. GSC locality 16831. 2 miles north of Ootsa Lookout.
   Pecten (Entolium) sp. indet.
   Macradon sp. indet.
   other indeterminable pelecypods
   Belemnites sp. indet.
2. GSC locality 16832. 2 miles north of Ootsa Lookout.
   Ammonites gen. and sp. indet.
   Cucullae? sp. indet.
   Leda? sp. indet.
   Corbula? sp. indet.
   other badly preserved pelecypods
   "*Rhynchonella*" sp. indet.
3. GSC locality 16833. 5 miles north of Ootsa Lookout, in sheared argillite.
   Belemnites sp. indet.
   Indeterminable pelecypods
4. GSC locality 20116. 1½ miles from the north end of Fawnie Nose Mountain, on crest of ridge.

Belemnites sp. indet.
"Rhynchonella" sp. indet.

5. GSC locality 20119. East side of small island near the outlet of Chelaslie Lake, Nechako area, B.C.
   "Terebratula" sp. indet.
   Pelecypods div. gen. et sp. indet.

6. GSC plant locality No. 4229. On road below Skins Dome in new road-cut, (B.C.).

   Determinations:

   Filicales

   Gleicheniaceae

   Gleichenites cf. *G. nordenskiöldi*

   a vegetative branch of a conifer.

7. GSC locality 21887. From hill 1 mile west of Kluskus village.
   Argillaceous tuffs and coarse tuffs.
   Belemnoids (indeterminate fragments)

8. GSC locality 21889. South side of Kuyakuz Mountain, ½ mile from Kuyakuz Lake.

   The collection consists of fragmentary pelecypods and echinoids which occur in fine tuff. The state of preservation is too poor for any detailed determination. No distinctive forms are present.

Upper Jurassic Rocks

Argillite and argillaceous limestone, before the flooding caused by the Kenney Dam, outcropped on Nechako River near the mouth of Big Bend Creek. None of these is now exposed. Two small areas of similar rocks that outcrop 5 miles to the east were tentatively mapped as an Upper Jurassic part of the Hazelton Group (Tipper, 1955) but, as mentioned on page 23, the Upper Jurassic rocks are now separated from the Hazelton Group and are mapped as Bowser Group. It would seem logical, therefore, to map these rocks as Bowser Group but as there is no known direct connection with the Bowser basin and little information on the extent, thickness, and lithology of these Upper Jurassic rocks, it seems better to map them as unit 7 unnamed. The extension of this group of rocks may well be southeastward, where rocks of similar age are known in the Ashcroft area (Duffell and McTaggart, 1952, pp. 31-33).

Lithology

These rocks are entirely sedimentary. Black, sheared argillites and argillaceous shales outcropped along Nechako River. Farther east, the outcrops are not sheared but are hard, finely banded, black argillite. On Nechako River, 2 miles south of Big Bend Creek, one 15-to-20-foot bed of black mudstone contains large, black, calcareous concretions up to 10 inches in diameter. These are nearly spherical and each contains one well-preserved ammonite.

Structural Relations and Age

This group of rocks is not in contact with any other group, their general northerly strike does not conform to the general northwest strike of the nearby Hazelton Group, and some dips recorded were vertical, unlike the gentler dips of the Hazelton Group. Moreover these rocks are sheared and, in places, badly contorted. From the foregoing, it is reasonable to assume that the group attained its isolated position by being downfaulted into the older rocks. Exposures are too few for any certain explanation.

Two fossil localities were noted very close together along Nechako River and were examined by Hans Frebold, Geological Survey of Canada, who commented as follows:

GSC locality 2188. One-half mile upstream from Big Bend on Nechako River.
Estheria sp.

This locality was found by G. M. Dawson in 1876 (Dawson, 1878, p. 71).

GSC locality 21885. On Nechako River, 2 miles upstream from Big Bend Creek. Fossils occur in concretions embedded in finely bedded, black, limy shale.

"This collection consists exclusively of well-preserved ammonites. They belong to *Lilloettia lilloetensis* Crickmay which is a typical Lower Callovian ammonite, which is also known from the Lower Callovian of Harrison Lake area and Alaska."

Ootsa Lake Group

The name Ootsa Lake Group was given by Duffell (1959, p. 67) to a group of volcanic rocks, mainly rhyolitic and dacitic, that outcrop in the northeast quarter of Whitesail Lake map-area. Although mainly acidic, andesitic and basaltic flows and breccias do occur, commonly near the base, sedimentary rocks form a minor part of the group.

Similar outcrops within the Nechako River map-area have been assigned to Duffell's group, the important difference being that whereas no subdivision was possible in Whitesail Lake area, in Nechako River area the group has been divided into two units—a rhyolite and an andesite.

Andesite Unit

This unit outcrops mainly from Uncha and Binta Lakes eastward to Hallett Lake and from Cheslatta Lake northward into Fort St. James map-area; a few outcrops occur along Ootsa Lake near Marilla. The rocks on the northeast side of Fawnie Range are lithologically similar but their relation to the rhyolite unit is in doubt.

Andesite forms more than half of this unit, basalt is less common, and dacitic to rhyolitic flows are least abundant. Pyroclastic rocks are equally as important as the flows. The total thickness of the unit varies from place to place and is difficult to estimate; more than 1,500 feet of flows and fragmental rocks are exposed in Fawnie Range and south of François Lake, but near Marilla the total thickness is less than 500 feet.

The flow rocks are generally grey, green, reddish brown, and black. The andesites are fresh and consist mainly of porphyritic rocks with phenocrysts of andesine in a groundmass of biotite, hornblende, epidote, and feldspar. In some rocks the groundmass is cryptocrystalline. Flow-banding is not common. Basalts are commonly dense black rocks that would best be described as trap but these grade in places to porphyries with labradorite or augite phenocrysts. Some basalts contain much magnetite and commonly most of the groundmass is a dark glass with embedded feldspar crystals. The basalts may be vesicular and amygdaloidal, particularly in the rocks near François Lake. Columnar joints are common. The rocks of this unit in Fawnie Range are characteristically reddish brown to purple.

A dense massive basalt and basalt breccia outcrops near Marilla and there conformably underlies the rhyolite unit. This basalt also occurs near the outlet of Ootsa Lake and near the east end of Cheslatta Lake. It lies near the base of the group.

The fragmental rocks are coarse, poorly sorted, and only crudely stratified. South of Anzus Lake, where they are best exposed, they are varicoloured and are made up of volcanic fragments from rocks derived from the unit itself. These different coloured rocks occur as distinct alternating layers of green, grey, brown, white, and black fragments or as a single bed with fragments of several colours. No evidence of water transportation is apparent and this intermixing of rock types suggests contemporaneous eruptions of more than one rock type within a small area.

Sedimentary rocks are exposed only on an island in Chief Louis Bay. Pebble-conglomerate and greywacke outcrop in beds 1 foot to 5 feet thick, with a total exposed thickness of 150 feet. These rocks are well consolidated, and are formed from detritus apparently derived from Mesozoic rocks. So far as the author knows none of the fragments present is derived from Tertiary rocks and from this it is concluded that the sediments occur at the base of the Ootsa Lake Group.

Rhyolite Unit

This unit is widespread in the map-area but is most extensive and best exposed in the northwest quarter where it is essentially an extension of the part of the Ootsa Lake Group to the west (Duffell, 1959, p. 67) and of similar rocks to the north (Armstrong, 1949, pp. 71-74). Scattered outcrops in all parts of the area suggest that the group may at one time have been more extensive than it is now.

This unit is composed of rhyolite, trachyte, dacite, minor andesite and basalt, and related breccias and tuffs. The fragmental rocks appear to be equal to the flows in volume. Sedimentary rocks are not abundant, but some beds of tuffaceous shales and sands occur, though they are neither thick nor widespread.

The lavas are creamy white, greyish white, pink, lavender, red, yellow, apple-green, dark green, black, and grey. Flow-banding is common and characteristic and in places is so even and regular that the rock resembles laminated shale; elsewhere banding is contorted. Spherulitic structures are common. Perlitic rhyolite or perlite occurs infrequently. Rhyolites are most common rock type but even these vary. A typical and widespread rhyolite has phenocrysts of clear quartz up to one eighth inch in diameter in a white to creamy matrix of cryptocrystalline quartz and feldspar. Dykes of this type of rock occur north of Chelaslie Lake and in great numbers along Tetachuck River, flows are present 8 miles north of Fawnie Dome, southeast of Mount Greer, and on both sides of Cheslatta Lake. A unique rhyolite occurs north of Borel Lake, consisting of many phenocrysts of smoky quartz to one eighth inch in diameter in a black cryptocrystalline groundmass. Commonly flow-banded, mauve rhyolites with phenocrysts of quartz and plagioclase feldspar outcrop frequently, particularly north of Knapp Lake. Grey flow rocks with salmon-coloured potash feldspar phenocrysts outcrop at the west end of Tetachuck Lake. Dark green or purple andesites with white lath-shaped feldspar phenocrysts form a minor part of the unit. Dense black basalt occurs infrequently and may in many places be younger sills or dykes rather than contemporaneous flows.

Fragmental rocks, tuffs and breccias, are equally abundant. Chalky white rhyolitic tuffs and breccias outcrop as poorly sorted beds up to 50 feet thick near Marilla, west of Natalkuz Lake, around Lucas Lake, along Chedakuz Creek, and north of Uduk Lake. Similar fragmental rocks occur in thinner beds elsewhere. Near Intata and Natalkuz Lakes a coarse breccia outcrops that consists mainly of rhyolite fragments with fragments of other Tertiary and Mesozoic rocks. It has more the appearance of eroded detritus than of an accumulation of volcanic ejectamenta. Many other breccia and tuff beds, equally as varied as the related flows, form important sections.

Normal sedimentary rocks, composed mainly of stream gravels and sands derived from Mesozoic and Tertiary strata, occur only along major valleys. The rocks are poorly consolidated, soft, and friable, and are generally less than 25 feet thick. White tuffaceous silt and fine sand have been noted at a few places not related to major valleys.

Structural Relations

The internal relations of the Ootsa Lake Group are not clear. Where the rhyolite and andesite units are exposed together the rhyolite unit is younger but the contact is not sharp or clearly defined. For the most part it is an arbitrarily chosen contact separating two units in one of which acidic and in the other basic rocks predominate. They are lithological units primarily and although the andesite unit is believed to be older than the rhyolite unit, parts of one unit in one place may be the same age as parts of the other unit elsewhere. The andesite unit of Fawnie Range may be younger than the rhyolite unit and if this is so the rocks in question may not be a part of the Ootsa Lake Group but a younger volcanic group most of which outcrops south and southeast of the map-area (Tipper, 1959).

The Ootsa Lake Group rests with angular unconformity on the Mesozoic rocks. Along Nechako River it rests on Topley granites, on Mount Davidson on Late Jurassic granites, and around Lucas Lake on Hazelton Group rocks. Much of the group occupies depressions in the eroded pre-Tertiary surface and sediments apparently accumulated mainly in pre-Tertiary valleys. The group is overlain unconformably by the Endako Group.

Age and Correlation

On an island in Chief Louis Bay on Ootsa Lake, one fossil occurrence in the basal sediments of the andesite unit contains freshwater mollusks and plant remains. W. A. Bell, Geological Survey of Canada, examined the plant remains and commented as follows:

> The collection consists of imprints of leaves in a rather coarse sandstone which also carries remains of pelecypods and gastropods. Most of the plant remains are too fragmentary to be of any value. The few complete or nearly complete leaves show, at best, only the primary and secondary nervation and hence even a generic identification is open to question. With this reservation the leaves are referred to the following:
>
> *Alnus* sp.
> *Rhamnites marginatus*? (Lesquereux)
> *Spirodela*? *scutata*? Dawson
>
> *Remarks:* The doubtful nature of the above identifications precludes any confident conclusion on the age represented. So far as evidence goes a Paleocene age is tentatively considered more probable than a late Upper Cretaceous or Post-Paleocene age.

The freshwater mollusks were examined by E. T. Tozer, Geological Survey of Canada, who reported as follows:

> GSC locality 17180.
> *Unionid* genus indet.
> *Sphaerium* sp. (cf. *S. heskethense* Warren)
> *Lioplacodes* sp. (cf. *L. sanctameriensis* (Russell))
>
> *Remarks:* Although this faunule is very rich in individuals it is poor in species and consequently a satisfactory comparison with other faunas cannot be made. No significance can be attached to the unionid but some of the sphaeriids have the prominent, posteriorly placed umbones characteristic of the Edmonton (upper Cretaceous) species *S. heskethense* Warren. The *Lioplacodes* is closer to *L. sanctameriensis* a contemporary of *S. heskethense*, than to any other described species.

Although the faunule does not permit a certain correlation, an upper Cretaceous age is suggested.

From the foregoing, an Upper Cretaceous or Paleocene age is suggested. These collections provide a lower age limit for the andesite unit of the Ootsa Lake Group.

In Fort St. James area, Armstrong mapped three units that together are equivalent to the Ootsa Lake Group but singly are not correlative with either unit of the group in Nechako River area. A few fragmentary fossils from the oldest unit were dated as Upper Cretaceous or later (Armstrong, 1949, p. 70). Several collections of fossil leaves from a sedimentary unit lithologically similar to sediments of the rhyolite unit indicated Eocene or Oligocene age for the sediments.

Although the evidence is inconclusive, the Ootsa Lake Group may be as old as Upper Cretaceous or as young as Oligocene. The evidence also suggests that the andesite unit in the main may be definable as Upper Cretaceous or Paleocene and the rhyolite unit as Eocene or Oligocene.

Rocks similar in all respects to the Ootsa Lake Group occur in Whitesail Lake map-area, the type area (Duffell, 1959, p. 67), in Fort St. James area (Armstrong, 1949, pp. 68-74), in Anahim Lake area (Tipper, 1957), in Carp Lake area (Armstrong, Hoadley, and Tipper, 1949), and in Quesnel area (Tipper, 1959b). From a cursory examination of outcrops in areas adjacent to these it may be concluded that lithologically similar assemblages are widespread but not continuous or locally extensive throughout central British Columbia. In the Sustut Group of McConnell Creek area, Lord (1948, pp. 36-41) reported dacitic tuff of Paleocene age.

Endako Group

The Endako Group was the name given by Armstrong (1949, p. 74) to a group of rocks along Endako River. These were described as "relatively flat-lying lava flows, as much as 2,000 feet thick, that were erupted during Oligocene or later time". As mapped by Armstrong, the group extends with little or no break into Nechako River map-area, where these or similar rocks can be traced without a break to the south margin of the area. Although all these rocks mapped as Endako Group are lithologically similar to the rocks of the type area and appear to occupy a comparable stratigraphic position, there is no assurance that they everywhere represent the same time span. The rocks along West Road River, for instance, may be much younger than those north of François Lake.

The Endako Group within Nechako River area occupies the low parts of the southeast half and fills pre-Miocene valleys in the hillier country in the northwest quarter. Nowhere do rocks of this group occur above 5,000 feet elevation and rarely above 4,000 feet. In the northwest quarter, near Cheslatta Lake, valleys have been cut into the flat-lying flows to a depth of more than 2,000 feet, but in the south half of the area dissection has not been pronounced and valleys over 300 feet deep in these flows are not common.

The group is best exposed along major valleys, where the eroded edges of the

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flows form the valley walls. Elsewhere a few small outcrops rise above the glacial mantle, and these, together with the characteristically flat topography and the large fields of basaltic erratics, are the only evidence to indicate the presence of the group in areas of low relief. Much of the drift-covered area, particularly in the northeast quarter, is believed to be underlain by this group.

Lithology

Most of the Endako Group consists of red, brown, grey, and black, andesitic and basaltic, massive, vesicular, and amygdaloidal lava flows. No dacitic, trachytic, or rhyolitic flows are present although some are tentatively included in the type area (Armstrong, 1949, pp. 74-76). Where such flows were encountered in Nechako River area they were mapped with the Ootsa Lake Group. Interbedded with these flows, and forming less than 15 per cent of the whole, are breccia, tuff, and agglomerate of closely related composition.

Features characteristic of plateau basalts are present in these rocks (*see* Pl. V). Columnar basalt is fairly common although the columns are rarely well formed. In a few places, such as the hill at the east end of Natuza Lake and on the north side of Tatalrose Lake, columnar basalt is exposed with well-formed, five-sided, vertical, straight columns 200 to 300 feet long. Some necks or plugs of basalt, such as Tyee Butte and The Devils Thumb, have exceptionally long columns but are not as perfectly formed; those of Tyee Butte are over 700 feet long. Pillow lavas on the other hand are a feature not commonly encountered and no well-formed or obvious pillows were noted; some flows weather into ellipsoidal masses but whether these are true pillow lavas is doubtful. Like most Tertiary plateau lavas of British Columbia and Washington, most of these rocks are flat-topped and when observed in section are horizontally layered. At a distance these layers appear even and regular but on closer examination are seen to consist of several flows from 10 to 75 feet thick with interlayered beds, lenses, or pockets of fragmental material. Although a cursory examination gives an impression of a great lateral extent to these flows, closer inspection shows that, as a distinct unit, they can be traced for only a few thousand feet and that flows 5 to 10 miles long are rare.

Some finer features are characteristic of the flows. Vesicular basalt is common but with many varieties. Some flows have a few scattered vesicles whereas in others the vesicles are so numerous that they form the greater part of the rock, which is in effect a scoria. Such rocks are abundant northwest of Holy Cross Lake. Vesicles are commonly small but have been noted up to 6 inches in diameter. Some are elongated parallel with the length of a flow. Amygdules are not characteristic but do occur; rarely are the cavities completely filled. The amygdules are commonly composed of chalcedony, common opal, and calcite, as well as siderite and aragonite.

