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COMINCO LTD.

EXPLORATION
NTS: 104K/11,12

WESTERN CANADA

GEOLOGICAL REPORT ON THE TULSEQUAH PROPERTY

(Webb, Co, Bull, Big Bull, Swamp Claim Groups)

ATLIN MINING DIVISION

LATITUDE: 58°42'N LONGITUDE: 133°38'W

OWNED AND OPERATED BY

COMINCO LTD.

WORK PERFORMED

JUNE 22-JULY 31,1987

January 1988

J.G. Payne
J.G. Sisson

GEOLOGICAL BRANCH
ASSESSMENT REPORT

17,054

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Geological Report
on the
TULSEQUAH-TAKU PROPERTY

(Webb, Co, Bull, Big Bull, Swamp Claim Groups)

1. INTRODUCTION

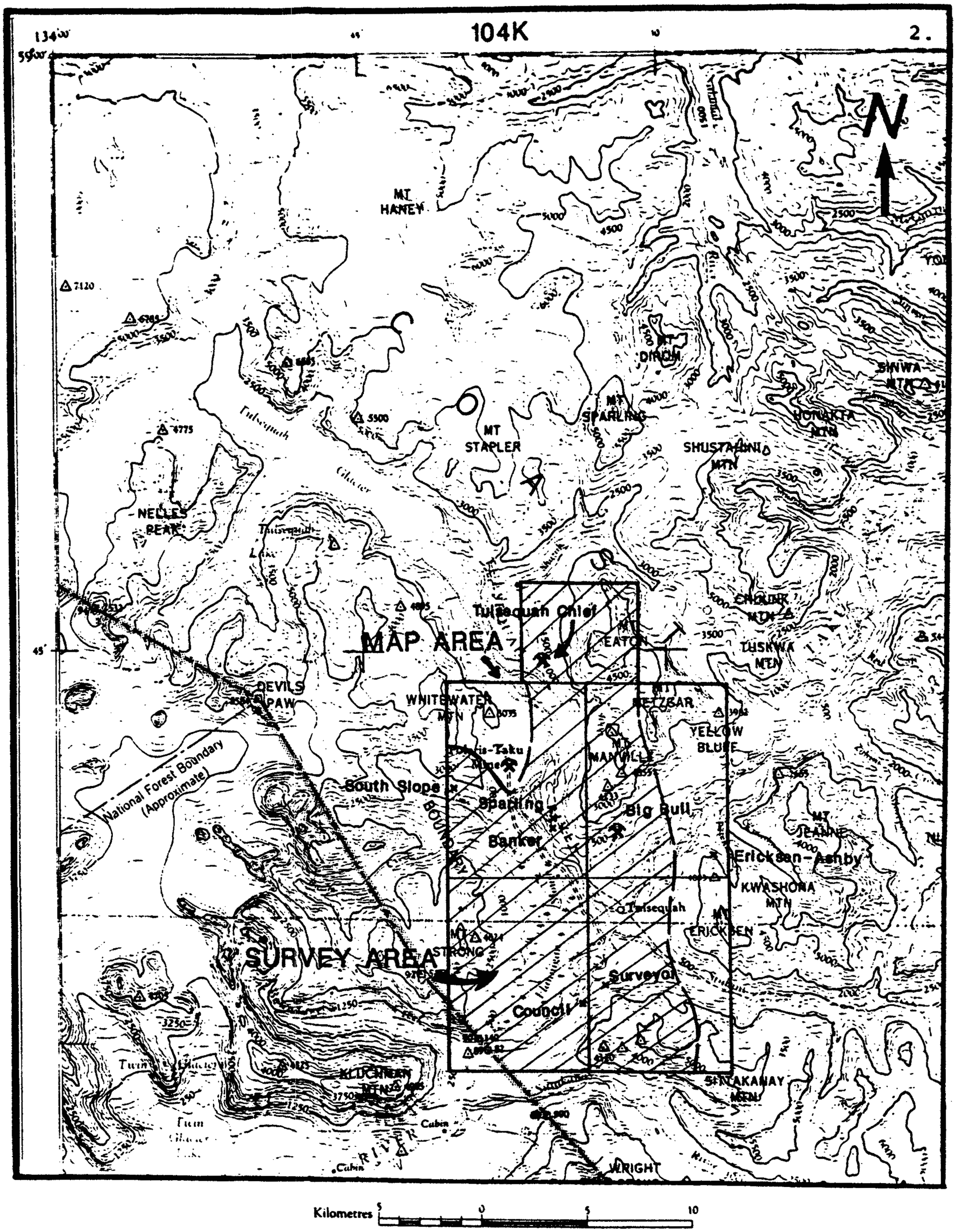
1.1 Location and Access

The property is at the junction of the Tulsequah and Taku Rivers in northwestern British Columbia at 54°42'N, 133°33'W (see Figure 1). Access from Whitehorse or Atlin is to a gravel airstrip along the Tulsequah River at the northeast edge of Flannigan Slough. The airstrip is suitable for a DC-3, but is threatened once or twice a year by floods along the Tulsequah Valley caused by rapid dumping of lakes impounded by the Tulsequah Glacier. Daily access to field areas was by helicopter from a base camp at the Tulsequah Chief mine. The Taku River is suitable for transportation of heavy supplies by shallow-water barge from Juneau, Alaska.

1.2 Topography and Vegetation

The property is on the eastern flank of the Coast Range at elevations between 30 and 1850 metres above sea level. Topography was moulded strongly by large valley glaciers along the Tulsequah and Taku Rivers, and by smaller alpine glaciers in many of the tributary valleys. Slopes are moderate to steep; cliffs are common, and range up to several tens of metres in height. Outcrop ridges form the upper slopes of the major mountains: Eaton, Manville, Metzgar, Ericksen, Sittakanay, Strong, and Whitewater. Snowfields and glaciers are abundant, the largest of which are the Mount Eaton and Manville Glaciers on the eastern border of the survey area, and the Whitewater Glacier and Snowfield on the northwestern margin of the map area. Many tributary rivers and creeks have carved deep, narrow canyons en route to the major alluvial valleys; because of heavy runoff the summer, many of these were inaccessible for geological mapping.

Lower slopes are covered by forests of hemlock and minor spruce. Slide and blowdown areas in the forests are covered by thick growths of devil's club, slide alder, etc. Outcrop in forested regions is sparse to moderate, and rare in slide areas.



Scale 1 : 250,000

× Showing

⚒ Mine, (Past Producer)