These lavas are generally basic, basalts or andesites, but except for this broad generalization, there is little uniformity of rock type. The rocks may be very fine grained, and massive, finely or coarsely porphyritic, or even coarse grained and gabbro-like. Although certain rock types predominate in several small areas, most types are common to all localities. A very coarse grained porphyritic basalt is present as flows and dykes in the northwest quarter of the area, near Takysie Lake and Danskin. The rock consists mainly of coarse, platy crystals of labradorite up to 1½ inches diameter in a fine-grained black groundmass. These platy phenocrysts are sometimes parallel with one another and parallel with the flow layer or the dyke wall. Fine-grained, grey or black massive basalt is probably the most common rock type in all parts of the area. Black obsidian was observed infrequently.

Under the microscope Armstrong found that rocks of this group were mainly andesites (1949, p. 75) but, although this may be true for the type area, it is not true everywhere within Nechako River area. The plagioclase feldspars commonly are close to the andesine-labradorite boundary—the criteria used to distinguish between basalt and andesite—and a small difference in their composition would throw the rock from one class to the other. It is, moreover, unlikely that the slides examined by the writer or by Armstrong are truly representative of the group, and at present it is best to say only that most of the flows are basaltic or andesitic. The porphyritic rocks consist of laths of plagioclase feldspar, one eighth to one quarter inch long embedded in a fine groundmass of feldspar, augite, magnetite, and glass. As previously mentioned the plagioclase feldspar is labradorite or andesine and in more basic flows, bytownite. Olivine basalt is not common.

Sedimentary rocks are found associated with the volcanic rocks, particularly where streams have cut through lavas that filled pre-Miocene valleys. The sediments seen so far occur, without exception, at the base of the group. The stratigraphic position of these sediments is ample justification for mapping them as a separate group or formation, but as they are poorly exposed and nowhere extensive it is best to map them with the group with which they are most closely associated, particularly in reconnaissance mapping. They consist of poorly consolidated, coarse sandstone and conglomerate, minor siltstone, and lignite. All are soft and very friable and as a result are rarely exposed; possibly this gives an erroneous impression of their extent. Most of the material of the conglomerates has been derived from older Tertiary and Mesozoic rocks and only rarely are there pebbles of Miocene basalt.

Mode of Extrusion

These plateau lavas were, in the writer's opinion, at one time much more widespread than now. Erosion has dissected them into several separate areas which if united would resemble the lava plateaus of central Washington. Such a comparison logically leads to a comparison of the modes of extrusion for the two areas.

The Columbia River lavas are considered to have erupted quietly from fissures and spread out laterally, coalescing to form the great lava sheets of central Washington. The evidence for this is (1) the abundance of dyke swarms in older rocks near the margins of the lavas, and (2) the absence of any known central vents or cones from which the flows may have come (Campbell, 1950, p. 80).

The flows of Nechako River area seem to have a somewhat different origin. Several basalt dykes have been noted cutting older rocks as well as flows of the Endako Group, but nowhere do they constitute dyke swarms. The number of dykes observed hardly seems large enough to have been the channels of the great volume of lavas that remains to-day. Distributed throughout the area are many small hills of basalt that are characteristically steep-sided, commonly columnar, circular in plan, and homogeneous throughout. In places flat-lying flows surround the bases of these hills but most of the hills consist of rock that has intruded early Tertiary or Mesozoic rocks and any Miocene flows that may have been present are now stripped away. Two or three of these hills may occur near one another and be aligned in a northeast direction. They infrequently occur on or near a fault, thus possibly explaining the alignment, but generally the relation of hills to faults is not obvious. The hills are believed to be necks or plugs from which issued very fluid lava that spread out laterally and did not build up cones.

Structural Relations and Age

Generally the Endako Group is flat lying but in places a slight eastward regional dip is obvious. North of Intata Lake the flows have been warped into a broad northwest-trending fold, but this is unusual. Some faults of slight displacement were noted. The group rests unconformably on the Ootsa Lake Group and older rocks and is overlain by Pleistocene and Recent deposits.

Fossil leaves were obtained from sedimentary rocks at the base of the group and were reported upon by W. A. Bell, Geological Survey of Canada as follows:

G.S.C. Locality No. 3981: 2.6 miles from The Devil's Thumb, north of Natalkuz Lake on bearing N272°.

Although some 25 plants are represented most are too fragmentary for specific or even generic identification. The following, however, are specifically identifiable with reasonable probability.

Coniferales	*Cephalotaxus californica* Potbury
	Glyptostrobus oregonensis Brown
	Metasequoia occidentalis (Newberry) Chaney
Dicotyledones	*Alnus corallina* Lesquereux
	Ostrya oregoniana Chaney
	Quercus consimilis Newberry
	Quercus cowlesi Chaney
	Macclintockia kanii (Heer) Seward & Conway
	Cercidiphyllum crenatum (Unger)
	Sassafras bendirei (Knowlton) Brown
	Porana speirii Lesquereux

Remarks: The identification of *Sassafras bendirei* is based on a single entire leaf that shows just as strong similarity to *Ocotea eocenica* Chaney and Sanborn as to *Sassafras bendirei*. Preference was given to *Sassafras bendirei* only because *Ocotea eocenica* is a member of a subtropical fossil flora from Oregon.

Other genera apparently represented in the collection are *Torreya*, *Pinus*, *Carya*, and *Magnolia*.

Although several of the identified species range from Paleocene to early Miocene, the assemblage as a whole correlates it with the flora contained in the Kitsilano formation of the Vancouver area and in the Bridge Creek deposits of the John Day Basin. Although Berry considered the Kitsilano flora to be either late Eocene or Oligocene, an Oligocene, probably late Oligocene age, now seems to be the more probable.

If the sedimentary rocks are of late Oligocene age, the overlying volcanic rocks must be late Oligocene and Miocene or younger. This accords with the age of the group as stated by Armstrong—Oligocene or later (Armstrong, 1949, p. 76).

Correlation

The Endako Group as defined in the Fort St. James area, appears to be a fairly distinct stratigraphic unit. The group as mapped in the Nechako River area, is comparable in age, lithology, and structure with minor exceptions. Recent work by the writer in the Anahim Lake and Quesnel map-area (Tipper, 1957; 1959b) has shown that there are three or more mappable units that may be correlated in whole or in part with the Endako Group. Furthermore there are two or three units that closely resemble rocks of the Endako Group but are older or younger. In reconnaissance mapping, it is difficult to separate these various units and it is possible that some of these units have been erroneously included with the Endako Group. For this reason any attempts at definite correlations are inadvisable until the group is more closely defined and its upper time limit established.

Intrusive Rocks

Serpentinized peridotite outcrops on Sinkut Mountain in Prince George map-area to the east and extends 2 to 3 miles into the northeast quarter of the Nechako map-area. These rocks are intruded by the Topley granitic rocks on the northeast side and probably on the southwest side. As the rocks here exposed lie mainly in a contact zone, they are varied. The central part is a serpentinized peridotite with talc schists, anthophyllite schists, and serpentinites near the granitic contact. They are poorly exposed and only a brief examination was made.

The age and correlation of this unit is uncertain. In Nechako River area the ultrabasic rocks are cut by the presumably Lower Jurassic Topley Intrusions. In the adjoining Prince George map-area, the ultrabasic rocks are younger than Upper Permian limestone. It can be concluded then that the ultrabasic rocks are late Upper Permian to early Lower Jurassic in age and most probably are Triassic. The Trembleur Intrusions (Armstrong, 1949, pp. 79-92) to the northwest apparently occupy the same stratigraphic position.

Topley Intrusions

The name Topley Intrusions was given to "a group of acidic intrusive rocks of probable pre-Jurassic age. They were first recognized in the Topley area . . ."

(Armstrong, 1949, p. 92). The Topley Intrusions or similar rocks underlie much of the southern part of Fort St. James area and extend into the northeast quarter of Nechako River map-area, from François Lake to Lily Lake, Nulki Hills, and Tatuk Lake. These rocks have been mapped as Topley Intrusions but, from evidence within Nechako River map-area that does not conflict with evidence in the type area, the writer has assigned to the group a different age (Tipper, 1959a). The Topley Intrusions in Nechako River area, like those in Houston and Fort St. James map-areas, form fairly large bodies of granitic rocks overlain by patches of Tertiary rocks and intruded by necks and dykes of basalt. Most of the granitic rocks occur in a single, large belt, with a few small stocks separated from the main belt. This group extends for an unknown distance east and southeast from Nechako River area.

Lithology

In Fort St. James map-area the Topley Intrusions were mapped as three subunits (1) granite and granodiorite, (2) diorite, and (3) syenite, and these were distributed in distinct mappable areas. Only the first two subunits have been recognized in Nechako River area. The granite and granodiorite subunit enters the area near the east end of François Lake, extends southeast as a unit 15 miles wide to Mount Hobson, from where it narrows to a belt about 3 miles wide. The diorite and quartz-diorite unit underlies the Nulki Hills and smaller hills farther southeast.

Coarse-grained pink porphyritic or non-porphyritic granite comprises the Topley Intrusions northwest of Nechako River. This is a characteristic rock that, in places, is so coarse as to be described as a pegmatitic granite. It is composed of pink potash feldspar, with smaller amounts of oligoclase and quartz, and a little biotite and hornblende. The pink feldspar forms the phenocrysts of the porphyritic types; plagioclase is restricted to the matrix, and never occurs as phenocrysts. Although the grain size varies, most of the rocks are coarse and crystals of pink feldspar up to 3 inches long have been noted. The quartz content may be as great as 35 per cent. Mafic minerals in some places are less than 1 per cent of the rock.

Grey and greenish granodiorite and granite with minor pink granite phases form the Topley Intrusions of Mount Hobson, and Finger and Tatuk Lakes. These are in part hybrid rocks, particularly those of Mount Hobson, with numerous inclusions of Takla volcanic rocks. The intrusive contact on Mount Hobson is difficult to delineate as inclusions, granitic dykes, part assimilated rocks, and normal granites are intermixed over a zone about 3 miles wide. Plagioclase feldspar is more abundant and the rocks grade from granites to granodiorites. Porphyritic rock types are not common.

The diorite and quartz diorites are easily distinguished from the granites because of the foliation almost all display. In some places this foliation is very distinct, in others the rocks are only slightly gneissic. Most of the foliation has a northwest trend.

The diorite commonly is grey or greyish green and consists of abundant hornblende and andesine. In a few places it grades into quartz diorite. They are coarse-grained rocks and, in Nechako River map-area at least, are weathered to a known depth of 3 feet; in the Nulki hills it was difficult to obtain an unweathered specimen.

Structural Relations and Age

Whether all the lithological phases of this group were intruded at the same time or not is a question as yet unresolved. The granites and granodiorites may have had at one time a mode of emplacement but whether the diorites are similar in age and origin is not known. No contact was exposed between these two distinct units and near Finger and Tatuk Lakes they are separated by a band of metamorphosed Takla volcanic rocks.

As mentioned previously, evidence from Nechako River map-area indicated an age of emplacement of the Topley Intrusions different from that stated by Armstrong (1949, pp. 96-97). In discussing the group, he outlined eight reasons for dating the intrusions as pre-Upper Triassic post-Middle Permian, and evidence from the Fort St. James area supported this conclusion. One reason given was that the Topley Intrusions, which were confined to Cache Creek Group rocks, were not known to intrude Upper Triassic Takla rocks and thus were thought to be pre-Upper Triassic. This reason was found to be invalid in Nechako River area (Tipper, 1959a, p. 32). In reviewing the Hazelton and Takla Groups the writer discussed the age of Topley Intrusions and briefly the pertinent evidence is as follows:

(1) Boulders and pebbles of Topley granites occur in the chert-pebble conglomerate unit of the Hazelton Group which is of Middle Jurassic (early Bajocian) age. Arkoses believed to have been derived from Topley granites are dated as Middle Jurassic. Topley granites must therefore have been intruded before Middle Jurassic time.

(2) On the north shore of François Lake, Topley granites intrude the marine part of the Red Bed Unit but are not in contact with the upper part of the red beds. Possibly the Topley granites were emplaced while part of this unit was being laid down; it would then be of latest Triassic age or more probably Lower Jurassic.

(3) Topley granites intrude fresh andesites and breccias southeast of François Lake. These volcanic rocks are believed to belong to the Takla Group because they are not as highly metamorphosed as the normal Cache Creek Group rocks. The possibility does exist that they may be of Middle or Lower Triassic age, although such rocks have never been recognized in central British Columbia.

From these three factors it is reasonable to conclude that the Topley Intrusions are of Lower Jurassic or late Upper Triassic age—a Lower Jurassic age is preferred.

Correlation

Lower Jurassic granitic rocks are not common in British Columbia. The Topley Intrusions, as several lithological units, have been extended now from the type area north of Topley, across Fort St. James and Nechako River areas and into Prince George map-area for an undetermined distance. Along the east side of Quesnel map-area (Tipper, 1959) granodiorite, granite and diorite of similar lithology and possibly the same age, outcrop discontinuously to the southeast corner of the area. The Guichon batholith of Ashcroft (Duffell and McTaggart, 1952) and Nicola (Cockfield, 1948) map-areas is of Lower Jurassic age but is not lithologically identical to the Topley Intrusions. All the areas and rocks mentioned trend southeast and their geological setting is very similar. This belt as a unit closely follows the distribution of the Cache Creek Group but is not parallel with it. In the type area of Topley Intrusions the Cache Creek Group is east of the granitic rocks; in the Quesnel area the granitic rocks in question are in the centre of the belt of Cache Creek rocks; and the Guichon batholith is to the east of much of the Cache Creek Group. If all these granitic intrusions represent a batholithic complex of Lower Jurassic age then the belt has a known length of more than 360 miles and is comparable in length to that of the Omineca Intrusions.

Post-Middle Jurassic Intrusions

Rocks of granitic to intermediate composition occur as stocks and bosses in Nechako Range, Fawnie Range, and the hills north and south of Tetachuck Lake. On the preliminary map (Tipper, 1957) these rocks were shown as two units, one of which comprised the batholiths of Fawnie and Nechako Ranges that cut the Middle Jurassic strata, and the other several smaller masses around Tetachuck Lake that were only known to intrude Lower Jurassic rocks. In Whitesail Lake map-area (Duffell, 1959), several lithologically similar granitic bodies that were mapped west of those under discussion were found to intrude Middle Jurassic rocks. There seems to be sufficient evidence to say that some of the similar rocks of the Tetachuck Lake area must also be later than Middle Jurassic. With the reservation that some unspecified granitic bodies of the Tetachuck Lake region may be older, all these rocks are tentatively mapped as post-Middle Jurassic.

These plutonic rocks as a unit differ from most granitic batholiths of British Columbia in that they do not parallel structure. Several bodies are irregular but most are roughly equidimensional. They commonly occur in low terrain or at the base of mountains. In Fawnie and Nechako Ranges, from the manner in which they outcrop it would seem that the granitic rocks were just being unroofed.

Lithology

The rocks of this unit are, for the most part, coarse-grained, equigranular, and light coloured. Only the body north of Tetachuck River and some border phases of the body west of Chutanli Lake are at all gneissic. Elsewhere the rocks are, with few exceptions, uniformly equigranular from the margins to the centres of the masses. Inclusions or xenoliths are rare. Appreciable shearing or faulting within the masses has not been found. The common size of feldspar grains is one eighth to one quarter inch, occasionally one half inch, but rarely are they less than one eighth inch. Fine-grained phases are neither extensive nor characteristic of the whole of any body seen in the area. In general the rocks are light coloured and weathered, in some places, very white. A few diorite bodies and some gabbroic phases are dark coloured. All rocks mapped weather readily to a depth of as much as 8 inches. Some of the more deeply weathered rocks may represent Tertiary weathering from which the cover has recently been stripped.

The batholiths of Fawnie and Nechako Ranges are very similar throughout, and are composed mainly of a white to pink, coarse biotite granite and grey granodiorite. The granites are comprised of 20 to 25 per cent quartz, about 50 per cent potash feldspar, 10 to 15 per cent oligoclase, 10 to 15 per cent biotite and amphibole, and minor accessory minerals. The quartz content does not vary appreciably and does not rise much above 25 per cent in any specimen studied. In a few places the potash feldspar is a deep salmon colour and forms nearly 70 per cent of the rock; there mafic minerals are less than 5 per cent. The granodiorite is similar in appearance to the lighter coloured granites, differing mainly in a lower quartz and feldspar content. Possibly many of the lighter coloured rocks called granite in the field but not studied under the microscope may actually be quartz monzonites or granodiorites. Whatever the true proportion may be, nearly all the rocks of these batholiths are either granites or granodiorites.

The igneous rocks farther west around Tetachuck are more varied in composition and range from gabbro to granite. Although no one rock type is typical of these bodies, diorite does predominate. The diorite bodies are much alike in composition—about equal amounts of andesine and hornblende, with quartz varying from none to 10 per cent. Some diorites grade into quartz diorites. The best exposure of such diorites occur north of Qualcho Lake, on both sides of Bryan Arm, northwest of Chelaslie Lake, and 10 miles up Chelaslie River. The mass northwest of Chelaslie Lake is mainly diorite but grades from a quartz diorite to a dark gabbro that forms a rim near the intrusive contact with basic Mesozoic lavas. One other gabbro-like mass occurs near the northwest end of Nechako Range; this may be a neck associated with Mesozoic volcanic rocks. Smaller bodies of granite, granodiorite, and quartz diorite occur in this general area but one rock type, particularly the granodiorite, grades into another within a single body or, in many places, into diorites or Mesozoic volcanic rocks. Many contain inclusions of the intruded rocks.

Structural Relations and Age

All rocks included in this group are younger than the Takla Group. In Fawnie Range at the west end of Johnny Lake and on Tatelkuz and Kuyakuz Mountains the granite batholiths intrude Hazelton Group rocks. At the southwest end of Euchu Lake gneissic granodiorites are in fault contact with Hazelton Group sediments. Boulders and pebbles of these granitic rocks occur in early Tertiary conglomerates. With the reservation that all these rocks may not have been emplaced at the same time, the age of this group can be stated as younger than Middle Jurassic (Bajocian) and older than early Tertiary.

The mode of emplacement of this group is uncertain. The granitic batholiths of Fawnie and Nechako Ranges have very sharp contacts with the intruded rocks. The composition and texture is uniform to the contact and in the intruded rocks there is a narrow zone of hornfels, although the contact effect is not pronounced nor does it extend more than a few feet from the contact. Dykes or pegmatites were seldom observed. Around Tetachuck Lake, although some of the granitic rocks were emplaced with a very sharp contact, the diorites and granodiorites more commonly have a gradational contact, particularly where basic volcanic rocks are intruded. In such examples, position of the contact must be arbitrarily selected—a difficult matter where the gradation is over distances of a mile or more. Inclusions and dykes further complicated the decision.

Correlation

This group cannot be readily correlated with any well-known group. The Topley Intrusions are older and lithologically different. The Omineca Intrusions bear some lithological resemblance but differ in form, topography, and outcrop patterns and may not be the same age. Also, the Topley Intrusions separate the Omineca Intrusions from these in Nechako River area. The Coast plutonic rocks of the Coast Mountains are lithologically similar, but these rocks are not within the Coast Mountains, topographically or physiographically. Duffell (1959) included adjacent rocks of Whitesail area with the Coast plutonic rocks and the bodies discussed here too may be satellites of the main mass of the Coast Mountains. Granodiorites of Bulkley and Babine Mountains (Armstrong, 1944a, b) have a similar position in space and time, and they are considered to be satellites of the Coast plutonic rocks.

Chapter IV

STRUCTURAL AND HISTORICAL GEOLOGY

Structural Geology

The scarcity of well-exposed rock and the paucity of information observable in outcrops made interpretation of the structural geology difficult. The Tertiary groups include few bedded sedimentary rocks so that a structural interpretation must be based on outcrop patterns and a close examination of all outcrops, usually impossible to accomplish during this type of mapping. The Mesozoic rocks offer more information, but even with these groups, the broad valleys and distance between outcrops preclude a satisfactory interpretation. The information available is briefly recorded.

Folds

All the volcanic and sedimentary rock groups of this area are folded to some degree, and practically all folds have a northwest trend. Similarly the Topley Intrusions have a northwest elongation but not the younger granitic rocks. At no place can the folds be described as tight or isoclinal except possibly within the Cache Creek Group strata, for which there is no information in the area. Admittedly the evidence is most incomplete, but nowhere were overturned folds recognized or suspected; the regional metamorphism, even in the Takla Group rocks, is low-grade (pronounced metamorphic effects, where seen, could be related to contact metamorphism around granitic bodies), and in general the deformation of rocks is not intense. Nonetheless, the high proportion of volcanic rocks, commonly structureless, may be responsible for masking what may well be a complex fold pattern.

The Takla Group rocks appear to be the most strongly deformed with dips up to 70 degrees and rarely steeper. The volcanic rocks of the Takla Group are commonly structureless so that for large areas there is no hint as to the structure.

The Hazelton Group rocks are composed of relatively competent volcanic and conglomeratic rocks interlayed with less competent shales. In general, this group occurs in broad folds with dips up to 45 degrees, but locally, where shales predominate, the rocks are more tightly folded with dips as high as 80 degrees. These shales are commonly sheared and badly contorted. The folds that do occur in these rocks, such as those of Fawnie Nose, Tatelkuz and Kuyakuz Mountains, and Batnuni Lake valley, cannot be traced far as they are cut off by faults or are covered by drift.

The Ootsa Lake Group has been warped into broad, open folds with dips rarely as great as 45 degrees. However the structure of this group is difficult to interpret for lack of dependable attitudes, and in some parts of the area the rocks may be little disturbed. Whereas the older groups have a distinct and consistent northwest trend, the Ootsa Lake Group has no consistent fold pattern, a conclusion supported by the disorganized topography characteristic of it. In the northwest quarter of the area several northeast- and north-trending folds are suggested by outcrop patterns and the rocks east of Qualcho Lake on the south edge of the area have been formed into a syncline plunging gently northeast (this was interpreted from outcrop patterns in the area to the south).

The Endako Group is the least deformed of the map-area. Over much of the area the rocks are essentially flat lying or probably have a regional dip of less than 5°E. North of Intata Lake around Deerhorn Hill it is possible to delineate a few, broad, northwest-trending flexures that are not believed to be initial volcanic structures. In this instance, however, the rocks in question may possibly be slightly older than the main mass of Endako Group rocks, which elsewhere in the area are essentially undeformed.

Faults

Faults are the more obvious structural features, but none can be classed as major. Because of excessive drift and poor stratigraphic information few details are known. From air photographs many lineaments are obvious. In the field many of these were recognized as faults, some can be shown to be joints, but for many no explanation is possible without detailed studies. In the writer's opinion most of these unexplained lineaments will eventually be recognized as faults or shears. This opinion is based on the discovery of many narrow shear and fault zones near Skins Lake by the Aluminum Company in testing for dam sites. These zones although unsuspected in outcrops were visible in air photographs.

The faults in this map-area are characterized by zones of intense shearing, slickensides, gouge, and breccia but in all places examined the zones are very narrow and steep. Neither directions nor magnitude of displacement is known. Faults associated with the folded Mesozoic rocks along Ootsa Lake, Fawnie Range, and Nechako Range are parallel to subparallel with the northwest structural trend; those associated with the Ootsa Lake Group strike in all directions. A few near-vertical normal faults cut the Endako Group but displacement is slight and none is of sufficient magnitude or importance to map; possibly they are original volcanic structures.

Near François Lake a set of intersecting steep faults strike northerly or northeasterly and in plan suggest a pattern of slip lines formed by compression along a northeast-southwest line. Several other faults in this same area are parallel or subparallel. These faults are prominent in air photographs but, except for determining that movement had occurred, little was learned to explain their unique pattern.

Historical Geology

The geological history presented here is an attempt to place in a logical sequence the events that led to the formation of the rocks and structures of Nechako River map-area. To obtain as complete a picture as possible it is necessary to go beyond the boundaries of the area for facts and inferences that directly affected geological history within the area. A broader interpretation of Mesozoic history has been given previously (Tipper, 1959a, pp. 42-48).

Pennsylvanian and Permian Time

During late Palæozoic time the area was probably inundated by seas that are better known north, east, and southeast of the area. In the Triassic rocks north of Ootsa Lake is a breccia that contains a large block of fossiliferous late Palæozoic limestone. The size and shape of the block indicate a nearby source and from this it follows that the sea covered at least some of the western part of the area during late Palæozoic time. From other areas it is known that the Permian was characterized by volcanism as well as by marine sedimentation and these processes probably operated throughout much or all of Nechako River area.

Early and Middle Triassic Time

No strata referable to this time have been mapped in any area west of the Rocky Mountain Trench, except in Stikine River area (Souther, 1959). In Fort St. James map-area, Armstrong (1949, pp. 42-53) suggested the presence of a major unconformity between Permian and Upper Triassic groups and his evidence, except for his assumption of the pre-Upper Triassic age of the Topley Intrusions, is still valid; nothing has been learned from Nechako River map-area to throw doubt on it. The proximity of Nechako River map-area to the region studied by Armstrong makes it reasonable to assume a comparable situation.

Late Triassic Time

Late Triassic seas probably covered most of the area and extended southward to the Chilko Lake region. Northward and northeastward the Triassic seas were interrupted by a land area from which Permian strata were being eroded to form conglomerates along the shoreline (*see* Fig. 3). Although coarse detritus accumulated near the margins of this landmass, in much of the marine basin fine muds and sands were interlayered with flows, tuffs, and breccias. This relatively fine clastic material suggests either a relatively deep basin or a topographically subdued borderland. The latter is more probable, as red sedimentary strata derived from the deep weathering of the northern land area started to accumulate at this time.

Early Jurassic Time

It is probable that in Early Jurassic time the marine basin covered much the same area as it did in Triassic time except that the margin of the central land area was farther south. Terrestrial red beds accumulated, probably on marginal plains in the northwest part of Nechako River map-area, while marine sedimentation and volcanism, similar to that of Upper Triassic time, occurred in the remainder of the area. Apparently the land underwent successive uplifts which extended the margins of the land area and caused the reworking of earlier deposits. The intrusion of the Topley granites probably began during this period and was closely related to these uplifts. Farther south, along the western boundary of the map-area, volcanic islands apparently were formed near the close of Early Jurassic time and were the forerunners of the land area that formed the southwest margin of the Middle Jurassic basin.

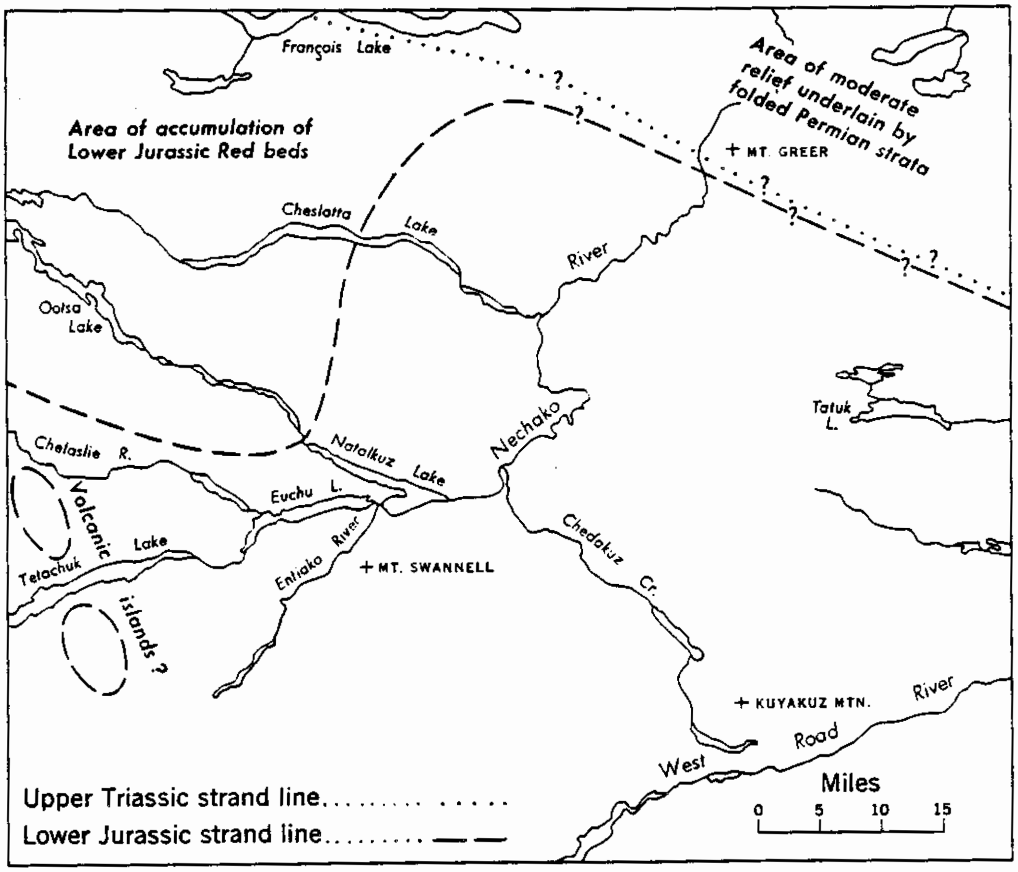

FIGURE 3. Suggested positions of Upper Triassic and Lower Jurassic strand lines within Nechako River map-area.

Middle Jurassic Time

By the beginning of Middle Jurassic time a northwesterly trending sedimentary trough or basin was formed, bounded on the north and northeast by a landmass in which the Topley Intrusions were beginning to be exposed, and on the southwest by a volcanic landmass or series of islands (*see* Fig. 3). The southeastern limit of the basin is not known. To the northwest the basin was constricted and may have had narrow connections with a marine area to the west. In this basin was deposited detritus derived from the erosion of the exposed Permian Cache Creek Group and Topley Intrusions on the northeast, detritus from the volcanic islands on the southwest, and flows, tuffs, and breccias of contemporaneous volcanism.

In the earliest part of the Middle Jurassic, chert-pebble conglomerates accumulated along the shores of this basin and interfingered with sandstones and shales. Volcanism continued intermittently in different parts of the basin. The sediments deposited were characteristically coarse and included little volcanic material. In later Middle Jurassic time finer sediments accumulated and there was much admixing with volcanic tuffs and fine breccias.

Apparently this basin underwent a change during Middle Jurassic time. The volcanic island arc on southwest margin continued to be uplifted so that the basin was shifted to the east and the former northeast margin was inundated. The northeastern borderlands were being rapidly eroded, as arkoses were formed nearby.

Late Middle Jurassic time has no known representative in Nechako River map-area.

Late Jurassic Time

Limy shales were deposited in a basin in the central part of the area in early Upper Jurassic time. Fossils collected from these shales represent the earliest zone of the English Callovian (Upper Jurassic), but fossils of this era have not been recognized north of the area. The occurrence of similar fossils and rocks of closely comparable age to the south suggest that the two marine basins may well have been connected.

Late Jurassic and Early Cretaceous Time

During this period or even earlier, regional deformation, intrusion, uplift, and erosion began, and probably continued until Late Cretaceous time. The granitic intrusions of the south and central parts were emplaced then or possibly in late Middle Jurassic time. During this period also the sea was completely and finally excluded from Nechako River area.

Late Cretaceous to Late Oligocene Time

By Late Cretaceous time most batholiths and stocks were emplaced, the area had been regionally deformed, and distinct ranges of northwest-trending

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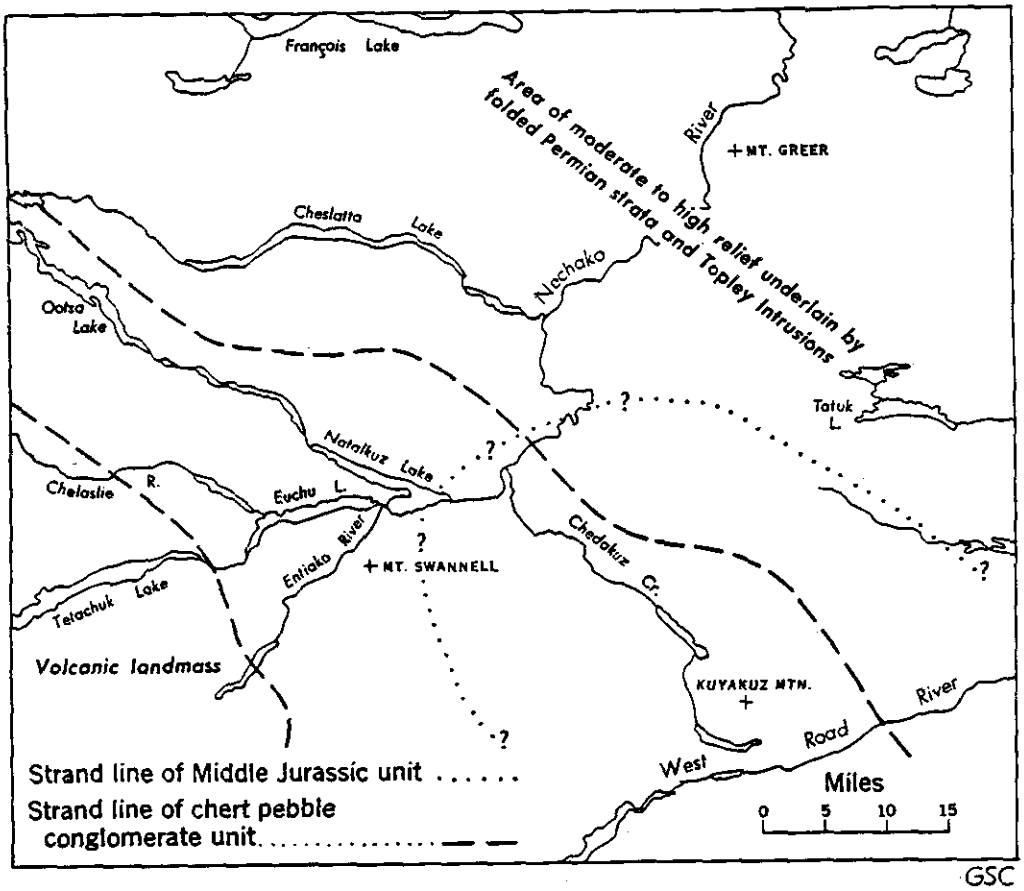

FIGURE 4. Suggested position of Middle Jurassic strand lines within the Nechako River map-area.

hills and mountains were established. Valleys were generally broad and the relief on the whole not great. In the low areas basaltic to andesitic flows began to accumulate, interbedded with thick layers of breccia and tuff. In freshwater lakes, mud and tuff beds formed, in which were preserved leaves and shells. By Eocene time much of the volcanic material was rhyolitic and trachytic composition although andesite was common. Still later (Oligocene time) rhyolitic flows greatly predominated.