<u>Figure 1</u>. Location Map

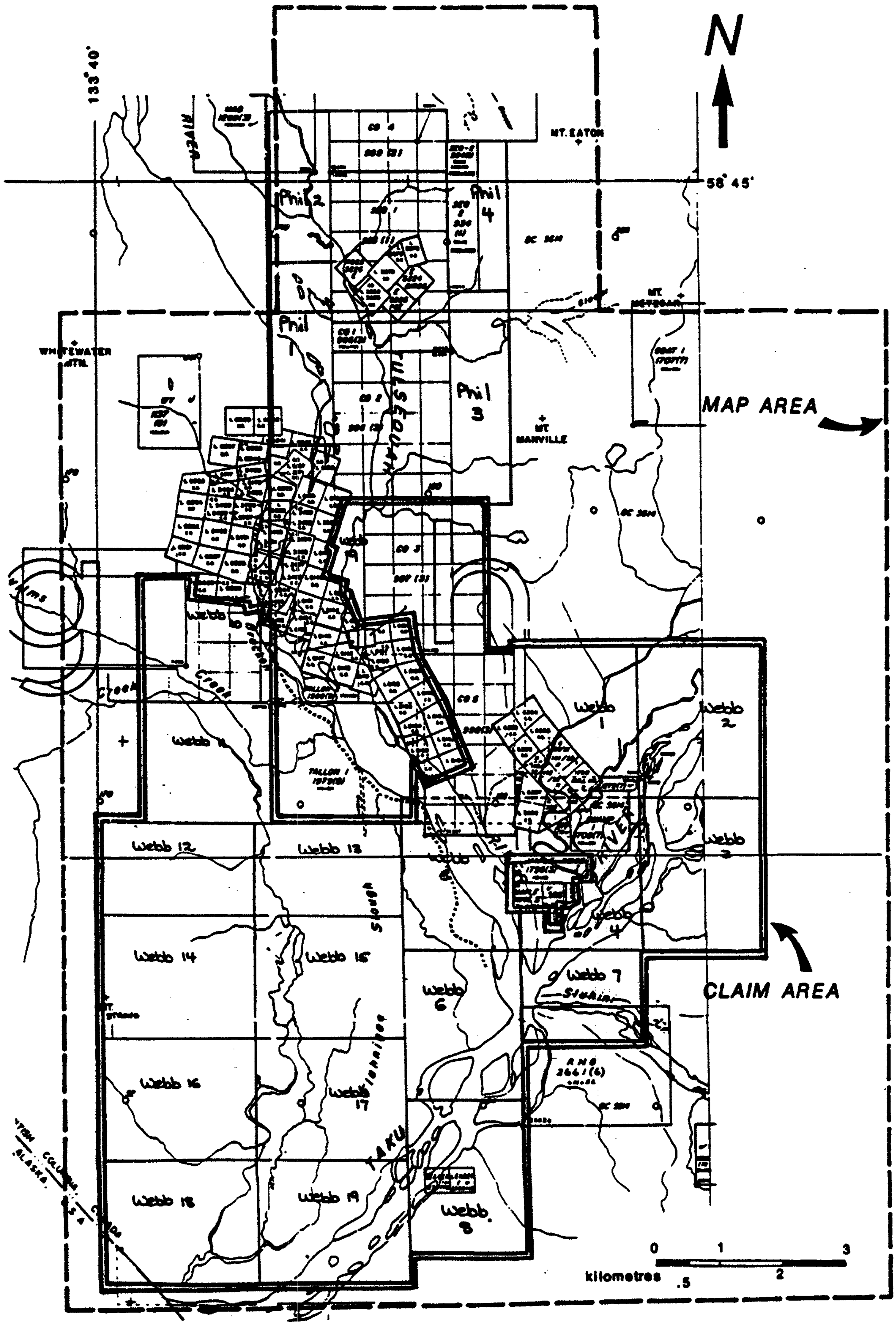


Figure 2. Property Definition

Table 1. Claim Data

A: Crown Grants

Name	Lot no.
Big Bull	6303
Bull No. 1	6304
Bull No. 5	6306
Bull No. 6	6305
Hugh	6308
Jean	6307

B: Claims

Name	Units	Record No.	Due Date
Big Bull Extension	1	37/21	18-06-92
Bruce Fraction	1	303	17-08-92
Bull No. 2	1	141/32	19-07-92
Bull No. 3	1	142/32	19-07-92
Bull No. 4	1	143/32	19-07-92
Bull No. 8	1	142	16-07-92
Bull No. 9	1	179	25-04-88
Co 3	20	997	04-03-88
Co 5	18	998	04-03-88
Swamp 1	4	1708	23-07-88
Swamp 2	1	1709	23-07-88
Swamp 3	1	1710	23-07-88
Webb 1	20	2766	27-11-87
Webb 2	20	2767	27-11-87
Webb 3	20	2768	27-11-87
Webb 4	20	2769	27-11-87
Webb 5	20	2770	27-11-87
Webb 6	20	2771	27-11-87
Webb 7	12	2772	27-11-87
Webb 8	20	2773	27-11-87
Webb 9	10	2774	27-11-87
Webb 10	16	2775	27-11-87
Webb 11	16	2776	27-11-87
Webb 12	15	2777	27-11-87
Webb 13	15	2778	27-11-87
Webb 14	20	2779	27-11-87
Webb 15	20	2780	27-11-87
Webb 16	20	2781	27-11-87
Webb 17	20	2782	27-11-87
Webb 18	20	2783	27-11-87
Webb 19	20	2784	27-11-87

1.3 Property Definition

The property consists of six (6) Crown grants and thirty-one (31) claim blocks (see Table 1 and Figure 2). All are owned and operated by Cominco, Ltd. The property contains the Big Bull mine, and is near the Tulsequah Chief and Polaris-Taku mines and the important showing of Ericksen-Ashby. Smaller showings on adjacent claims are the Sparling and Banker. Minor showings in or on the border of the claim group include the Surveyor, Council, and South Slope. These minor showings could not be located in the field during this study because of ambiguity as to their field location in the old records, and because of thick vegetation overgrowth. North of the map area, the Mount Stapler showing occurs in rocks similar to those along the Tulsequah River. Locations of the deposits and showings are indicated in Figure 1.

1.4 Brief Description and Economic History of Deposits in Map Area

The Big Bull and Tulsequah Chief deposits are of massive Zn-Pb-Cu-Ag-(Au) sulfide associated with felsic volcanic rocks. Both were discovered in 1929 by Alaska-Juneau, which did considerable development work until 1930. Work was resumed in 1946, leading to production from both by Cominco between 1951 and 1957.

The Polaris-Taku deposit contains gold-bearing quartz-carbonate veins in deformed andesite. It was discovered in 1929, and operated between 1937 and 1951, with the exception of the war years between 1942 and 1946.

The Ericksen-Ashby showing consists of pods and lenses of massive Zn-Pb-Ag sulfide and Mn-rich "skarn" associated with felsic volcanic rocks, chert, and limestone. It was discovered in 1929, and was worked extensively in the mid 1960's by the Ericksen-Ashby Mining Co., and in 1979-1981 by Anglo Canadian Mining Corp.

The Sparling showing is a Pb-Zn-Ag bearing quartz vein in andesite. The nearby Banker showing contains similar sulfides in replacement zones in limestone. They were discovered in 1929, and have received minor sporadic exploration since.

The Surveyor and Council showings are veins of stibnite and pyrite with minor gold in a quartz-carbonate gangue in shear zones in argillite. They were discovered in 1930, and have received minor exploration since.

The South Slope showing is a gold-bearing quartz vein associated with a dike in a major fault. It was discovered in 1931, and has received minor exploration since.

1.5 Previous Regional Geological Mapping

Kerr (1948) published a geological map of the Taku River area at a scale of 1:50,000. His work did not recognize the major folds and faults in the Paleozoic rocks. Souther (1971) mapped the Tulsequah area (NTS 104-K) at a scale of 1:250,000.

Payne et al (1981) mapped much of the Tulsequah-Taku area at a scale of 1:50,000 as part of a regional exploration program. They recognized the structural complexity of the region, and suggested that many of the rocks previously ascribed to the Upper Triassic Stuhini Group were older, and probably of Upper Paleozoic age. Nelson and Payne (1984) collected fossils of Middle Pennsylvanian to Permian age in these rocks, and named the volcanic and sedimentary sequence, the Mount Eaton Group, after the type-locality on Mount Eaton.

1.6 Purpose of Study

The purpose of the study was to evaluate the economic potential of the property, for which purpose the claim area and surrounding ridges were mapped at a scale of 1:10,000. More detailed mapping was done on the slopes above the Big Bull mine. Of particular interest would be felsic volcanic centers in rocks of the Mount Eaton Group, which might host deposits similar to those at Tulsequah Chief and Big Bull. Other zones of interest would be faults and altered rocks south of the Polaris Taku mine, which might host similar gold deposits.

1.7 Work

The claims and surrounding ridges were mapped at a scale of 1:10,000, and the slope above the Big Bull mine was mapped at a scale of 1:5,000. Mapping was done on orthophotos with contour data superimposed. In concurrent programs, detailed mapping was done of the Tulsequah Chief and Big Bull mine areas, and around the Sparling and Banker showings. Data from these studies was incorporated in the maps in this report.