During this time, at least by late Oligocene time, the area was deformed again and the youngest rocks were folded into broad open folds.

Miocene Time

Beginning in late Oligocene or early Miocene time basaltic and andesitic plateau lavas were extruded and floored many of the valleys or built accumulations up to 2,000 feet thick. In a few places these flows were warped into gentle folds and the whole group may have acquired a general easterly dip.

Late Miocene and Pliocene Time

No rocks of this age are known in the area. However, as there is palæontological evidence only for the lower limit of the Endako Group, it is possible that many of the flows included are as young as late Miocene and Pliocene. This time was also characterized by areal erosion and down-cutting of streams. The drainage system that was disrupted by the Endako lavas re-established itself and many canyons were cut in the Tertiary volcanic rocks. Much Tertiary rock was eroded, established valleys were broadened, and deep weathering may have occurred.

Pleistocene Time

During Pleistocene time the area was covered by glacier ice to a depth of at least 5,000 to 6,000 feet. At its maximum the ice may have moved in a north-south direction as indicated by indistinct grooves but the last ice movement was from southwest to northeast.

Recent Time

In Recent time streams have been re-establishing the drainage channels disrupted by glaciation. No further volcanic activity has occurred.

Chapter V

ECONOMIC GEOLOGY

Despite seemingly suitable geological conditions, no significant economic mineral occurrences have been found within the map-area. The reasons for this may be as follows:

(1) overburden and forest cover are greater than in more mountainous areas to the east and west thus obscuring mineral occurrences;

(2) prospectors are attracted to areas of better rock exposure, and relatively little prospecting has been attempted in the area;

(3) results of prospecting so far in the area have been discouraging and have not been conducive to a more thorough search;

(4) the Tertiary rocks that underlie most of the area are apparently barren of ore-mineral occurrences.

During field work ore minerals were rarely observed, and little of any economic interest was seen. However, it cannot be said that the area is barren and that no economic mineral deposits occur. Over 90 per cent of the area is drift covered and heavily timbered, and the 5 to 10 per cent that is rock outcrop can hardly be considered a fair sample, particularly as the presumably barren Tertiary rocks are probably the best exposed.

The Takla Group, particularly the main unit, appears to be the map-unit most worthy of further prospecting. The mineralized zones noted were all in this group of rocks. Near intrusive bodies, rocks of this group are commonly sheared and altered, and pyritization is common. In the Tetachuck Lake area many such pyrite zones occur and although none seen was large or extensive, prospectors have reported a low content of gold in many occurrences. Elsewhere in central British Columbia Takla Group rocks are mineralized and are considered worthy of careful prospecting.

No deposits of ore minerals were seen in the Hazelton Group rocks. This group is however deformed, metamorphosed, and intruded, and does not appear to differ markedly from equivalent rocks elsewhere in British Columbia which are known to be mineralized. Nechako Range, Tatelkuz Mountain, and Kuyakuz Mountain would be the more likely areas for further prospecting.

The Ootsa Lake Group includes perlitic flows that may eventually be of economic importance. North of Cheslatta Lake, some of these flows are coated with a little copper carbonate believed to be derived from some small amount of chalcopyrite disseminated through the flow; this chalcopyrite is thought to have been an original constituent of the flow. No other occurrence of ore minerals is known in this group in the area.

The Endako Group is generally considered to be barren of any ore mineral deposits. The most important use for this group to date was in the construction of Kenney Dam.

Description of Mineral and Rock Deposits

Iron Mountain

Reference: B.C. Minister of Mines, Ann. Rept. 1921, pp. 110-111.

A deposit of specular and massive hematite occurs on a small hill on the north side of Finger Lake at 4,200 feet elevation. The country rock is sheared and metamorphosed volcanic rock, presumably Takla Group, that is present as a pendant in the Topley granites. The hematite occurs along numerous shears, replacing the brecciated country rock. Minerals are massive red hematite, specular hematite, magnetite, and quartz. The mineralized zones are up to 2 feet wide and 100 feet or more long, but much country rock is included in these zones.

This deposit has been staked several times and extensive trenching and stripping has been carried out but without significant success. No work on the property has been attempted in recent years.

Two selected samples assayed: 19.66 and 14.58 per cent iron and a trace of silver. No gold, lead, zinc, or copper was detected.

Tetachuck Lake

On the southeast side of Tetachuck Lake, near the outlet of Bryan Arm, a small vein of sphalerite and calcite cuts Lower Jurassic (?) argillite. The vein is 2 to 4 inches wide with an unknown length. A selected sample assayed zinc 26.80 per cent; gold 0.005 ounce per ton, and silver 0.15 ounce per ton. No lead or copper was detected although rocks nearby had a coating of copper carbonate.

In the area around Tetachuck Lake several pyritized zones were noted, none of great extent or heavily mineralized. Some of these are reported to carry a low gold content but no samples were taken for assay by the author.

Fawnie Mountains

The north end of Fawnie Nose Mountain has a conspicuous rusty colour, a feature well known to local prospectors. Much of the mountain slope is rusty talus that creates the impression of a very large deposit of limonite. A brief examination showed that the north slope of the mountain and the adjacent valley bottom was the site of several strong shears but that no economic mineral occurrences were present. The country rock, green andesite or greenstone, is impregnated with finely disseminated pyrite that weathers readily to limonite. No large concentration of any metal sulphides was noted.

Molybdenite

Several molybdenite occurrences have been described north of the map-area near François Lake (Armstrong, 1949, pp. 192-3), and small amounts of molybdenite have been noted in quartz veins in the Topley granites of the area. Molybdenite was also noted in a small quartz vein about 2 miles north of the west end of Chelaslie Lake. None of these occurrences was of significant size or extent.

Perlite Deposits

References: Ann. Rept., Minister of Mines, B.C., 1953, pp. 194-5; 1958, pp. 97-8.

Perlitic rhyolite or perlite flows, 30 to 40 feet thick, form part of the Ootsa Lake Group. Although it has not been possible to establish the stratigraphic position of these flows (if, indeed they form a stratigraphic unit) in general it is believed that they are near the top of the group, certainly in the rhyolite unit.

Perlite has been described as "... one variety of obsidian, characterized by a perlitic or spherulitic texture, a waxy to pearly luster, a perlitic, splintery, or columnar fracture, and the presence of a relatively large amount, 2 to 5 per cent, of chemically combined water" (Barr, 1949, p. 749). When perlite is crushed and heated to the softening point, the combined water is released as fine bubbles of steam. The resulting product is a synthetic pumice used as a light weight aggregate in cement.

Perlite flows in Nechako River area vary in colour from black to pearl grey. Such flows have been noted south of Uncha Lake, south of Cheslatta Lake, near the outlet of Ootsa Lake, and near the north end of Entiako Lake. Other flows may occur within the area, as the Ootsa Lake Group is widespread. Although none of the perlite from these occurrences was tested, it is probable that deposits of commercial size and grade will be found when the demand is great enough; commercial perlite from the Ootsa Lake Group is mined north of the area near François Lake (Armstrong, 1949, pp. 198-199).

In 1953 perlite occurrences were staked by C. S. Powney and John Rasmussen of Fort St. James, on Dayeezcha Mountain south of Uncha Lake. These claims were not visited subsequent to staking but presumably the occurrence is the one mentioned in the preceding paragraph.

Asbestos

Asbestos is reported by local residents to occur on or near Sinkut Mountain, which is east of the northeast corner of the area. This is in the area underlain by ultrabasic rocks. Although no prospects or claims carrying asbestos were examined, a fibrous mineral was noted along a forestry road. This mineral was identified by X-ray analysis as anthophyllite. The mineral occurs in an anthophyllite-talc-chlorite schist presumably derived from the metamorphism of ultrabasic rocks within the contact zone of the Topley granites. The fibres observed in these rocks are white and brittle.

Lignite

Lignite float has been noted at many places in the map-area but as it is Tertiary lignite, occurring with soft Tertiary sediments, no good exposures were seen.

North of Cheslatta Lake, 5 miles east of Tyee Butte, large blocks of carbonized wood, dull lignite, and a bright, light-weight, waxy 'coal' were found in a creek bottom. The material was not in place but had not travelled far. The blocks were of a size to indicate a minimum seam thickness of a foot. The material was compact when found but on drying the lignite broke into rectangular fragments and the 'coal' broke with a conchoidal fracture. The extent, quality, or origin of this lignite is unknown but it is believed to be Tertiary, probably as late as Oligocene.

Along Nechako River north of Kenney Dam large blocks of lignite are strewn along the exposed river bottom, but a careful search failed to disclose their source. Dawson (1878, p. 82) reported a 4-foot seam along Nechako River near Mount Greer but this was not seen—possibly is no longer exposed. The blocks were sufficiently large to suggest that such a seam does exist. In all probability the lignite is inter-basalt or is from the base of the plateau basalts and hence of late Tertiary age.

Along Tsacha Lake, in Batnuni Valley, and along Chedakuz Valley small fragments of lignite and fossil wood were noted. The source was not seen but the fragments resemble previously described lignite. Possibly these too are derived from concealed lignite beds in or beneath the Endako Group.

Hydrocarbons

A black hydrocarbon was noted in rhyolite 1½ miles east of Batnuni Cone, and another 2 miles south of the west end of Batnuni Lake on Swede Creek. It occurs in vugs and cavities and in small fractures as a black, dull, tar-like substance. In places the material is brittle and has a conchoidal fracture.

A sample from near Batnuni Cone was examined by D. S. Montgomery, Fuels Division, Mines Branch who reported that: "The hydrocarbon material in the vugs is a native asphalt, which closely resembles liverite but is not identical with this substance."

Pumice and Diatomite

In 1876 Dawson (1878, p. 79) described an occurrence of pumice and diatomite in a section of Tertiary sediments on the south side of Tsacha Lake. The occurrence was exposed in a creek that enters the lake 1½ miles from the southwest end. The sediments underlie plateau basalts that occur on the flat upland to the south. The creek has cut through the basalt exposing the sediments, immediately below the basalts. They consist of grey fragments of pumice in a crumbly and badly slumped bed possibly 50 feet thick. Farther downstream fragments of a white or cream-coloured diatomite occurred in the valley bottom, presumably a part of the sedimentary section below the pumice. The position of the diatomite below the plateau basalts is similar to that of the diatomite near Quesnel, British Columbia (Tipper, 1959b). Deposits of diatomite and pumice may be extensive in the Tsacha Lake area below the plateau basalts but such soft sediments are generally obscured by drift.

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A. François Lake, looking west.

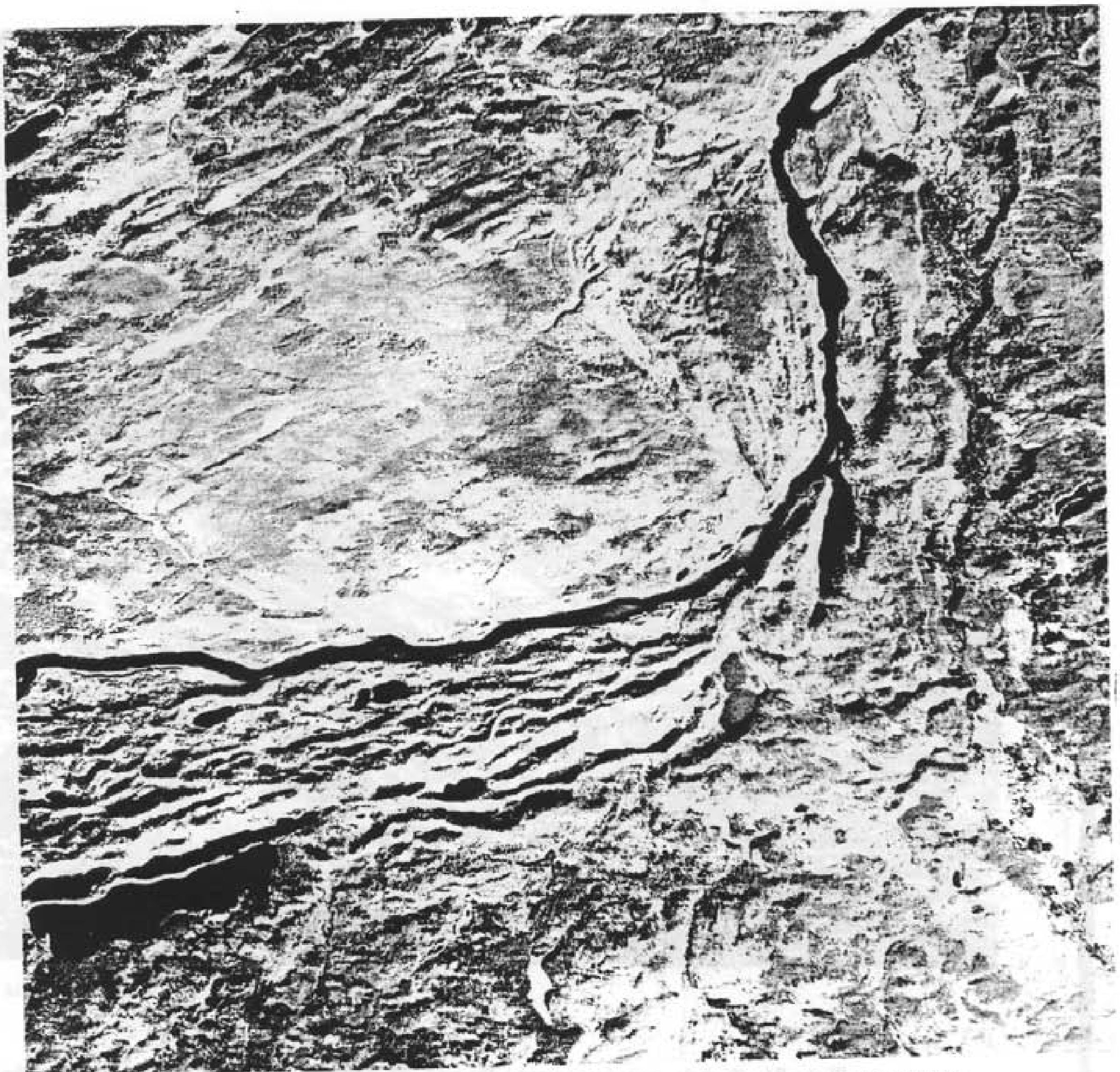
Plate I

B. Falls on West Road (Blackwater) River.

A. Rounded summits of Interior Ranges. Kuyakuz Mountain in background.

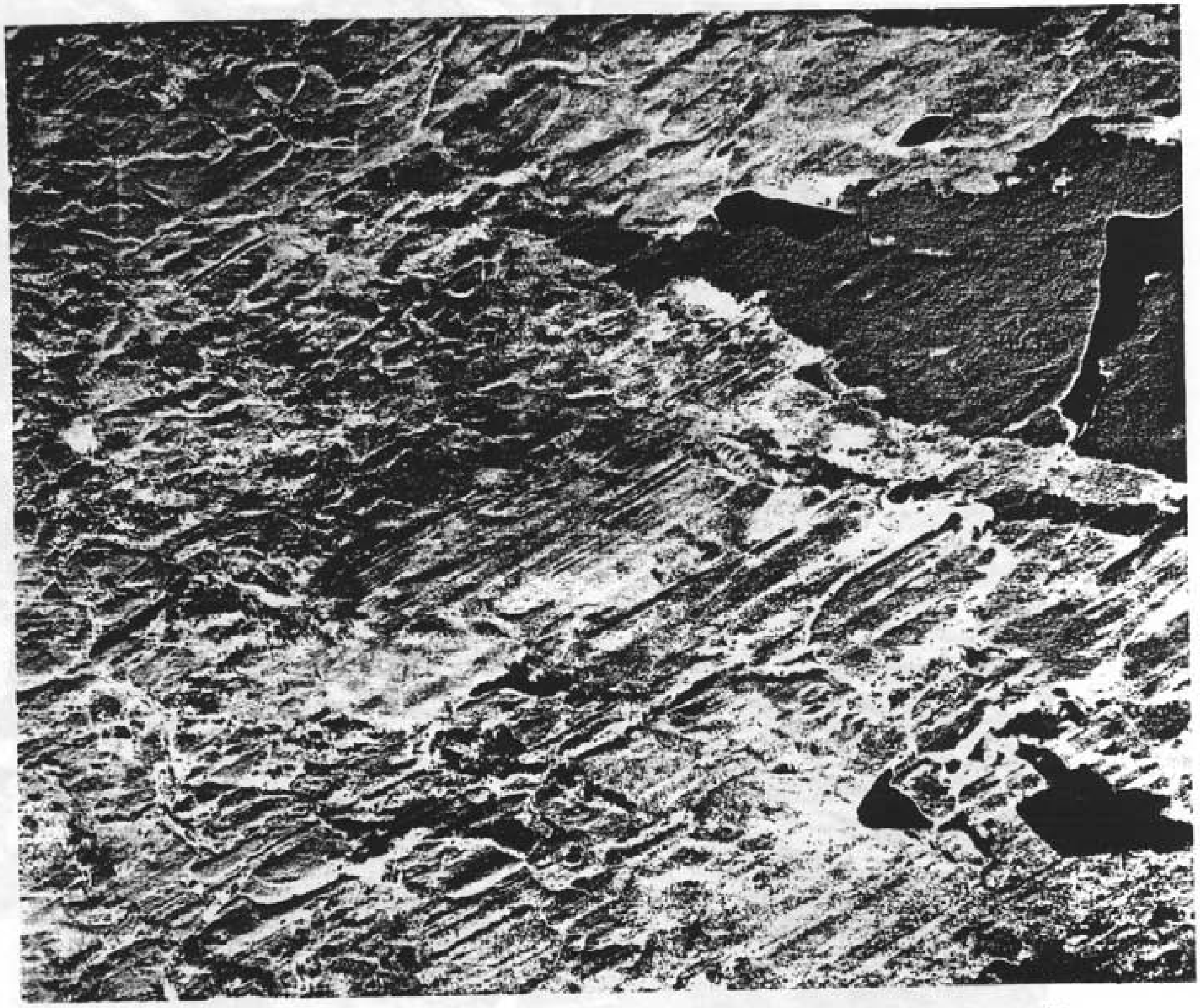
Plate II

B. Low hills south of François Lake, characteristic of areas of early Tertiary rocks.



RCAF 23-5310

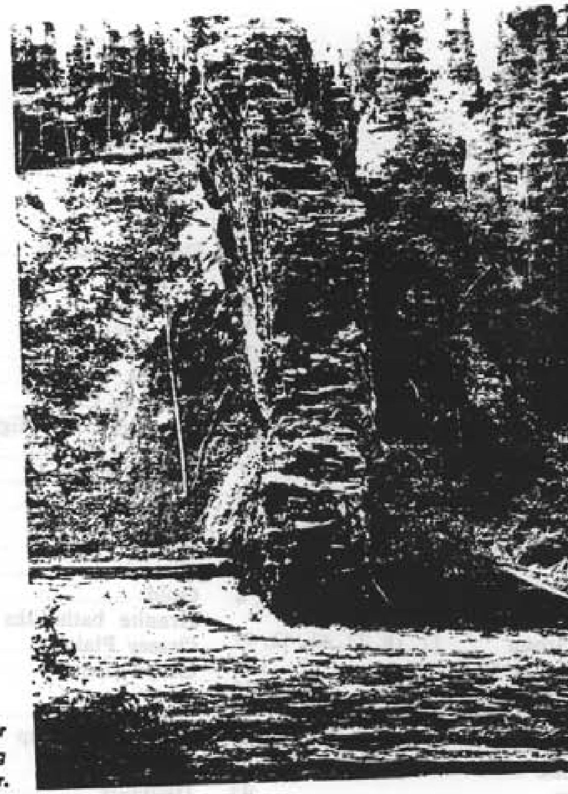
Plate III. *Esker complex along Nechako River east of Natalkuz Lake.*