The survey area covers 200 km^2, including 105 km^2 within the claim borders, 80 km^2 on the surrounding ridges, and 15 km^2 in adjacent claim groups for which concurrent detailed studies were carried out.

Traverses covered much of the well exposed ridges, where outcrop boundaries, geological contacts and faults could be extrapolated easily away from traverse lines. Mapping of the ridges was necessary in order to understand the regional structure and stratigraphy, which then could be extended down to the regions of sparse outcrop on the wooded slopes. Creeks generally provided more abundant and continuous outcrop than wooded slopes; however many of them contain inaccessible canyon sections.

2. GEOLOGY

2.1 Regional Geology

Monger (1980) showed the relationship of the rocks in the Tulsequah-Taku area to the regional features of the Cordillera (see Figure 3), using data from Souther (1971) in NTS sheet 104K. Nelson and Payne (1984) mapped the Tulsequah-Taku area at a scale of 1:50,000, and reassigned many of the rocks from Souther's Upper Triassic Stuhini Group to the Pennsylvanian-Permian Mount Eaton Group (their definition) (see Figure 4). Rocks of the Mount Eaton Group correlate with similar rocks to the south near Tatsamenie Lake, which Monger grouped in the Stikine Assemblage.

The following major groups of rocks are distinguished in this study in the Tulsequah-Taku area:

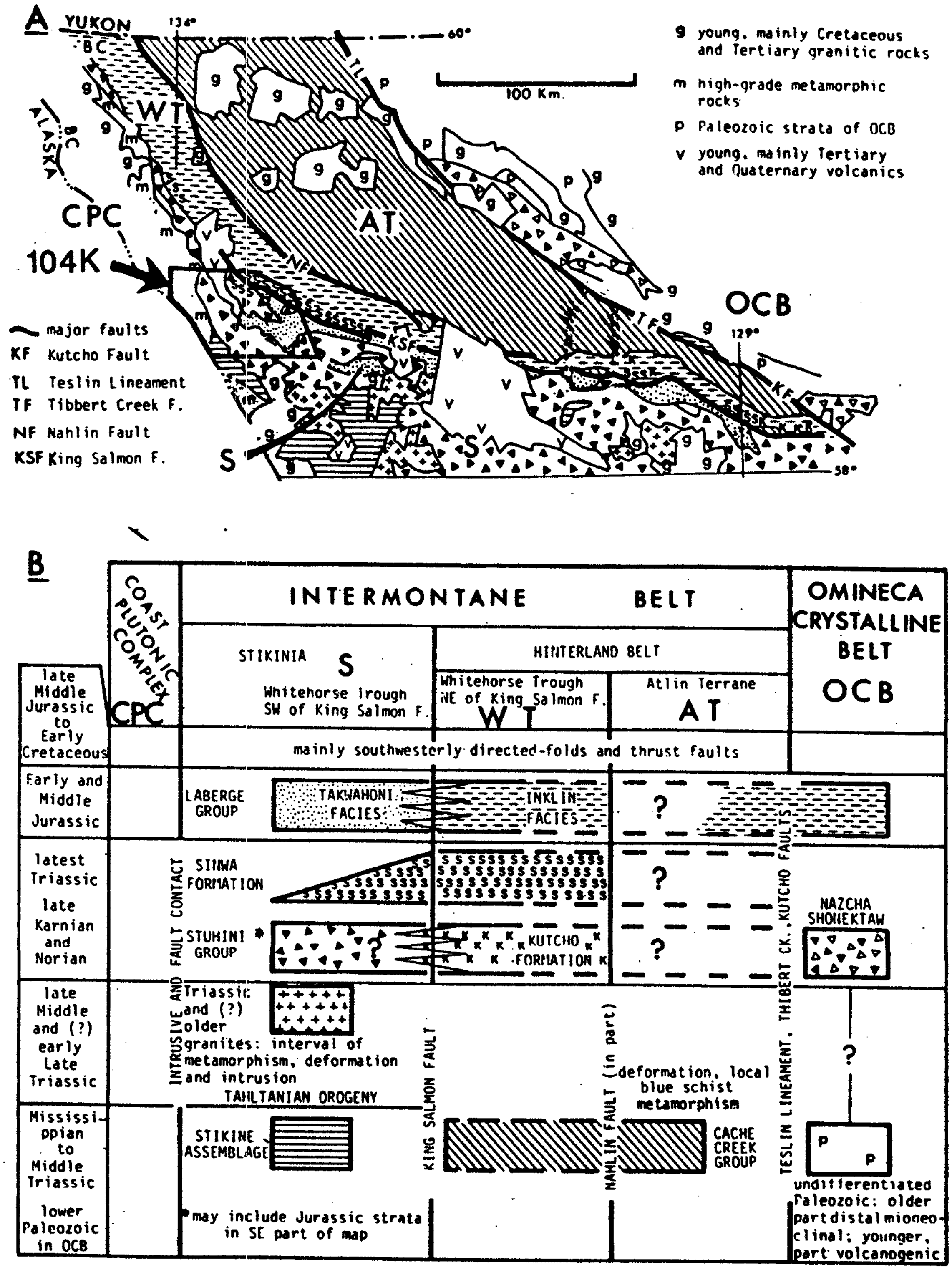
1. Pre-Pennsylvanian metamorphic rocks west of the Whitewater Fault, herein defined as the Whitewater Group.
2. Pre-Pennsylvanian(?) metamorphic rocks along the Tulsequah river between the Whitewater Fault and the Chief Fault, herein defined as the Tulsequah Group.
3. Pennsylvanian-Permian volcanic and sedimentary rocks of the Mount Eaton Group, outcropping east of the Chief Fault, and to the south on Mount Strong and Mount Sittakanay.
4. Mesozoic(?) intrusions ranging widely in composition and texture, and in part belonging to the Coast Plutonic Complex.
5. Early Tertiary intrusions, mainly dikes, probably related genetically to the Sloco Group volcanic rocks, which are abundant east and northeast of the map area.

Regional metamorphism affected the pre-Mesozoic rocks as follows:

Whitewater Group:	dominated by gneisses in upper greenschist to amphibolite facies
Tulsequah Group:	dominated by schist, phyllite, and subgneiss of the upper greenschist facies
Mount Eaton Group:	dominated by weakly deformed to strongly deformed (locally) rocks of the lower greenschist facies

In contact metamorphic zones along borders of some plutons host rocks are metamorphosed in the upper greenschist to almandine amphibolite facies, and in some, the intensity of deformation of host rocks increases towards the contact with the plutonic rocks.

Major faults separate rocks of different intensities of metamorphism, deformation, and of different lithological assemblages. This suggests that the major faults may be terrain-boundary structures with large displacements. Many of the faults are loci for emplacement of Early Tertiary dikes.



A Index map showing location of areas studied in detail, on a geological sketch map of northwestern British Columbia.

B Tentative correlation chart of upper Paleozoic and lower Mesozoic rock units in northwestern British Columbia, showing intervals of deformation.

Figure 3. Regional Geology, Northwestern B.C. (after Monger, 1980).

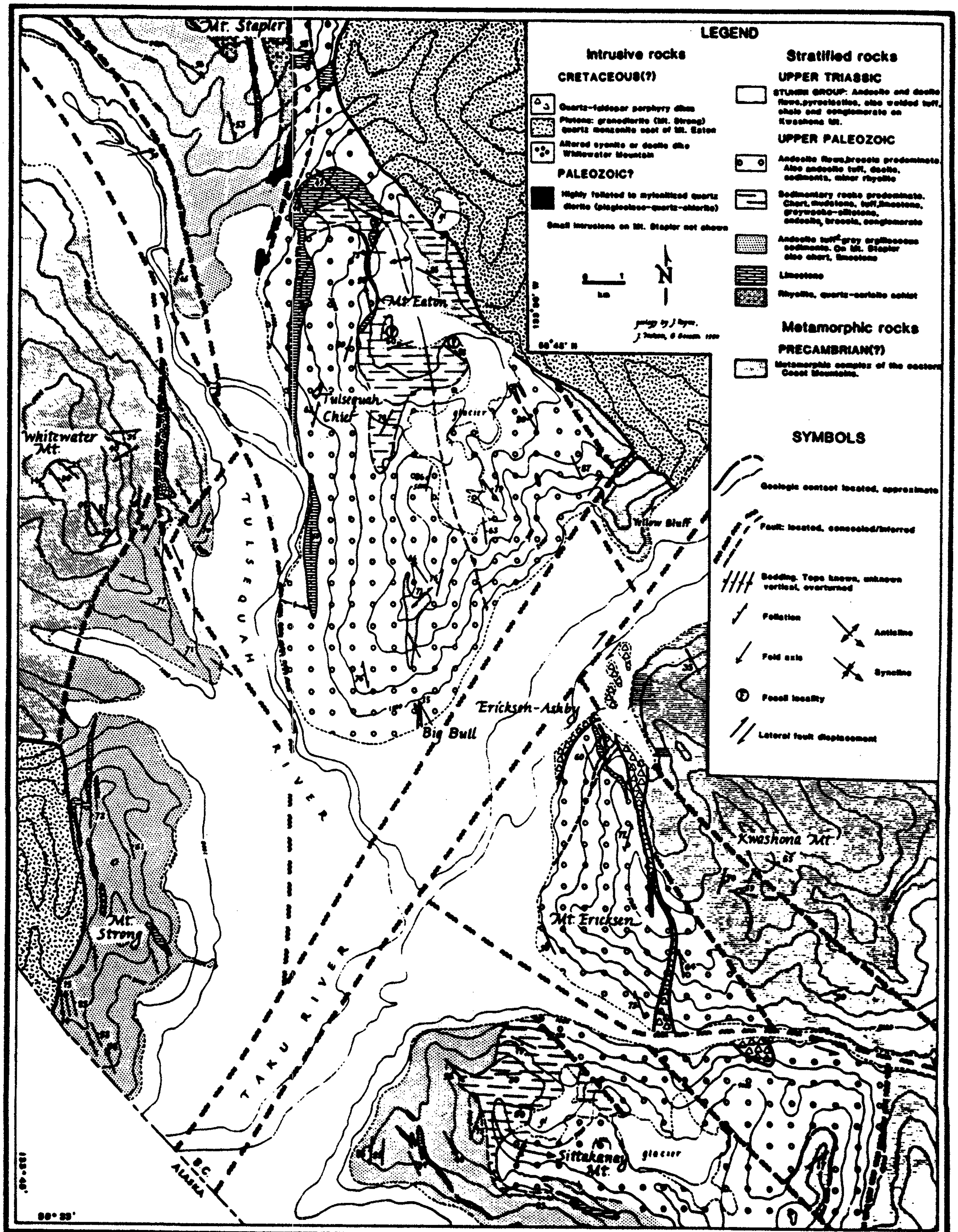


Figure 4. Regional geology. Tulsequah–Taku area, British Columbia.
(after Nelson and Payne, 1984)

Post-Early Tertiary faults along the Taku and Tulsequah Rivers produced offsets of up to a few kilometres in all rock units and in the major north-south-trending faults.

Major mineral deposits include the volcanogenic massive, base- and precious-metal sulfide deposits at Tulsequah Chief, Big Bull, and Ericksen-Ashby, associated with felsic volcanic centers in the Mount Eaton Group, and the gold deposit at Polaris-Taku, hosted by volcanic and sedimentary rocks of either the Tulsequah Group or the Mount Eaton Group.

2.2 Lithologic/Chronologic Units

The distribution of geological units mapped in this study is shown in Plates 6, 7, 8, 9, and 10, and the legend is shown as well in Table 2. Data near the Tulsequah Chief mine and the Sparling and Banker showings is a compilation of geology from a few traverses in this study plus data from more detailed maps produced in concurrent studies of those deposits. Data for the Ericksen-Ashby deposit is from Payne (1979). Other data in the map area but outside the study area (see Figure 1) is from Payne et al (1981).

2.2.1 Whitewater Group (Unit 1)

This unit is exposed west of Whitewater Fault on Whitewater Mountain, at the south end of Mount Strong, and on both sides of the Tulsequah River north of the map area. In this study it was examined only briefly. Payne et al (1981) defined the following stratigraphic sequence along the Tulsequah River:

1) a lower quartz-muscovite-biotite gneiss, locally with almandine garnet, hornblende, and pyrite, with interlayers of quartzite and quartz-muscovite gneiss. The parent rocks were clastic sedimentary rocks formed at moderate to shallow depth near a stable craton. In this study, this sequence is classified as Unit 1b.

2) an upper unit comprising one or more of quartz-biotite-chlorite-muscovite-(graphite) schist, generally dark grey with local dark green layers containing porphyroblastic andalusite (Unit 1e of this study); and plagioclase-quartz-chlorite schist/gneiss, in part with plagioclase augen (Unit 1c of this study). Minor limestone lenses are interlayered. These rocks probably represent a volcanoclastic sequence formed in water of moderate to shallow depth.

3) Tectonic lenses of actinolite-epidote(plagioclase-biotite), and of serpentinite and talc-actinolite or tremolite/actinolite, probably derived from alpine ultramafic rocks (Unit 1f of this study).

Other rock types include a felsic gneiss dominated by plagioclase and quartz, with minor to moderately abundant biotite and/or muscovite (Unit 1a), and a mafic gneiss composed of plagioclase, hornblende, and chlorite (Unit 1d). These probably represent meta-dacite and meta-andesite/basalt, respectively.

In this study, no stratigraphic sequence was determined because of the limited amount of mapping of the unit, and because of the sparse outcrop at the south end of Mount Strong.

2.2.2 Tulsequah Group (Unit 2)

This unit consists mainly of metamorphosed volcanic and volcanosedimentary rocks, with lesser clastic sedimentary and plutonic rocks. Most are schists and phyllites, showing a well defined foliation and moderate to strong deformation. The Unit is exposed along the Tulsequah River between the Whitewater and Chief faults, and on the lower eastern slope of Mount Strong.

It contains the following rock types:

Unit 2a: felsic subgneiss (well foliated rock dominated by plagioclase and quartz, but generally without distinct mineral segregation into distinct layers) consisting of plagioclase and quartz, with minor to moderately abundant muscovite and lesser chlorite. It is mainly medium grained, and probably was largely formed from felsic volcanic rocks. It locally contains rocks which were interpreted as cataclastically deformed quartz diorite to granodiorite (Subunit $2a_1$); these contain fragments of parent rock up to several mm across in a mylonitic groundmass. Along the Chief Fault is a zone of somewhat more massive rocks, which may represent a slightly later or much later intrusive body (Subunit $2a_2$). All rocks are light grey to light green to cream in color.