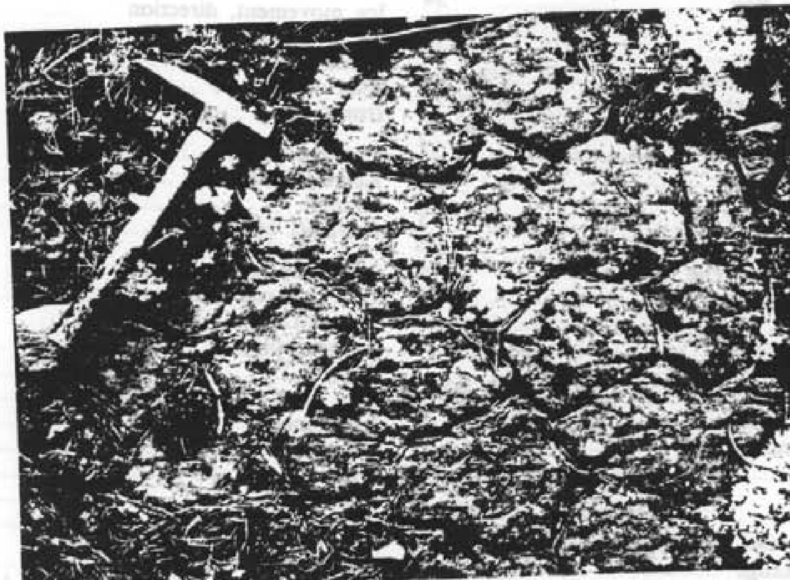
RCAF 23-5314/15

Plate IV. *Glacially striated topography. The area with crag-and-tail features, in the lower half of the photograph, has shallow drift-cover and is underlain by Ootsa Lake Group rhyolite. The area in the upper half is heavily drift-covered and is underlain by flat-lying Endako Group basalt (note the indistinct shallow groves). The sharply defined gullies are meltwater channels cut, for the most part, into bedrock and now mainly abandoned. Ice movement was from left to right.*

Plate V



A. Basalt dyke cutting soft Upper Cretaceous sediments along Entiako River.



B. Late Tertiary basalt showing an end view of columns.

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PROVISIONAL MAP
93 F/10

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CANADA

EDITION 1

CARTE PROVISOIRE
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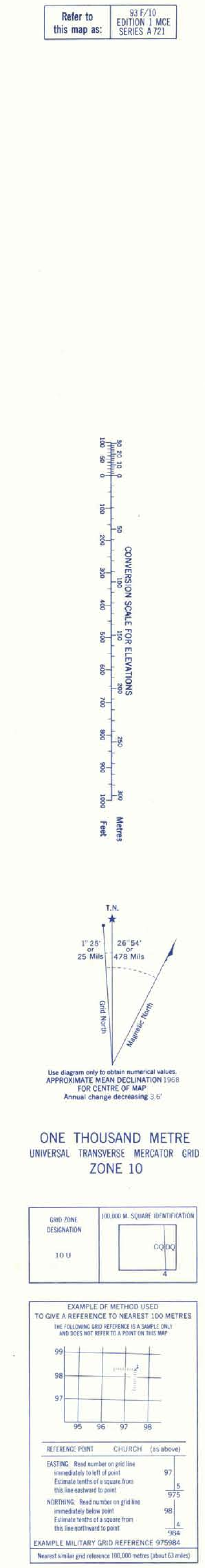

BIG BEND CREEK

COAST DISTRICT RANGE 4

BRITISH COLUMBIA

Scale 1:50,000 Échelle

801

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loose surface, dry weather and unclassified streets	de gravier, temps sec et rues hors classe	
cart track	de terre	
trail or portage	sentier ou portage	

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North American Datum 1927
Transverse Mercator Projection

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Système de référence géodésique nord-américain 1927
Projection transverse de Mercator

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CANADA

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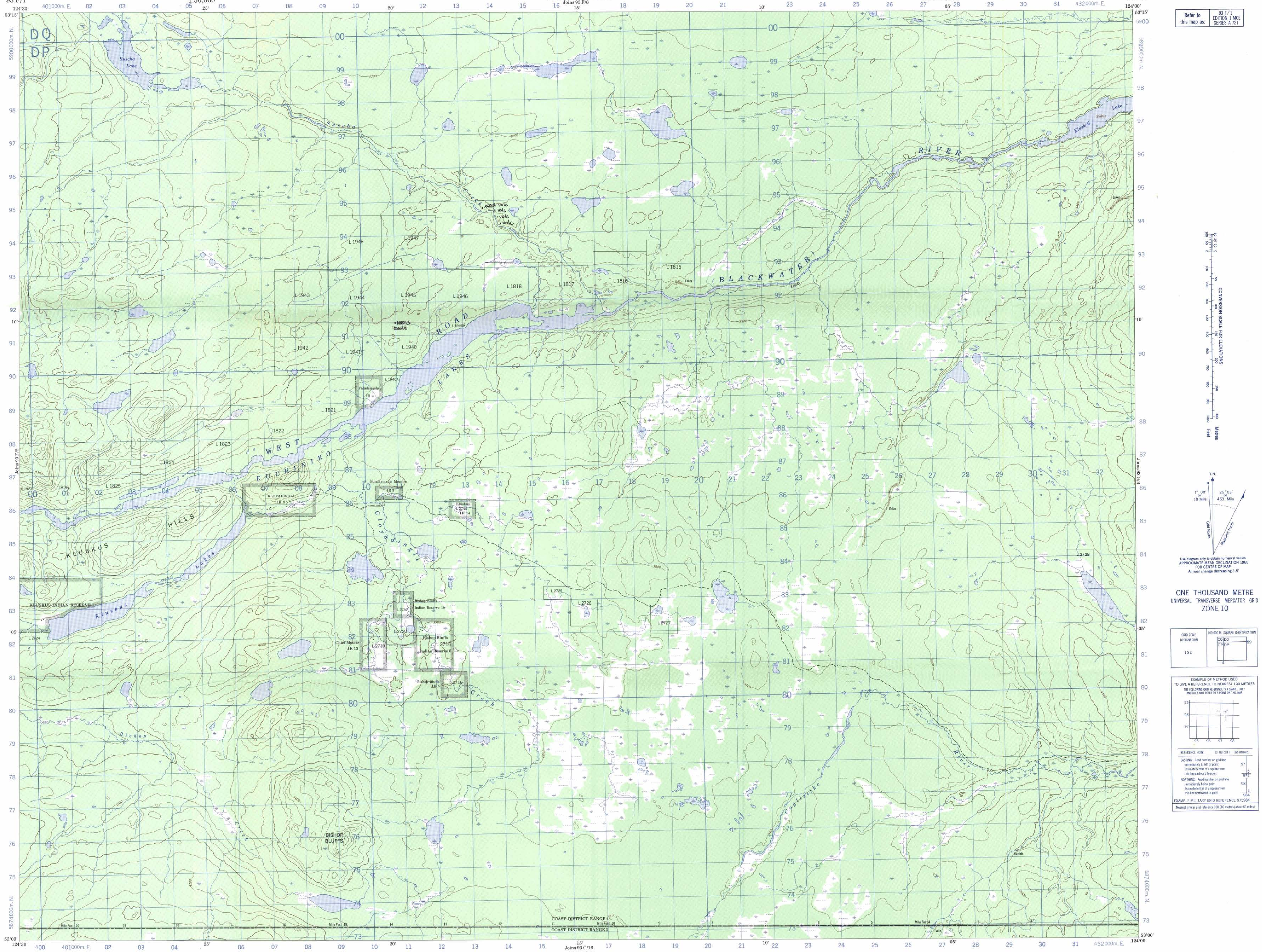

ONE THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 10

SUSCHA CREEK

BRITISH COLUMBIA

Scale 1:50,000 Échelle

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CANADA

Joins 93 F/10

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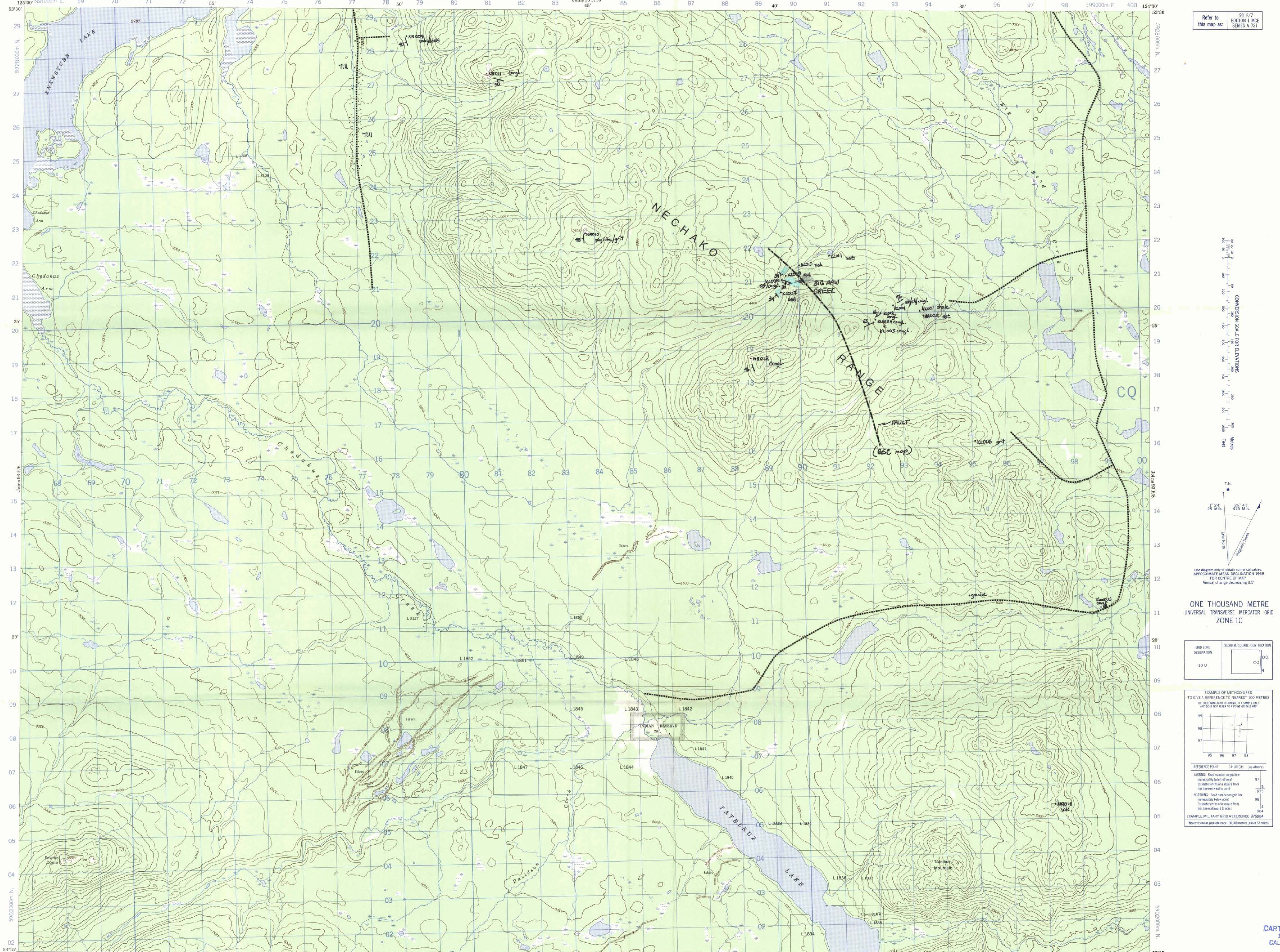

ONE THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
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Joins 93 F/2

CHEDAKUZ CREEK

COAST DISTRICT RANGE 4
BRITISH COLUMBIA

Scale 1:50,000 Échelle

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Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

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Niveau de référence nord-américain 1927
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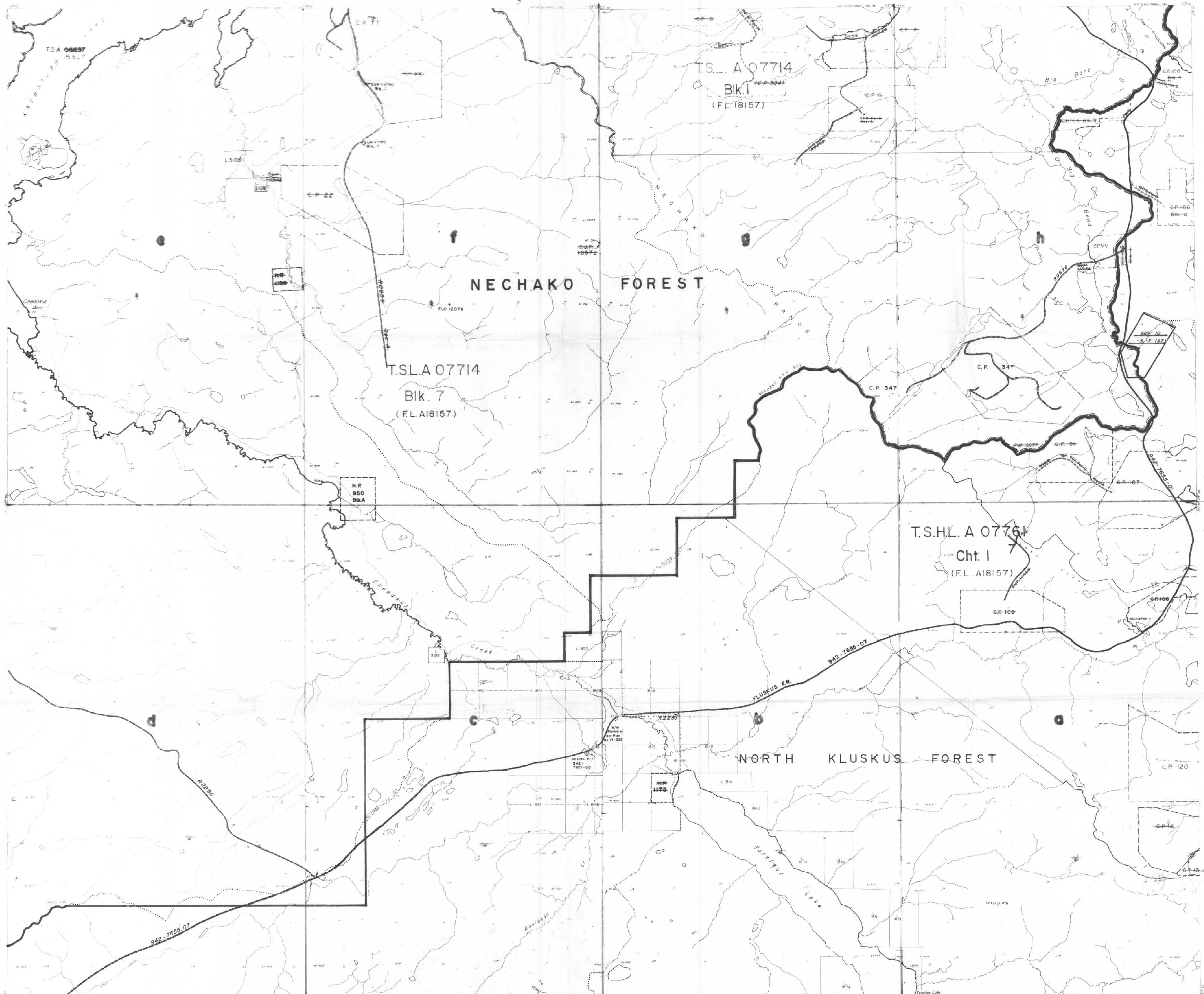