Unit 2b: meta-andesite, commonly massive, characterized by coarse grained (up to 1 cm) phenocrysts of augite in a medium to dark green groundmass. Most of the unit is interpreted as a metamorphosed sequence of flows, which because of their competency relative to the surrounding rock units, were much less affected by the regional deformation. The following subunits are present:

- Subunit $2b_1$: massive, abundant augite phenocrysts. This is the dominant subunit.
- Subunit $2b_2$: massive, moderately abundant plagioclase phenocrysts, minor augite phenocrysts. Not abundant.
- Subunit $2b_3$: schistose variety of Subunit $2b_1$, with a moderate to strong foliation. This subunit is common along the borders of Subunit $2b_1$, and was formed by regional deformation from Subunit $2b_1$.
- Subunit $2b_4$: pyroclastic andesitic rocks, ranging from lapilli tuff to tuffaceous sediments; mainly occurs along the Tulsequah River north of the Sparling showing.

| 12 | QUATERNARY
alluvium |

12	QUATERNARY
	alluvium
11	EARLY TERTIARY INTRUSIONS
	(in part equivalent to Sloco Group Volcanic Rocks)

11a felsite dikes (undifferentiated)

- $11a_1$ aphanitic, in part flow banded
- $11a_2$ plagioclase phenocrysts, vfgr groundmass
- $11a_3$ quartz ± plagioclase phenocrysts, vfgr groundmass

11b quartz monzonite, granodiorite

- $11b_1$ fine grained, commonly porphyritic
- $11b_2$ medium to coarse grained

11c andesite, diorite dike, sill : aphanitic to fgr

11d dacite dike, sill : plagioclase phenocrysts

INTRUSIVE CONTACT WITH OLDER ROCKS

10 — MESOZOIC(?) INTRUSIONS (in part Coast Plutonic Complex)

10a granodiorite, quartz monzonite : mgr to cgr

10b diorite

- 10bz with epidote-actinolite alteration

10c pyroxenite, biotite pyroxenite

- 10cz serpentine-carbonate alteration along fault

INTRUSIVE CONTACT WITH OLDER ROCKS

3-9 PENNSYLVANIAN-PERMIAN (MOUNT EATON GROUP)
(subdivisions are lithological, not stratigraphic)

SEDIMENTARY ROCKS

9 — CLASTIC SEDIMENTARY ROCKS

9a mudstone, siltstone, ± tuffs, tuffaceous sediments

9b siliceous mudstone, siltstone; in part gradational to Subunit 5ts

9c interbedded greywacke and mudstone/siltstone, commonly graded beds, possibly AE turbidite sequence

8 — CHERT, CALCAREOUS CHERT

8a thick bedded to massive

8b thin to medium bedded with limestone interlayers, in part rhythmic interlayering

8c medium bedded with andesite lenses, inclusions, and irregular dikes and sills

7 LIMESTONE, SILICEOUS LIMESTONE

7a thin to thick bedded

7b thin to medium bedded with chert interlayers, in part rhythmic interlayering

7c thin bedded with mudstone interlayers

7d limestone breccia, fragments of limestone and andesite or only andesite in an abundant limestone groundmass

7e dolomite

SUFFIXES FOR UNITS 7-9

f fossiliferous (Unit 7a, 7c)
m metamorphosed more strongly than normal in contact metamorphic aureole

VOLCANIC, VOLCANOCLASTIC ROCKS, SUBVOLCANIC INTRUSIONS

6 RHYODACITE, RHYOLITE

5 DACITE

4 ANDESITIC DACITE, DACITIC ANDESITE

3 ANDESITE, BASALTIC ANDESITE

SUBSCRIPTS FOR VOLCANIC AND RELATED ROCKS

A MAGMATIC ROCKS

a flow, undifferentiated
ax flow breccia, undifferentiated

(for Unit 3a,3ax the following subdivisions)

3a,3ax no dominant phenocrysts
$3a_1$,$3ax_1$ plagioclase phenocrysts prominent
$3a_2$,$3ax_2$ augite phenocrysts prominent
$3a_3$,$3ax_3$ plagioclase and augite phenocrysts prominent

b intrusion (dike, sill, dome)

3bg diabase, gabbro

B PYROCLASTIC ROCKS

x breccia
L lapillistone
Lt lapilli tuff
Ltx lapilli tuff with prominent breccia-sized fragments
t tuff
tx tuff with prominent breccia-sized fragments
ts tuffaceous sediment, very fine tuff, mainly well and thinly bedded

SUFFIXES FOR UNIT 3

p pillowed
v amygdular, vesicular
c calcareous groundmass (in pyroclastic rocks)

Table 2. (continued)

(for andesite fragmental units, the following subdivisions based on nature of fragments

subdivision	fragment type(s)
$3x_1$, $3Lt_1$, $3Ltx_1$	andesite
$3x_2$, etc.	andesite, minor dacite
$3x_3$, etc.	andesite, moderate to abundant dacite
$3x_4$, etc.	andesite, minor to abundant limestone
$3x_5$, etc.	purple andesite, locally abundant limestone; commonly calcareous groundmass

FAULT CONTACT

2 PRE-PENNSYLVANIAN(?) METAMORPHIC ROCKS (TULSEQUAH GROUP)

(possibly in part equivalent to Mount Eaton group)
(dominantly schist, phyllite, subgneiss; greenschist facies)

2a felsic schist, subgneiss, origin uncertain

- $2a_1$ cataclastically deformed quartz diorite, granodiorite
- $2a_2$ relatively massive, possibly younger intrusion

2b andesite flow, tuff; characterized in most subunits by coarse augite phenocrysts

- $2b_1$ massive, augite phenocrysts abundant
- $2b_2$ massive, plagioclase phenocrysts abundant
- $2b_3$ schistose, augite phenocrysts common
- $2b_4$ well bedded tuff, lapilli tuff, tuffaceous sediments
- 2bg gabbro, diorite: coarser variety of $2b_1$ or subvolcanic intrusion; in part porphyritic

2c andesite/dacite tuffaceous sediments, tuff, argillitic in part, in part with mudstone/siltstone interlayers; commonly strongly folded

2d mudstone, greywacke, siltstone, in part gradational to Unit 2c; in part difficult to distinguish from Unit 9

2e limestone, commonly sheared and recrystallized; difficult to distinguish from Unit 7am

FAULT CONTACT

1 PRE-PENNSYLVANIAN METAMORPHIC ROCKS (WHITEWATER GROUP)

(gneiss, schist, minor phyllite; upper greenschist to amphibolite facies metamorphism)

1a felsic gneiss: plagioclase-quartz-biotite-muscovite

1b quartz-biotite-muscovite gneiss, quartzite

1c intermediate gneiss: plagioclase-quartz-chlorite-biotite-(hornblende-muscovite)

1d mafic gneiss: plagioclase-hornblende-chlorite

le	argillite, phyllite; in part carbonaceous, graphitic
lf	tremolite/actinolite-rich lenses (possibly tectonic after alpine peridotite)

ALTERATION AND HYDROTHERMAL MINERALIZATION TYPES

Z	quartz-pyrite-sericite (mainly in felsic volcanic rocks near massive sulfide deposits)
qz	quartz
se	sericite
py	pyrite
cp	chalcopyrite
sl	sphalerite
gl	galena
ap	arsenopyrite
ct	calcite
do	dolomite
ak	ankerite
cl	chlorite
ma	mariposite, fuchsite

VEIN TYPES

Qv	quartz
Cv	carbonate (calcite, dolomite)
Ev	epidote
Hv	specular hematite
Pv	pyrite
Av	ankerite
QECv	quartz-epidote-carbonate (example of combination)

Subunit 2bg: gabbro and diorite, dark green, medium to coarse grained, in part porphyritic. It occurs only with Subunit $2b_1$ and Subunit $2b_3$, and is probably in part a coarser grained variety of the andesite flow, and in part small subvolcanic intrusions. Bodies are less than a few tens of metres across.

Unit 2c: tuffaceous sediments, thinly bedded, mixed andesitic and dacitic tuffaceous sediments and fine to locally medium tuffs, in part argillitic, and in places containing thin interlayers of mudstone and siltstone. Color ranges from pale to dark green, with shades of grey in argillitic varieties. Rocks commonly are deformed by isoclinal folding. The unit is gradational into Subunit $2b_4$. At the north end of Wilms Ridge is a thick sequence of dominantly dark green, chlorite-rich andesitic tuffs and tuffaceous sediments; this sequence is much more uniform in composition than elsewhere in the unit.

Unit 2d: clastic sedimentary rocks, mudstone, siltstone and lesser greywacke, medium to dark grey in color, with interlayers of andesitic and dacitic tuffs and tuffaceous sediments. Unit 2d occurs mainly along the South Fork of Wilms Creek. Rocks are more strongly deformed and metamorphosed than normal, probably because of the proximity of the Bacon Creek pluton. Unit 2d is gradational into Unit 2c.

Unit 2e: limestone, white to grey to cream in color, recrystallized to fine to coarse grained marble, and commonly strongly fractured. Thin lenses are scattered throughout Unit 2. The largest intervals are at the base of Mount Strong along Flannigan Slough and on Mount Stapler just north of the map area. Unit 2e cannot be distinguished lithologically from metamorphosed limestone of the Mount Eaton Group (Subunit 7am), and some misclassification may have occurred in areas of sparse outcrop.

On Mount Stapler, just north of Shazah Creek is a thick felsic volcanic pile containing abundant disseminated pyrite and a few small lenses of massive pyrrhotite-chalcopyrite. To the east of the felsic pile is a thick section of chert which in turn is overlain by thin bedded andesitic tuffs and limestone. These rocks are somewhat similar to some of those in the Mount Eaton Group at the Tulsequah Chief mine and at the north end of the Mount Eaton Glacier. This suggests that some of the rocks classified in the Tulsequah Group may be more strongly deformed and metamorphosed equivalents to rocks in the Mount Eaton Group.

2.2.3. Mount Eaton Group (Units 3 to 9)

Rocks of the Mount Eaton Group are exposed east of the Chief Fault on Mounts Eaton and Manville, and to the south along this trend on Mounts Ericksen and Sittakanay. Rocks similar to those on the west end of Mount Sittakanay occur the crest and southeast flank of Mount Strong. The eastern border of the Mount Eaton Group is along the Ericksen and Yellow Bluff Faults and the Tuskwa Pluton at the eastern edge of the map area (not mapped in this study).

East of the Chief Fault, the rocks are dominated by thick piles of andesite and basaltic andesite flows, flow breccias, and pyroclastic rocks, with thinner interlayers of derived sedimentary rocks and felsic pyroclastic rocks. Major felsic volcanic centers occur at the Tulsequah Chief and Big Bull mines and on the southwest flank of Mount Manville. Interlayered with the volcanic rocks are sedimentary-basin deposits containing variable amounts of limestone, chert, and fine clastic sedimentary rocks. Some of these are continuous over a distance of several kilometres, and are important in the understanding of the regional structure within the Mount Eaton Group.

On Mount Ericksen, most rocks are andesite flows and tuffs. At the Ericksen-Ashby deposit, a major sedimentary interval dominated by chert and limestone contains minor felsic volcanic intervals and related massive sulfide and hot-spring deposits.

On Mount Strong, a major limestone-chert unit is flanked by mudstones and siltstones with minor tuffaceous intervals. On the west end of Mount Sittakanay, the same limestone-chert unit is flanked by andesitic tuffs and flows. Further east on Mount Sittakanay is a second sedimentary interval of chert and mudstone interlayered with andesitic volcanic rocks.

The rocks of the Mount Eaton Group are classified into the following lithologic units and subunits:

Volcanic and Related Rocks

These are divided into four units, based on composition as follows:

- Unit 3 andesite and basaltic andesite
- Unit 4 dacitic andesite and andesitic dacite
- Unit 5 dacite
- Unit 6 rhyodacite and rhyolite

Volcanic units are subdivided on the basis of textures and mode of origin as described below. Divisions will be discussed for andesitic rocks of Unit 3, for which the classification is the most intricate; for other rock types, only a few subdivisions were made, and the classification nomenclature generally is similar to that for the andesitic rocks.

Unit 3a: andesite, basaltic andesite flow; medium to dark green, massive, with three main subunits and one minor subunit defined on the basis of prominent phenocryst type.

- 3a aphanitic to very fine grained, no prominent phenocrysts
- $3a_1$ prominent plagioclase phenocrysts (andesite)
- $3a_2$ prominent augite phenocrysts (basaltic andesite)
- $3a_3$ prominent plagioclase and augite phenocrysts (subunit is not abundant)

Phenocrysts average 0.5-1.5 mm in size, and occupy up to 20% of the rock. Some flows and flow tops are vesicular to amygdaloidal (these are indicated by the suffix, "v"). Pillows are common in a few flows; these are up to 30 cm in size. Some show concentric color banding between lighter and darker green rings. Pillowed flows are indicated by a suffix, "p". Epidote alteration is common, and gives the rock a paler green color with increasing epidote content.

Unit 3ax: andesite, basaltic andesite flow breccia; similar to Unit 3a, and occurs with flows in stratiform and crosscutting relationships. Some breccias are flow-top breccias, which grade downwards or are in sharp contact downwards with more massive parts of the flow. Subrounded to subangular, lapilli-sized to breccia-sized fragments commonly are porphyritic and amygaloidal flows; they generally are surrounded by a groundmass of similar composition and texture, but with less abundant amygdules. Epidote alteration is common and in places intense; in some rocks it is concentrated in the groundmass, and in others it is concentrated in certain fragments, especially in those with large and abundant amygdules. Flow breccias are best distinguished from flows on clean, weathered surfaces. On other surfaces the fragmental texture is much more obscure. Flow breccias were distinguished from pyroclastic breccias by their magmatic as opposed to tuffaceous groundmass, and by the fact that in flow breccias most fragments are of one lithologic type, whereas in pyroclastic breccias, generally several types of fragments are present. Subdivision of flow breccias is identical to that of flows (see above).

Unit 3b: andesite, basaltic andesite intrusions; massive, very fine to fine grained rocks, whose outcrop distribution and texture suggest they are intrusions (dike, sill, or dome). Color is light to dark green. Phenocrysts of plagioclase and/or augite may be present in minor amounts.

A few subvolcanic intrusions are of fine to medium grained diabase and gabbro (Subunit 3bg).

Pyroclastic rocks of Unit 3 are classified according to standard fragment sizes as follows:

Unit 3x	breccia, dominant fragments greater than 64 mm in a groundmass of lapilli- and tuff-sized fragments; breccia fragments generally occupy over 50% of the rock. Fragments commonly are up to 20 cm across.
Unit 3L	lapillistone, dominant fragments between 4 and 64 mm in size, with lesser tuffaceous groundmass, commonly well sorted.
Unit 3Lt	lapilli tuff, with abundant fragments between 4 and 64 mm in size in a tuffaceous groundmass, with the groundmass generally occupying over 60% of the rock
Unit 3Ltx	lapilli tuff-breccia, similar to lapilli tuff, but with distinct and moderately abundant (over 10%) fragments of breccia size.
Unit 3t	tuff, with dominant fragments from 0.1-4 mm in size. Tuff beds commonly are well sorted, and a few show graded beds. In the field, classification was further subdivided into fine (0.1-0.5 mm), medium (0.5-2 mm), and coarse (2-4 mm) varieties.
Unit 3ts	tuffaceous sediments, very fine tuff, with fragments less than 0.1 mm in size. Rocks probably were somewhat reworked by erosional and sedimentary processes. Most are well bedded and finely to very finely bedded, with interlayers commonly between 1 and 5 mm thick. This unit commonly is interlayered with clastic sedimentary rocks.