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T.S.L. A 07714
Blk. I
(F.L. 18157)
T.S.H.L. A 07761
Cht. I
(F.L. A18157)
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KLUSKUS F.R.
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Chedakuz Arm
Chedakuz Creek
Davidson Cr.
Tatelkuz Lake
C.P. 347
C.P. 109
C.P. 120
C.P. ZZ
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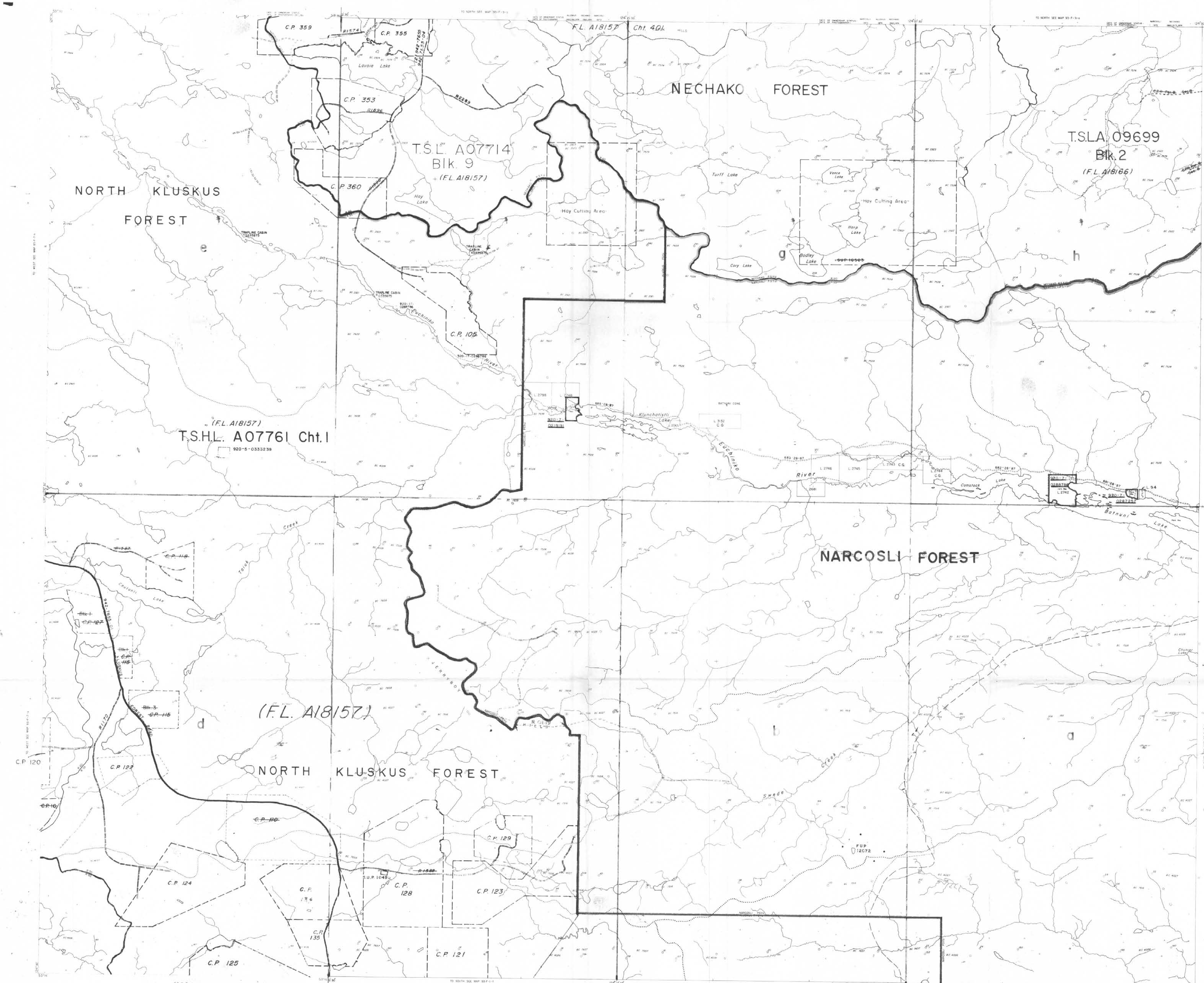
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g
h
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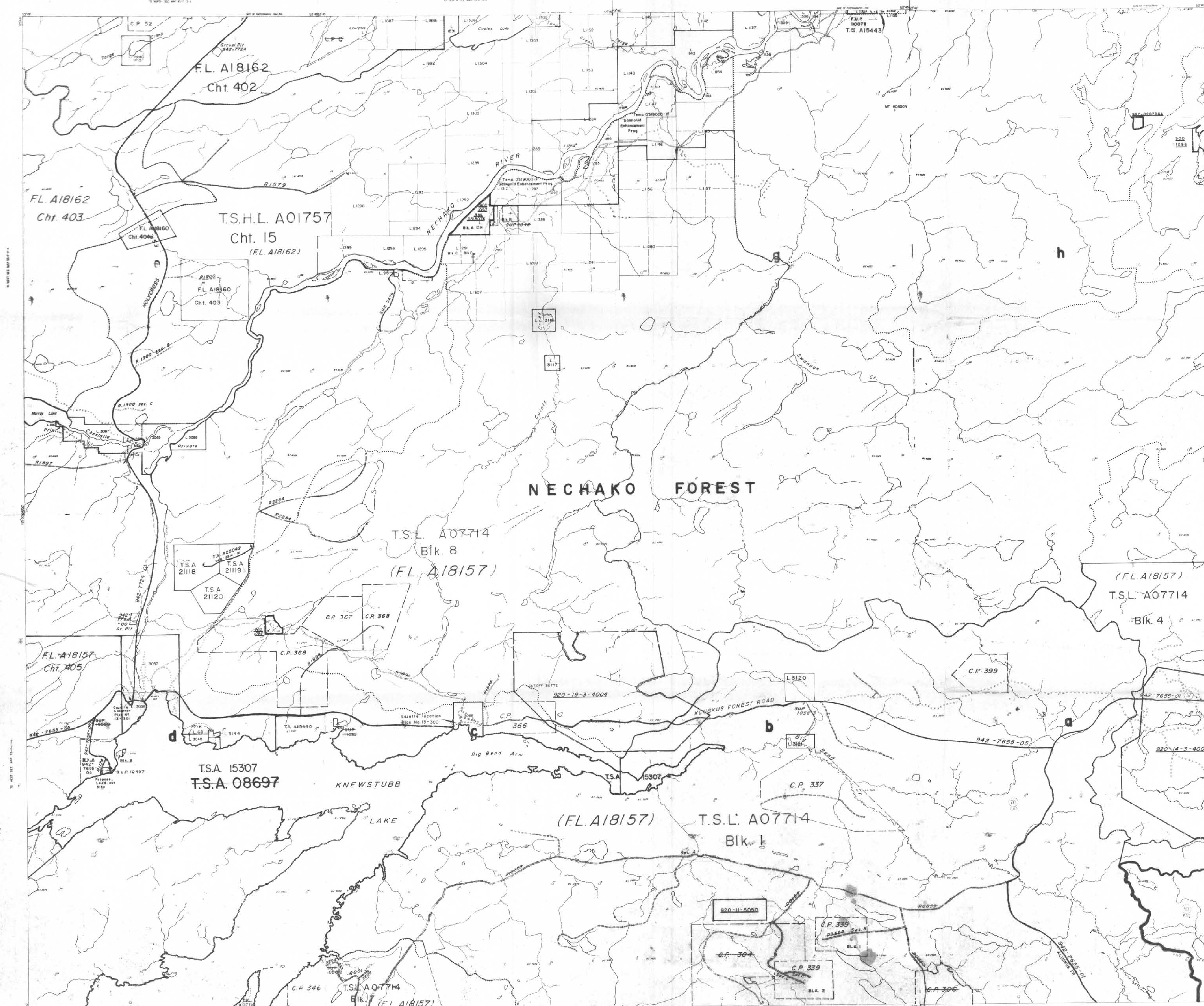
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MT HOBSON
Swanson Cr.
Murray Lake
h
d
c
b
a

CANADA
DEPARTMENT
OF
MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

SHEET 93 F

LEGEND

CENOZOIC

QUATERNARY
PLEISTOCENE AND RECENT

13 — *Till, gravel, sand, clay, and silt*

TERTIARY
MIOCENE AND (?) LATER
ENDAKO GROUP

12 — *Vesicular and amygdaloidal andesite and basalt; flow breccia, tuff, conglomerate, greywacke, and lignite;* **12a**, *necks, plugs and dykes*

PALEOCENE (?), EOCENE, AND OLIGOCENE

11 — *Rhyolite, dacite, and associated tuffs and breccias; minor andesite, basalt, and conglomerate;* **11a**, *rhyolitic and dacitic dykes, necks, and stocks*

CRETACEOUS AND (?) TERTIARY
UPPER CRETACEOUS AND (?) PALEOCENE

10 — *Basalt, andesite, and related tuffs and breccias; minor rhyolite and dacite;* **10a**, *conglomerate and greywacke*

MESOZOIC

JURASSIC AND/OR CRETACEOUS
UPPER JURASSIC AND/OR CRETACEOUS

9 — *Granite, quartz diorite, and granodiorite*

JURASSIC
UPPER JURASSIC
HAZELTON GROUP (In part)

8 — *Argillite and argillaceous limestone*

MIDDLE JURASSIC
HAZELTON GROUP (In part)

7 — *Greywacke, argillite, conglomerate, tuff, breccia, andesite, and arkose; minor rhyolite*

MIDDLE AND/OR LOWER JURASSIC
HAZELTON GROUP (In part)

6 — *Andesite, related tuffs and breccias, chert pebble conglomerate, shale, and sandstone;* **6a**, *mainly volcanic rocks;* **6b**, *mainly sedimentary rocks*

LOWER JURASSIC (?) AND/OR LATER

5 — *Quartz diorite, granite, granodiorite, and diorite*

LOWER JURASSIC
TOPLEY INTRUSIONS

4A, 4B — **4A**, *granite and granodiorite* **4B**, *diorite and quartz diorite*

TRIASSIC AND JURASSIC
UPPER TRIASSIC AND LOWER JURASSIC
TAKLA GROUP (2,3)

3 — *Red and brown shale, conglomerate, and greywacke*

2 — *Andesitic and basaltic flows, tuffs, and breccias; interbedded argillite and minor limestone*

PALÆOZOIC

PENNSYLVANIAN (?) AND PERMIAN
CACHE CREEK GROUP

1 — *Greenstone, gneiss, talc and chlorite schists; includes dykes and contact zone of the Topley Intrusions*

Bedding (inclined, vertical)
Fault (defined, approximate, assumed)
Anticline
Syncline
Glacial striæ
Drift ridges
Fossil locality Ⓕ
Mineral occurrence Fex

MINERAL OCCURRENCES

Iron . . . . Fe	*Silver* . . . . Ag
Perlite	*Zinc* . . . . Zn

Geology by H. W. Tipper, 1949-1953

Approximate magnetic declination, 26°44' East

Cartography by the Geological Cartography Division, 1954

PUBLISHED, 1955

Printed by the Surveys and Mapping Branch

PRELIMINARY MAP 54-11

NECHAKO RIVER

COAST DISTRICT
BRITISH COLUMBIA

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

Miles 4 2 0 4 8 12

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

801

LEGEND

Road
Wagon Road
Trail
Telephone or telegraph line
Provincial Park boundary
Indian Reserve boundary I.R.
Triangulation station
Stream (intermittent)
Marsh
Sand or gravel
Contours (interval 500 feet) 5000
Height in feet above mean sea-level (approximate) . 4558

DESCRIPTIVE NOTES

The best exposures of bedrock occur above tree-line, in river and creek canyons, and on some of the steeper hills. Elsewhere glacial drift, to a maximum depth of 500 feet, covers much of the area, less than 5 per cent of it being rock outcrops.

The oldest rocks in the area belong to the Cache Creek group(1) and occupy a small area in the northeast quarter where they occur along the contact of the Topley intrusions(4B). They are contorted and metamorphosed rocks, not typical of the group as represented farther north.

The Takla group(2, 3) has been subdivided, division 2 being characteristic of the group as exposed in the type area, whereas division 3 is a non-marine, red-bed sequence. The two divisions are lithologically distinct, but were deposited contemporaneously and are in part interbedded. The group is at least 5,500 feet thick, but is not necessarily a conformable succession. Marine shells indicate that part of the group is Upper Triassic and part probably Lower Jurassic.

The intrusive rocks(4A, 4B) in the northeast quarter of the area are an extension of similar rocks to the north and northwest that have been called the Topley intrusions. The granites and granodiorites(4A) are coarse-grained, equigranular, deeply weathered rocks, and include many pink pegmatitic granites. The diorites and quartz diorites(4B) are coarse-grained, gneissic rocks occurring northeast of the granitic rocks(4A). The trend of the gneissosity is northerly or northwesterly. The relation between the different rock types is not known; several intrusions may be represented but are here mapped as essentially one unit. The intrusions are believed to be younger than the Upper Triassic strata of the Takla group but are not demonstrably younger than Lower Jurassic.

The intrusions around Tetachuck Lake(5) cut Lower Jurassic strata of the Takla group but are not known to cut Hazelton group rocks(6, 7, 8). They differ from the Topley intrusions(4A, 4B) and Upper Jurassic intrusions(9) in texture, manner of weathering, topographic expression, size of individual bodies, and composition. Although they may be a phase of other intrusions in the area, there is no evidence to suggest such a relationship.

The Hazelton group(6, 7, 8) is a marine and non-marine assemblage of sedimentary and volcanic rocks over 7,500 feet thick. The lowest division(6), characterized by chert-pebble conglomerate, rests unconformably on the Takla group and includes detritus derived from the Topley intrusions. This division is overlain, probably disconformably, by a fossiliferous Middle Jurassic division(7). A fossiliferous Upper Jurassic division(8) is not known in contact with the other divisions. Although volcanic and sedimentary rocks form locally distinct units, these units cannot be traced for any distance in Nechako map-area. The group as a whole is distinguished from the Takla group by the dominance of coarse, clastic, sedimentary rocks.

The intrusions(9) occurring in the south and central parts of the area rarely form the cores of mountains but occur mainly in the valley bottoms, most boundaries being near the bases of mountains. The rocks are coarse grained and, as most erode readily, they are deeply weathered. Their effect on the intruded rocks is generally slight and inclusions within the granites are rare. Although these intrusions have been mapped as younger than the Hazelton group, they have not been seen in contact with the youngest division(8) of that group.

The volcanic rocks of Upper Cretaceous to Oligocene age(10, 11) are a complex non-marine assemblage, in places at least 1,500 feet thick, which rests unconformably on Jurassic rocks. In many parts of the area it was noted that most of the rhyolitic flows are younger than most of the basaltic and andesitic flows. As these rocks are in discontinuous patches, there is no certainty that the rhyolites or basalts and andesites are everywhere correlative, and the division into two distinct units, as has been done in this map-area, may not be wholly true. The rhyolitic rocks(11) are buff, cream-coloured, mauve, or white, flow-banded or massive rocks, commonly with abundant rounded phenocrysts of quartz. Associated tuffs and breccias are chalky. The andesites(10) are commonly green or bright red to reddish brown and the basalts(10) are dense, black to grey rocks. Both basalts and andesites commonly have plagioclase feldspar laths as phenocrysts.

The Endako group(12) is an assemblage of essentially flat-lying basaltic flows reaching a maximum thickness, in this area, of 1,900 feet. It rests unconformably on the early Tertiary volcanic rocks. Conglomerate and greywacke is locally interbedded with the flows, particularly along Nechako River.

The entire area was overridden by a piedmont glacier moving in a direction varying from east to north 40 degrees east. The glacier, to override the highest point of the area, must have been at least 3,500 feet thick and was probably much thicker. It did not retreat in the usual manner but stagnated and melted in situ. Resulting accumulations of glacial materials(13) took the form of ground moraine, drumlins, eskers, kettles, lake clays, and outwash. The whole area was covered by till and this was in turn dissected by post-glacial meltwater forming deep channels.

Scarcity of exposed rock and paucity of information in outcrops resulted in little information being secured by which to interpret the structural geology. In general, most structures have a northwesterly trend except near François Lake where northeast trends are indicated. The most pronounced periods of deformation were during the Lower and Middle Triassic, in the late Lower Jurassic, and in the Lower and Middle Cretaceous, the last two being also periods of intrusion.

Prospecting in this area has been neither intensive nor rewarding. Poor exposure, thick vegetation, low relief, and discouraging results have been the main deterrents. Few mineral occurrences have been reported from the area and indications of mineralization were rarely observed, despite seemingly suitable geological conditions.

Specular hematite with traces of silver occurs on a mountain north of Finger Lake in sheared greenstone near the contact with the Topley granites. Although known for many years, this occurrence has not proved rich enough or large enough to warrant development.

Sphalerite with traces of silver and gold occurs in argillaceous limestone northwest of Tetachuck Lake. It forms a vein of massive sphalerite 2 to 4 inches wide but of unknown extent.