The coarser fragmental rocks (breccia and lapilli-sized fragments) were subdivided on the basis of the major fragment type(s) as follows:

Subunit $3x_1$, $3L_1$, $3Lt_1$, $3Ltx_1$	fragments of one or more varieties of andesite.
Subunit $3x_2$, etc.	as $3x_1$, but with up to 5% fragments of dacite.
Subunit $3x_3$, etc.	as $3x_2$, but with over 5% and up to about 20% fragments of dacite
Subunit $3x_4$, etc.	as $3x_1$, but with minor to moderately abundant fragments of limestone
Subunit $3x_5$, etc.	a distinct lithologic unit with fragments of purple to maroon andesite flow in a groundmass of similar composition and color (lapilli and tuff-sized fragments). The groundmass commonly is calcareous, and the unit contains sections with abundant fragments of limestone up to 1 metre in length.

Locally, pyroclastic rocks (mainly fine tuffs) show graded beds and minor erosion and fill features, which indicate stratigraphic tops. Some pyroclastic rocks, especially those interbedded with limestone or calcareous clastic rocks, and those near major limestone intervals, have a calcareous groundmass, indicated by a suffix, "c", e.g., 3tc.

Rocks of Units 4, 5, and 6 are much less abundant than those of Unit 3, and fewer lithologic types were distinguished. Major types are listed for each unit below.

Unit 4: dacitic andesite and andesitic dacite; these rocks are mainly flows (Unit 4a) and tuffs (Unit 4t). Color varies widely from pale to medium green with various shades of purple, grey, and maroon. Plagioclase phenocrysts are common in most rocks, except those which are aphanitic. Rocks of Unit 4 grade compositionally into those of Units 3 and 5, and commonly the line of demarcation between these units is vague. Rocks of Unit 4 are most abundant on the south slope of Mount Manville above the Big Bull mine; there, outcrop is sparse and the geology sufficiently complex that contacts could not be drawn between outcrops to define major areas of Units 3, 4, and 5.

Unit 5: dacite; flows (Unit 5a) and pyroclastic rocks (Units 5Lt, 5Ltx, and 5t) are most common throughout the region, with a major dacitic intrusion (Unit 5b) south of the Tulsequah Chief mine. Plagioclase phenocrysts are common. Fragmental textures are difficult to distinguish, and probably more rocks are fragmental than indicated on the maps. Color ranges from pale grey and green to light green and medium grey, with cream-colored varieties occurring in zones of alteration. Coarser pyroclastic rocks contain fragments almost entirely of dacite and rhyodacite. Dacite is most abundant in three main felsic centers: at and south of the Tulsequah Chief mine, around the Big Bull Mine, and on the southwest flank of Mount Manville. Smaller bodies are interlayered with sediments and tuffaceous sediments on Wendy Peak, north of Wendy Lake, and south of Roger Creek (possibly an extension of the Tulsequah Chief zone). At the Tulsequah Chief and Big Bull mines, dacites are strongly altered to quartz-sericite-pyrite, and are hosts for massive sulfide deposits (see later for description). Similar altered dacites occur at the Ericksen-Ashby deposit. Other dacite bodies are relatively fresh, with only local quartz-sericite alteration, and minor disseminated pyrite (up to 2% maximum).

Unit 6: rhyodacite, minor rhyolite; these rocks are similar to dacite, but contain quartz phenocrysts, with or without those of plagioclase. The main occurrence of rhyodacite is on the west side of the Tulsequah Chief mine (stratigraphically overlying the massive sulfide deposits. Both fragmental rocks (Units 6Lt and 6Ltx) and flows (Unit 6a) are present. Pyritic alteration is abundant in parts of the unit.

2.2.3.2 Sedimentary Rocks

The thickness and nature of sedimentary intervals is inversely related to the intensity of volcanism and to the proximity of the volcanic source(s). During major periods of andesitic volcanism, nearby basins were loci of accumulation of fine andesitic pyroclastic rocks mixed with clastic sedimentary rocks. The abundance of clastic rocks elative to pyroclastic rocks increased away from the centers. At several times, andesitic volcanism stopped and was replaced by felsic volcanism, which was more sporadic in nature and localized at a few major centers. During these times, thicker accumulations of clastic sedimentary rocks were formed, including minor intervals of limestone and chert. Away from the felsic centers, thicker sedimentary sequences were deposited in broad basins, with minor influx of felsic material. These deposits include limestone, chert, and clastic sedimentary rocks. Facies changes are moderately rapid, reflecting a tectonic control associated with the island-arc setting. Renewed andesitic volcanism blanketed the sedimentary basins.

Unit 7: Limestone, Siliceous Limestone

Major carbonate intervals occur at the north end of Mount Eaton, further south in the same sedimentary basin at Mount Ericksen and (on the other limb of the Mount Eaton Anticline) along the Tulsequah River near Wendy Creek, and in a linear belt along the crest and southeast flank of Mount Strong and across the western ridge of Mount Sittakanay. Carbonates are divided into the following units:

Unit 7a: free of interbeds of chert or mudstone; intervals of limestone, with at most only minor interbeds of chert or mudstone, in places containing abundant wispy seams of silica which represent original bedding and which are useful in outlining minor folds. Chert commonly forms pods and lenses of irregular shapes (distorted by folding) and of sizes ranging up to a few tens of centimetres across; these are abundant only near regions of bedded chert. Limestone ranges in color from white to medium bluish grey to cream. Much of it is recrystallized to very fine to locally coarse grained marble. Coarser varieties of marble are designated Subunit 7am, and occur in regions more strongly metamorphosed than normal, e.g., along the crest of Mount Strong near the Bacon Creek pluton.

Unit 7b: interlayered with chert; layers average from a few to several centimetres in thickness, with the dominant phase commonly forming thicker layers than the subordinate phase. In places the subordinate phase forms discontinuous lenses in the dominant phase. Layering commonly is rhythmic over widths of several metres. As chert becomes the dominant phase, this unit grades into Unit 8b. Mudstone interlayers are very rare in Units 7b and 8b.

Unit 7c: interlayered with mudstone; beds are of the order of several millimetres to a few tens of centimetres in thickness. Limestone commonly is muddy, and mudstone commonly limy. Less abundant interlayers include siltstone, greywacke, and fine andesitic tuff and tuffaceous sediments. This unit is most abundant along the base of the major sedimentary basin at the north end of Mount Eaton. Several of the limestone beds in it contain very abundant fossils, which, considering the strongly folded nature of the rocks, are very well preserved. Fossils are dominated by rugose corals, crinoid stems, and fusilinids, with abundant unidentifiable fossil debris. Nelson and Payne (1984) reported that the rugose corals were of Middle Pennsylvanian to Lower Permian age, and that the fusilinids were of probable Middle Pennsylvanian age. Fossiliferous beds and sequences are indicated by a suffix "f". Similar beds occur locally in Unit 7a.

Unit 7d: limestone breccia; very variable unit containing fragments up to several tens of centimetres across of limestone, and much fewer fragments of andesite and cherty limestone in a limy groundmass. Locally a second type of breccia contains abundant andesite fragments and lesser limestone fragments in a groundmass of limestone. This type of breccia grades into Subunit $3x_4$ (andesite breccia with abundant limestone fragments). The breccias are most common near, but not necessarily at the lower contact of the main sedimentary basin on Mount Eaton. Similar breccias occur locally at Ericksen-Ashby and on Mount Strong.

Unit 7e: dolomite; thin layers and intervals, commonly along borders of andesite tuff units. These rocks weather light brown, suggesting a moderate iron content of the carbonate. The largest body occurs on the north end of Mount Eaton near the stratigraphic top of the main sedimentary basin, where a thin carbonate layer overlies a thicker unit of andesitic tuffs and lapilli tuffs.

Unit 8: Chert, Calcareous Chert

Major chert intervals occur at the north end of Mount Eaton, at Ericksen-Ashby, and on Mount Sittakanay. These are associated with the thick intervals of limestone in those regions. Three varieties are distinguished on the basis of associated rock types.