Perlite or perlitic rhyolite occurs south of Uncha Lake, south of Cheslatta Lake, and near the outlet of Ootsa Lake. Smaller occurrences have been noted and it is probable that there are many perlitic flows in the Tertiary rocks.

Disseminated molybdenite occurs in Topley granites in the north part of the area, but none of the occurrences is large or important.

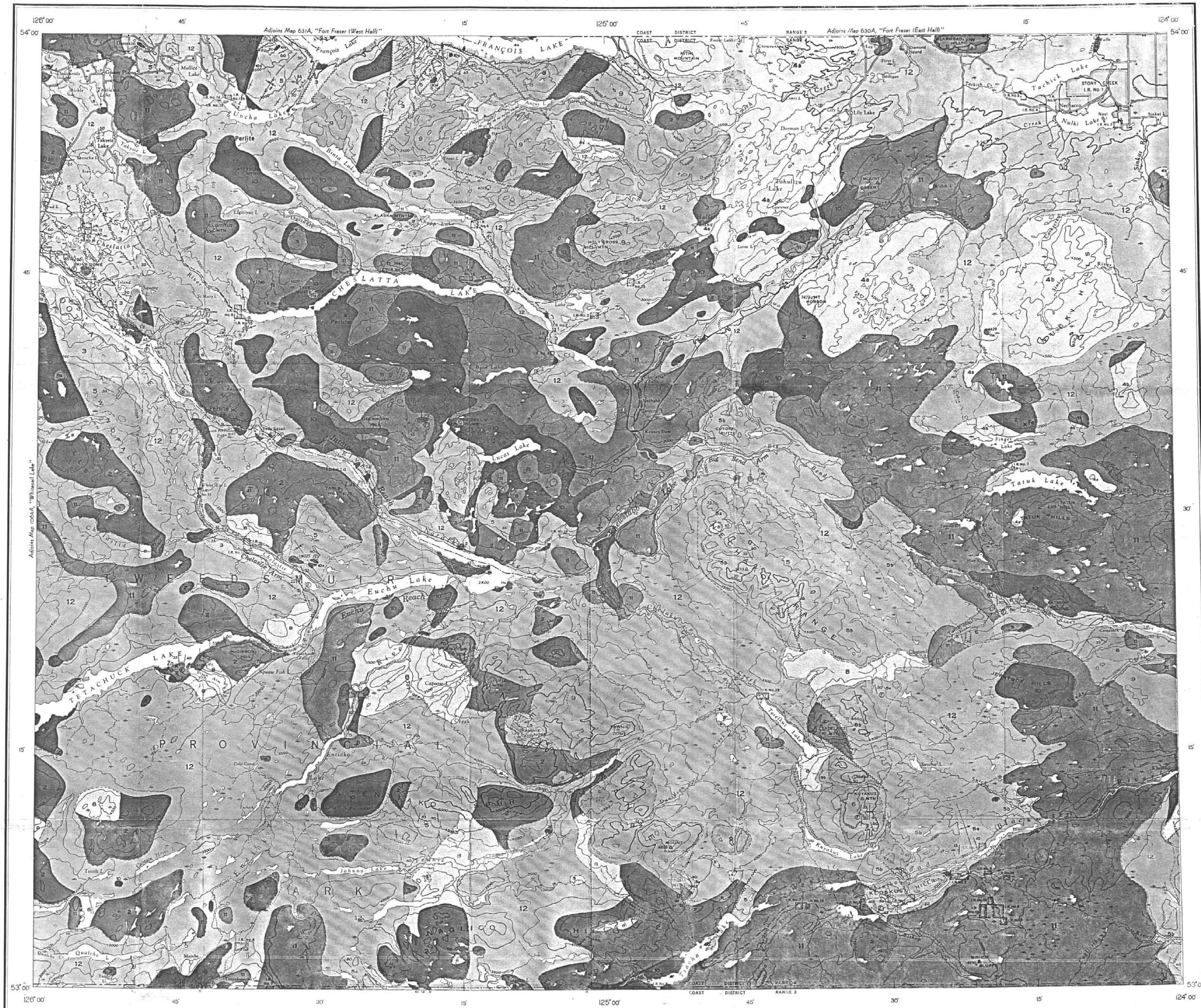
Some tremolite asbestos has been reported in the Permian rocks(1).

PRELIMINARY MAP 54-11
NECHAKO RIVER
BRITISH COLUMBIA

SHEET 93 F

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

SHEET 93 F



PUBLISHED, 1963

PRINTED BY THE SURVEYS AND MAPPING BRANCH

LEGEND

CENOZOIC

QUATERNARY
PLEISTOCENE AND RECENT

12 — Till, gravel, sand, clay, and silt

TERTIARY
MIOCENE AND (?) LATER
ENDAKO GROUP

11 — Vesicular and amygdaloidal andesite and basalt; flow breccia, tuff, conglomerate, greywacke, and lignite; 11a, necks, plugs and dykes

PALEOCENE (?), EOCENE, AND OLIGOCENE
OOTSA LAKE GROUP (In Part)

10 — Rhyolite, dacite, and associated tuffs and breccias; minor andesite, basalt, and conglomerate; 10a, rhyolitic and dacitic dykes, necks, and stocks

CRETACEOUS AND (?) TERTIARY
UPPER CRETACEOUS AND (?) PALEOCENE
OOTSA LAKE GROUP (In Part)

9 — Basalt, andesite, and related tuffs and breccias; minor rhyolite and dacite; 9a, conglomerate and greywacke

MESOZOIC

JURASSIC AND/OR CRETACEOUS
UPPER JURASSIC AND/OR CRETACEOUS

8 — Granite, quartz diorite, granodiorite, and diorite

JURASSIC
UPPER JURASSIC

7 — Argillite and argillaceous limestone

MIDDLE JURASSIC
HAZELTON GROUP (In Part)

6 — Greywacke, argillite, conglomerate, tuff, breccia, andesite, and arkose; minor rhyolite

MIDDLE AND (?) LOWER JURASSIC
HAZELTON GROUP (In Part)

5 — Andesite, related tuffs and breccias, chert pebble conglomerate, shale, and sandstone; 5a, mainly volcanic rocks; 5b, mainly sedimentary rocks

LOWER JURASSIC
TOPLEY INTRUSIONS

4 — 4a, granite and granodiorite; 4b, diorite and quartz diorite

TRIASSIC AND JURASSIC
UPPER TRIASSIC AND LOWER JURASSIC
TAKLA GROUP (2,3)

3 — Red and brown shale, conglomerate, and greywacke

2 — Andesitic and basaltic flows, tuffs, and breccias; interbedded argillite and minor limestone

PALÆOZOIC

PENNSYLVANIAN (?) AND PERMIAN
CACHE CREEK GROUP

1 — Limestone

A — Serpentinized peridotite. Probably Mesozoic

Bedding, tops not indicated (inclined, vertical)
Fault (defined, approximate, assumed)
Anticline
Syncline
Fossil locality
Mineral occurrence . . . x Fe

MINERAL OCCURRENCES

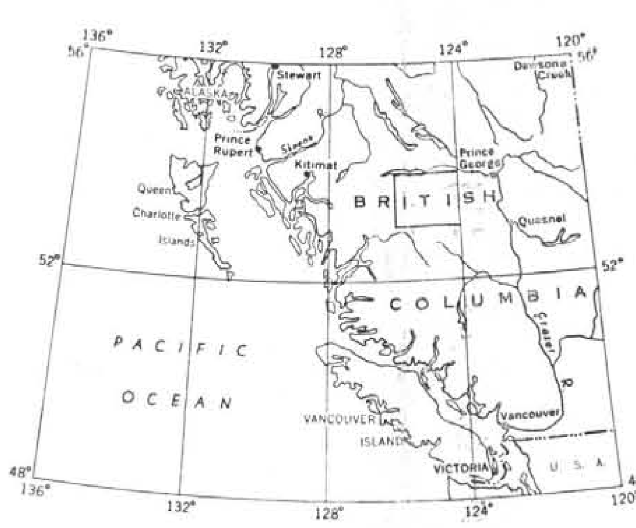
Iron . . . Fe Silver . . . Ag
Perlite . . . Perlite Zinc . . . Zn

Geology by H. W. Tipper, 1949-1953

To accompany G. S. C. Memoir 324 by H. W. Tipper

Cartography by the Geological Survey of Canada, 1962

Mean magnetic declination, 26° 15' East decreasing 3.5' annually. Readings vary from 25° 47' in the SE corner to 26° 40' in the NW corner of the map area



INDEX MAP

801

MAP 1131A
GEOLOGY

NECHAKO RIVER

BRITISH COLUMBIA

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

Miles

4 2 0 4 8 12

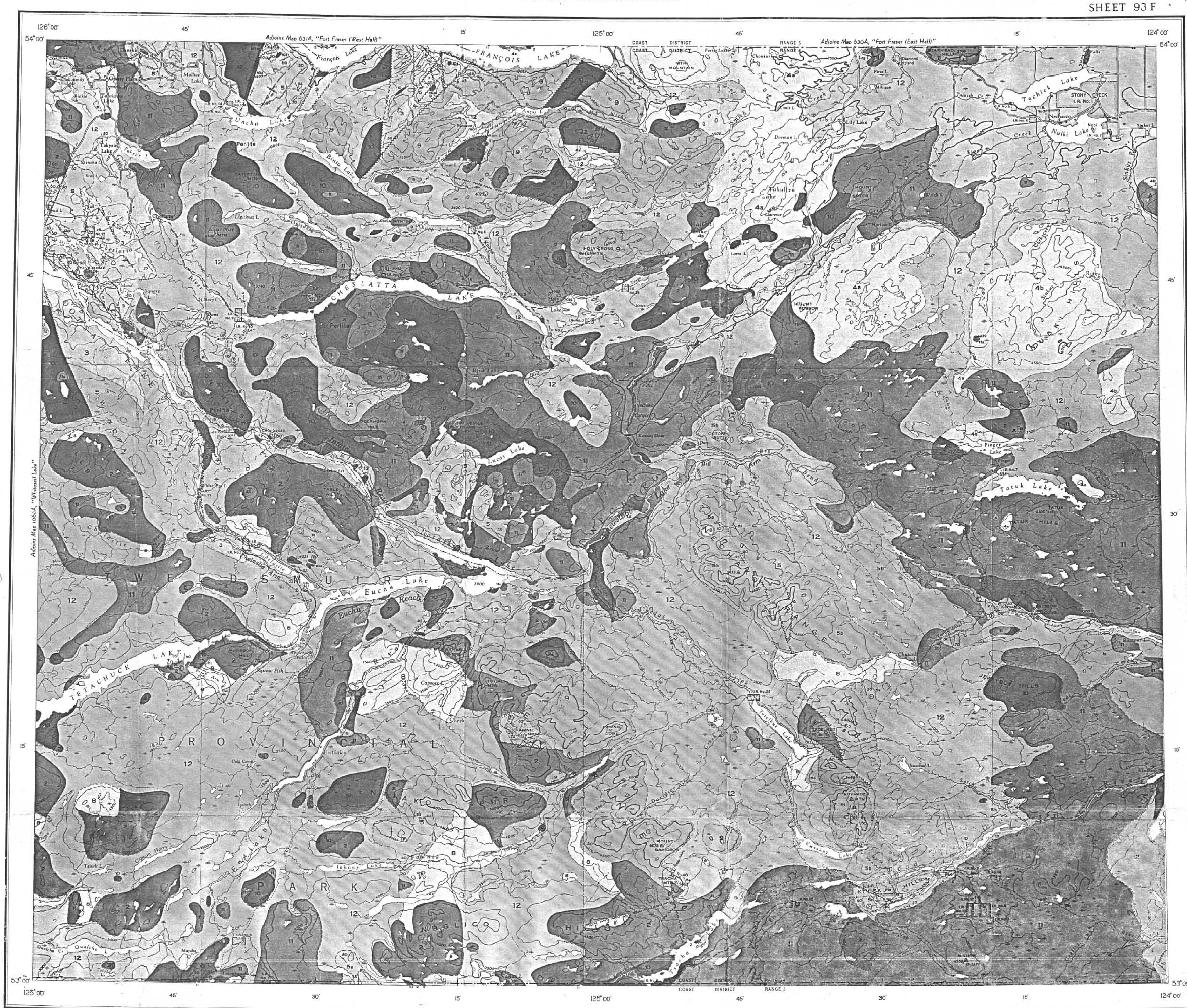
COPIES OF THIS MAP MAY BE OBTAINED FROM THE DIRECTOR, GEOLOGICAL SURVEY OF CANADA, OTTAWA

Road, all weather
Road, dry weather
Cart track
Trail
Building
Church
School
Post Office
Horizontal control point
District boundary
Park and Indian Reserve boundary
Present shoreline above Kenney Dam
Stream (intermittent)
Falls and rapids
Marsh or swamp
Sand or gravel
Contours (interval 500 feet)
Height in feet above mean sea-level

Base-map by the Surveys and Mapping Branch

GEOLOGICAL SURVEY OF CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

SHEET 93 F



PUBLISHED, 1963

PRINTED BY THE SURVEYS AND MAPPING BRANCH

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MIOCENE AND (?) LATER
ENDAKO GROUP

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Bedding, tops not indicated (inclined, vertical)
Fault (defined, approximate, assumed)
Anticline
Syncline
Fossil locality
Mineral occurrence .... x Fe

MINERAL OCCURRENCES

Iron .... Fe   Silver .... Ag
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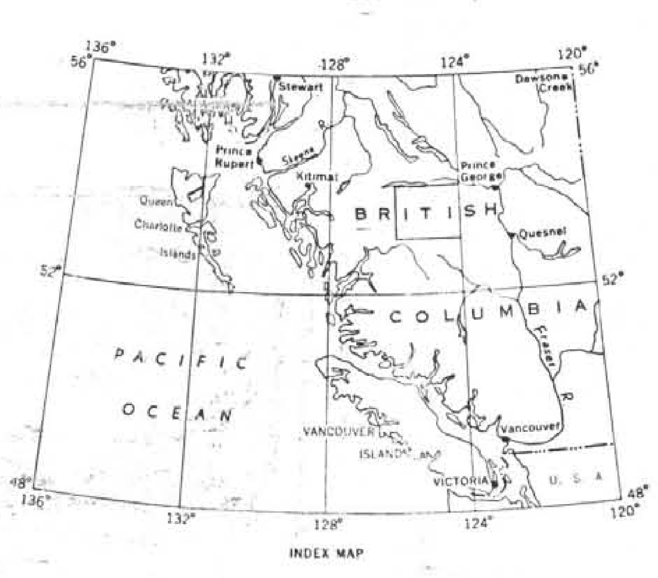


INDEX MAP

801
dup.

MAP 1131A
GEOLOGY
NECHAKO RIVER
BRITISH COLUMBIA

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

Miles
4 2 0 4 8 12

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

Road, all weather
Road, dry weather
Cart track
Trail
Building
Church
School
Post Office
Horizontal control point
District boundary
Park and Indian Reserve boundary
Present shoreline above Kenney Dam
Stream (intermittent)
Falls and rapids
Marsh or swamp
Sand or gravel
Contours (interval 500 feet)
Height in feet above mean sea-level 2300

Base-map by the Surveys and Mapping Branch

Xerox.
-1131A-
93F

93F

801

93-F-10


NECHAKO FOREST
F.L. A18162
Cht. 402
T.S.H.L. A01757
Cht. 15
F.L. A18160
NECHAKO RIVER
T.S.L. A07714
Blk. 8
F.L. A18157
F.L. A18157
T.S.L. A07714
Blk. 4
F.L. A18157
T.S.L. A07714
Blk. 2
T.S.A. 15307
T.S.A. 08697
KNEWSTUBB
LAKE
Big Bend Arm
KLUSKUS FOREST ROAD
942-7655-05
942-7655-01
C.P. 356
C.P. 307
C.P. 399
C.P. 337
C.P. 339
C.P. 304
C.P. 306
C.P. 346
C.P. 52
F.L. A18157
T.S.L. A07714
Blk. 1
920-11-5050
R1579
CUTOFF BUTTE
MT HOBSON
Swanson Cr.
Murray Lake
VOLCANICS
VESICULAR BASALT
NC05
NC02
NC03
NC04
NC06
NC07
NC08
a
b
c
d
h

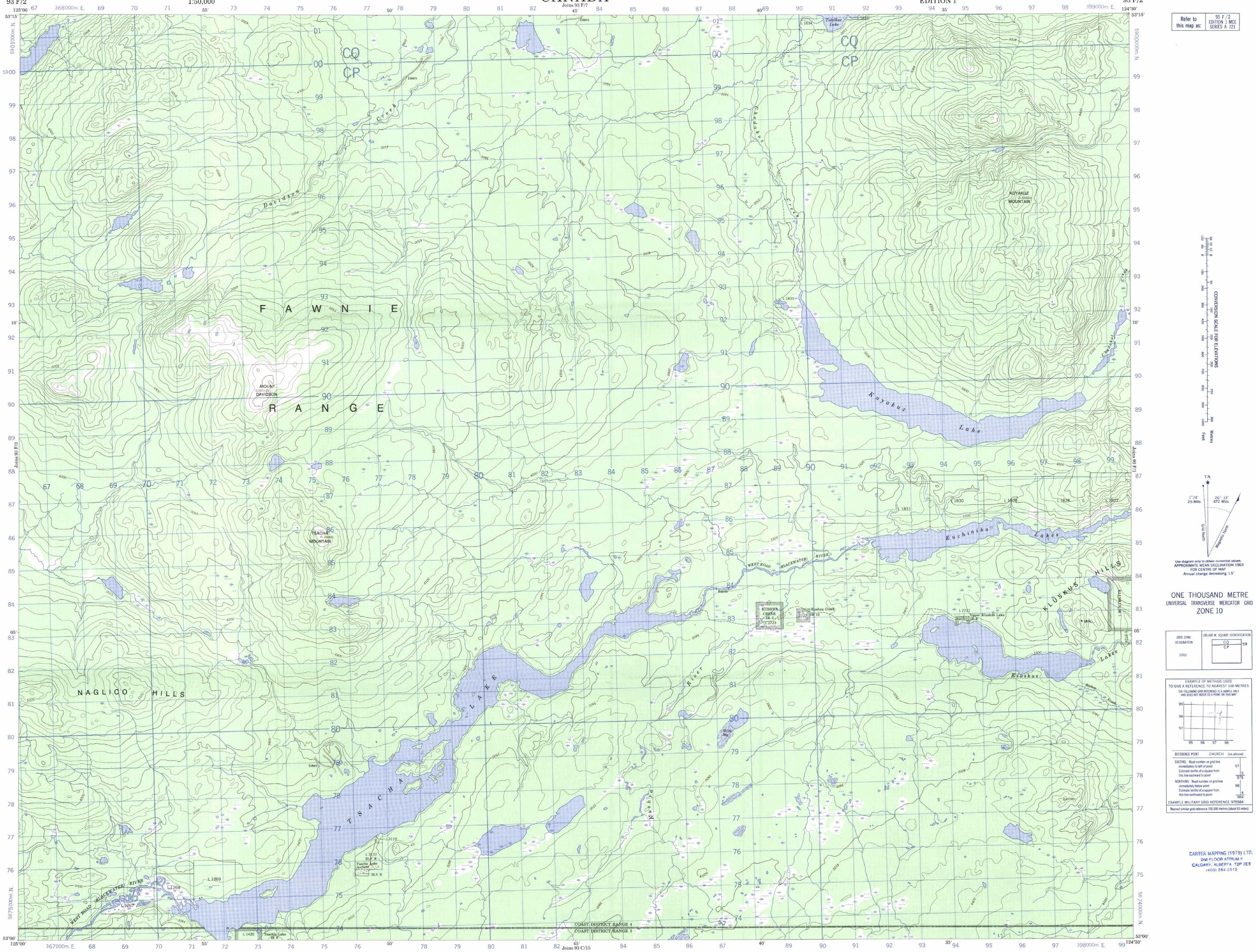
PROVISIONAL MAP
93 F/2

CANADA

1:50,000

EDITION 1

CARTE PROVISOIRE
93 F/2



801

TSACHA LAKE
BRITISH COLUMBIA

Produced, 1967, by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF ENERGY, MINES AND RESOURCES, from aerial photographs taken in 1964. Field surveys 1966. Printed 1970.

Copies may be obtained from the Map Distribution Office, Department of Energy, Mines and Resources, Ottawa.

Roads:	Routes:		
loose or stabilized surface, all weather	gravier aggloméré, toute saison	2 lanes or more / 2 voies ou plus	less than 2 lanes / moins de 2 voies
loose surface, dry weather and unclassified streets	de gravier, temps sec et rues hors classe		
cart track	de terre		
trail or portage	sentier ou portage		

Scale 1:50,000 Échelle

Miles 1 0 1 2 3 Miles
Metres 1000 0 1000 2000 3000 4000 Mètres
Yards 1000 0 1000 2000 3000 4000 Verges

This Provisional Map is equivalent to a standard map in accuracy of content.

Some names on this map are not yet official. Corrections or additions are invited by the Surveys and Mapping Branch.

CONTOUR INTERVAL 100 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

Cette carte provisoire équivaut une carte régulière au point de vue précision de l'information.

Certains noms inscrits sur cette carte ne sont pas encore officiels. La Direction des levés et de la cartographie saurait gré au public de lui signaler corrections et additions.

ÉQUIDISTANCE DES COURBES 100 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Système de référence géodésique nord-américain 1927
Projection transverse de Mercator

Établie en 1967, par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES, d'après des photographies aériennes prises en 1964. Levés sur le terrain en 1966. Imprimée en 1970.

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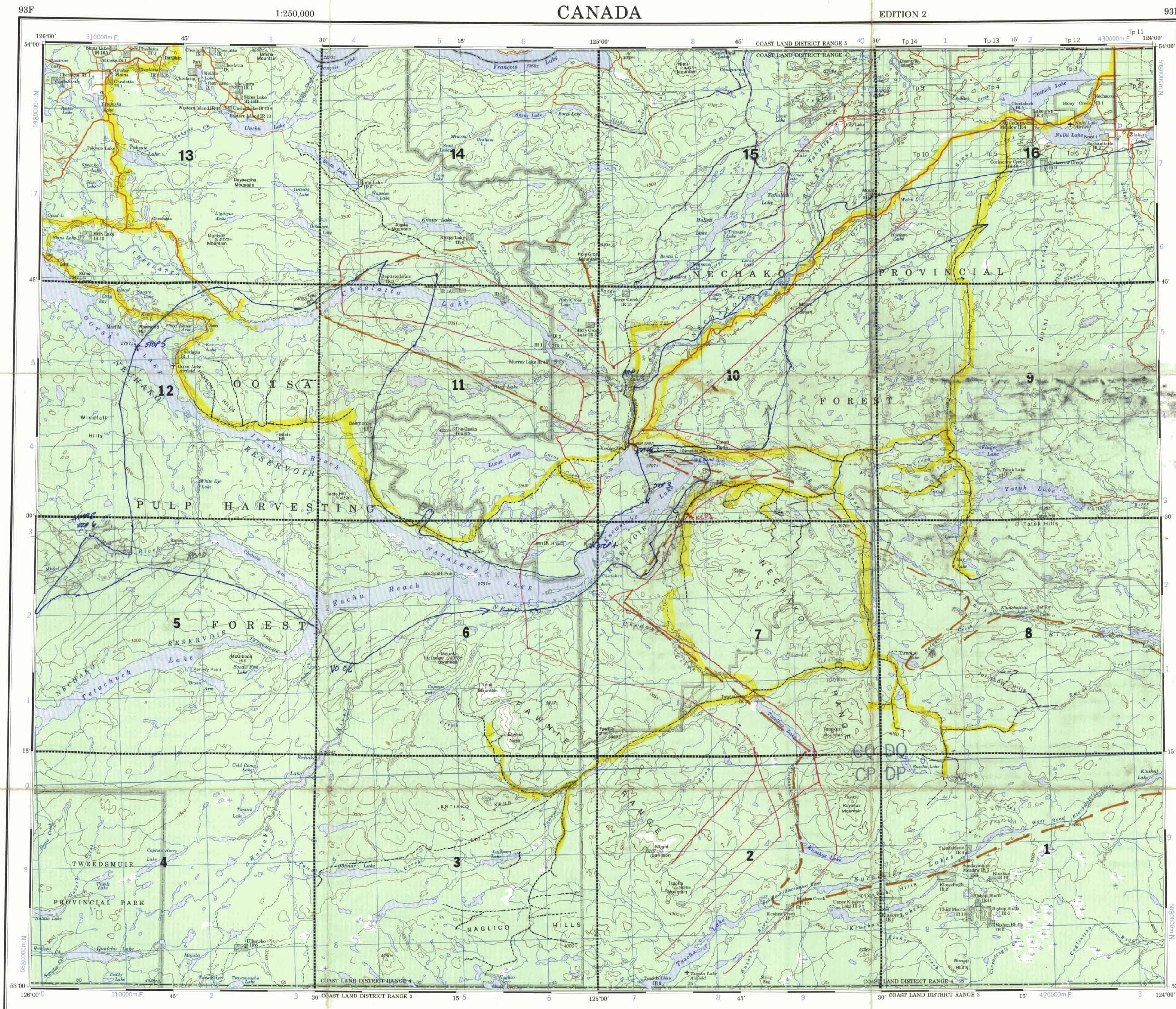
93 F/2
EDITION 1

93F 1:250,000

CANADA

EDITION 2 93F

Refer to this map as: 93F EDITION 2 MCE SERIES A502



f = coal float
coal = coal outcrop
1 = sedimentary rock
2 = sedimentary rock capped by columnar basalt
3 = sedimentary rock
4 = sedimentary rock capped by columnar basalt

CONVERSION SCALE FOR ELEVATIONS

Feet Metres

TEN THOUSAND METRE
UNIVERSAL TRANSVERSE MERCATOR GRID
ZONE 10

GRID ZONE DESIGNATION 10U

100,000 M. SQUARE IDENTIFICATION
BQ CQ DQ
BP CP DP

EXAMPLE OF METHOD USED TO GIVE A REFERENCE TO NEAREST 1000 METRES

THE FOLLOWING GRID REFERENCE IS A SAMPLE ONLY AND DOES NOT REFER TO A POINT ON THIS MAP

REFERENCE POINT: ROCKS (as above)

SQUARE: Read letters of 100,000 m. square NU

EASTING: Read number on grid line immediately to left of point. Estimate tenths of a square from this line eastward to point. 54

NORTHING: Read number on grid line immediately below point. Estimate tenths of a square from this line northward to point. 04

EXAMPLE MILITARY GRID REFERENCE NU5404

If reporting beyond 18° in any direction, prefix Grid Zone Designation as: 15VNU5404

Yellow - indicates roads driven, Sept 84
Orange - helicopter recon flight plan, Sept 84
Blue - helicopter recon July 84
Red - helicopter recon Sept 83

RELIABILITY DIAGRAM - CROQUIS D'EXACTITUDE

A - Large scale mapping, photogrammetric, from 1964 aerial photography

A - Cartes à grande échelle, photogrammétrie, d'après des photographies aériennes prises en 1964

801

Produced, 1973, by the SURVEYS AND MAPPING BRANCH, DEPARTMENT OF ENERGY, MINES AND RESOURCES, from large scale maps. Printed 1975.

Magnetic declination 1974 varies from 25°58' easterly at centre of west edge to 25°46' easterly at centre of east edge. Mean annual change 3.1' westerly.

NECHAKO RIVER
BRITISH COLUMBIA

Établie en 1973, par la DIRECTION DES LEVÉS ET DE LA CARTOGRAPHIE, MINISTÈRE DE L'ÉNERGIE, DES MINES ET DES RESSOURCES, d'après des cartes à grande échelle. Imprimée en 1975.

La déclinaison magnétique pour 1974 varie de 25°58' Est au centre de la limite Ouest à 25°46' Est au centre de la limite Est. Variation moyenne annuelle 3.1' Ouest.

Roads:
loose or stabilized surface, all weather — 2 lanes or more — less than 2 lanes
loose surface, dry weather
cart track
trail, cut line or portage

FOR COMPLETE REFERENCE SEE REVERSE SIDE

Scale 1:250,000 Échelle

Miles 5 0 5 10 15 20 Milles

Kilometres 5 0 5 10 15 20 25 30 Kilomètres

CONTOUR INTERVAL 500 FEET
Elevations in Feet above Mean Sea Level
North American Datum 1927
Transverse Mercator Projection

ÉQUIDISTANCE DES COURBES 500 PIEDS
Élévations en pieds au-dessus du niveau moyen de la mer
Système de référence géodésique nord-américain, 1927
Projection transverse de Mercator

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Routes:
gravier aggloméré, toute saison — 2 voies ou plus — moins de 2 voies
de gravier, période sèche
de terre
sentier, percée ou portage

POUR UNE LISTE COMPLÈTE DES SIGNES, VOIR AU VERSO

Index to adjoining Maps of the National Topographic System

Tableau d'assemblage du Système national de référence cartographique

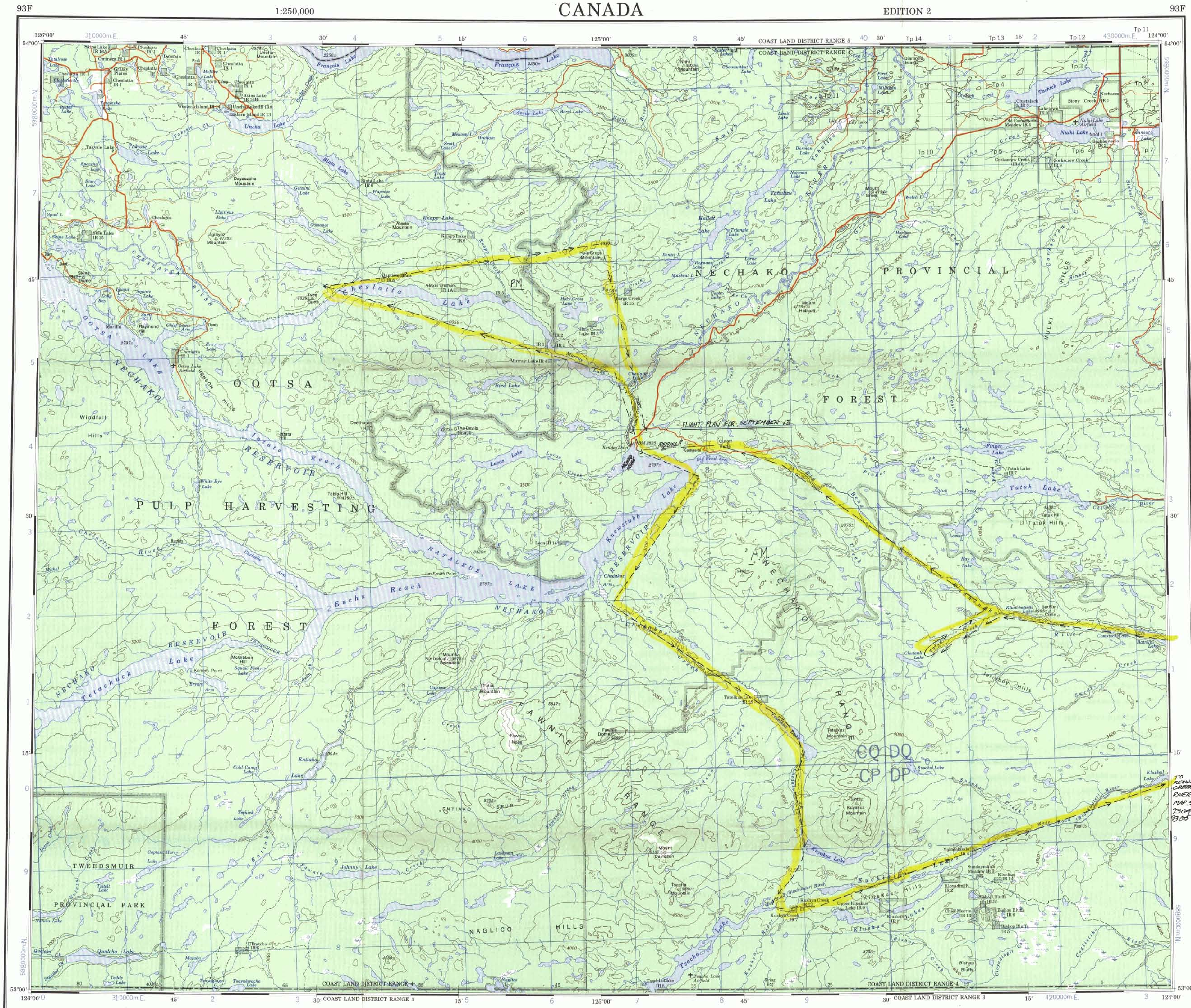
NECHAKO RIVER
93F
EDITION 2

93F 1:250,000

CANADA

EDITION 2 93F

Refer to this map as: 93F EDITION 2 MCE SERIES A502



CONVERSION SCALE FOR ELEVATIONS

Feet Metres

TEN THOUSAND METRE UNIVERSAL TRANSVERSE MERCATOR GRID ZONE 10

GRID ZONE DESIGNATION 10U

100,000 M. SQUARE IDENTIFICATION

BQ CQ CQ DQ
BP CP CP DP

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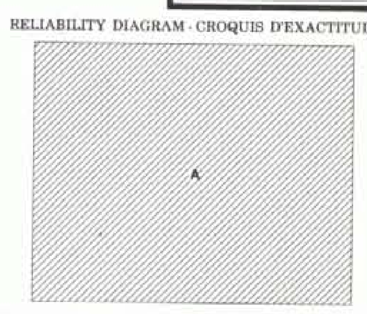
RELIABILITY DIAGRAM - CROQUIS D'EXACTITUDE



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NECHAKO RIVER

BRITISH COLUMBIA

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- cart track
- trail, cut line or portage

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Kilometres 5 0 5 10 15 20 25 30 Kilomètres

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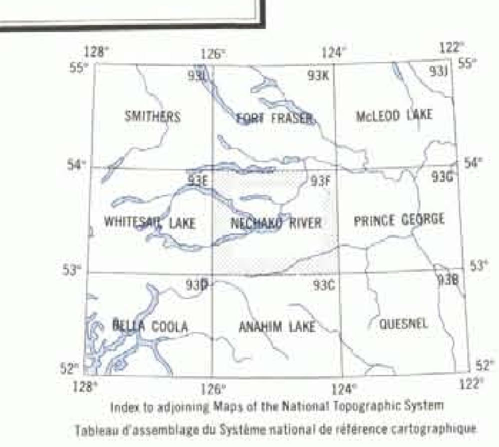
POUR UNE LISTE COMPLÈTE DES SIGNES, VOIR AU VERSO



Index to adjoining Maps of the National Topographic System

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93F
EDITION 2