Unit 8a: chert, no limestone interbeds; commonly pure chert in beds from a few to a few tens of centimetres thick. In small outcrops bedding commonly is not obvious. At the north end of Mount Eaton near contacts with Subunit $3x_5$, chert commmonly contains disseminated pyrite, which weathers to give a strong red-brown limonite stain. Along this contact is a fairly continuous layer up to 1 metre thick of Unit 5t containing strong alteration to quartz-pyrite-sericite, and containing lenses up to several millimetres in width of massive pyrite.

Unit 8b: interbedded with limestone; commonly rhythmically layered beds as in and gradational to Unit 7b. Facies changes are rapid between chert-dominated and limestone-dominated sequences. Chert commonly contains minor disseminated calcite. In ridges below treeline, chert stands out and limestone commonly is somewhat recessive, giving the impression that the chert/limestone ratio is greater than the fact.

Unit 8c: with andesite; just below the northwest end of Mount Eaton Glacier, one section of a thick chert sequence contains abundant lenses, pods, and dike-like bodies of aphanitic andesite. The andesite probably was formed by minor pulses of volcanic activity. Similar andesite bodies occur in chert and limestone at the Ericksen-Ashby deposit.

Unit 9: Clastic Sedimentary Rocks

Clastic sedimentary rocks form thick intervals at the north and northeast ends of Mount Eaton and on Mount Strong. Thinner but significant intervals are near Roger Lake and on Mount Manville. Outside the map area, a major interval is on the south side of Mount Sittakanay.

Clastic sedimentary rocks generally are well bedded, with beds ranging from a few millimetres to a few centimetres in thickness, with thicker beds commonly being of coarser grained varieties. Color ranges from light grey to black, generally being darker in finer grained varieties.

Three main types of clastic sedimentary rocks were distinguished.

Unit 9a: mudstone, siltstone; medium grey to black, with some greenish varieties, well bedded, thinly laminated. In places it contains interbeds and thin intervals of andesitic and/or dacitic tuffs and tuffaceous sediments. Adjacent beds may vary in grain size, but no graded beds were recognized. With increasing silica content, Unit 9a grades into Unit 9b.

Unit 9b: siliceous mudstone, siltstone; pale to medium grey and greenish grey, otherwise similar to Unit 9a except for higher silica content. This unit is gradational into Unit 5ts (dacitic tuffaceous sediments).

<u>Unit 9c</u>: <u>interbedded greywacke and mudstone/siltstone</u>; intervals up to several tens of metres thick are dominated by interbedded greywacke with finer clastic rocks. Inter beds commonly are rhythmically layered, suggesting that the rocks represent an AE-type Bouma turbidity sequence. Stratigraphic top indicators are common, and include graded beds (mainly in coarser grained layers) and minor erosion and fill features. Greywacke is lithologically gradational into fine to medium andesite and dacite tuffs, and in places Unit 9c is interlayered with or gradational into such tuffaceous units.

2.2.4 Mesozoic(?) Intrusions

Scattered through the map area are small intrusions of several types. Some of these are most probably part of the Coast Plutonic Complex, although no radiometric ages are available, and crosscutting relations are only with Paleozoic rocks. They have been grouped as Mesozoic intrusions because of their field relations and by the fact that they do not resemble plutonic rocks associated with the Sloco Group volcanic rocks of Early Tertiary age.

<u>Unit 10a</u>: granodiorite, quartz monzonite; on the south side of Mount Strong, a few outcrops within a dominantly gneissic terrain of Unit 1 consist of medium to locally coarse grained plutonic rocks. The dominant phase is a biotite or biotite-hornblende granodiorite with a pink to grey color. Rocks are massive and appear to have intruded the gneisses, although no contact relations were seen.

<u>Unit 10b</u>: diorite; two small intrusions of fine to medium grained, medium grey diorite occur on the south side of Mount Manville, one along Manville Creek and the other just above the West Bull Fault. The body along Manville Creek cuts across the foliation of andesite tuffs and tuffaceous sediments of Units 3t and 3ts. Contacts of the other body are not exposed. Intrusive into rocks of Unit 2 north of the Tulsequah Chief mine is a small body of fine grained diorite in which plagioclase is strongly altered to epidote and mafic minerals to actinolite. The rock is massive and medium greyish green in color. It may be older than the diorites on Mount Manville. It is classified as Subunit 10bz.

<u>Unit 10c</u>: <u>pyroxenite, biotite pyroxenite</u>; on the east flank of Mount Strong is a plug a few kilometres long and up to two kilometres wide of medium to fine grained, massive pyroxenite. Fine grained phases are most common along borders of the plug. Magnetite is abundant, and biotite and hornblende are minor to locally moderately abundant phases. Most of the rock appears fresh, except where it is cut by the Mount Strong Fault, where the rock is strongly

fractured and altered strongly to completely to serpentine, with or without ankeritic carbonate and talc (Subunit 10cz). The age of the body is uncertain. It is not displaced by the Mount Strong Fault, but is strongly altered along it. This suggests that it may have been intruded after the main movement on the fault, and that it was fractured and altered during later minor movement along the structure.

2.2.5 Early Tertiary Intrusions (Unit 11)

Many felsic and fewer intermediate and andesitic dikes and a few dike swarms cut across the deformed rocks. Many of the major faults are loci for intrusion of the dikes, indicating that the dikes are later than the faults. A few larger dikes and plutons of similar composition and coarser grain size are of about the same age as the dikes. These rocks are considered to be subvolcanic equivalents of the Sloco Group felsic to intermediate volcanic rocks, which outcrop abundantly on the high ridges northeast and east of the map area (see Figure 1). The intrusions are grouped into four major types, of which the first is by far the most abundant in the survey area.

Unit 11a: felsic dikes: these are up to several tens of metres wide, averaging a few metres. Color is pink to light grey to cream, with some limonitic zones formed by weathering of disseminated pyrite. Three subunits were distinguished based on phenocryst type and grain size; within a given dike, these may be gradational.

Subunit $11a_1$: aphanitic, commonly flow banded felsite, forming most of dikes narrower than a few metres and the border zone of wider dikes. Flow banding is parallel to the walls of the dike, and is most prominent along the contacts. In some dikes a prominent lineation of uncertain origin was developed on these surfaces. As well, a prominent joint set was formed parallel to flow banding and to the walls of thinner dikes.

Subunit $11a_2$: characterized by plagioclase phenocrysts in a very fine grained to aphanitic groundmass. It forms the cores of some larger dikes. Minor mafic phenocrysts may be present. Flow banding is weak or absent, and orthogonal joint sets are moderately to well developed, one of which is subparallel to the walls of the dike.

Subunit $11a_3$: quartz phenocrysts, with or without plagioclase and minor mafic phenocrysts in a very fine to locally fine grained groundmass. Disseminated pyrite is widespread but not abundant. The subunit forms a few large dikes, in which a well developed orthogonal joint set is developed, one member of which is subparallel to the walls of the dike.

Unit 11b: granodiorite, quartz monzonite; in very large dikes and plutons, coarser grained and deeper-seated equivalents to rocks of Unit 11a. Two phases were distinguished.

Subunit $11b_1$: fine grained, porphyritic to equigranular. Phenocrysts are of plagioclase, with or without those of quartz, biotite, and hornblende. The Bacon Creek pluton and the dike at the south end of Mount Strong are of this subunit; both have a well developed orthogonal joint set.

Subunit $11b_2$: medium to coarse grained, mainly equigranular. It includes the Tuskwa pluton just east of the map area. A pluton on Niagara Mountain, a few tens of kilometres southeast of the map area was dated by the K/Ar method at 69 m.A. (Leech et al, 1963, in Souther, 1971).

Unit 11c: andesite, diorite; dikes and sills averaging a few to several metres in width, commonly equigranular and ranging from aphanitic to fine grained. Color is from light to dark green to greyish green. In some places, these occupy the same structures as do felsic dikes of Unit 11a. At the north end of Mount Eaton, a porphyritic andesite dike of this unit appears to be cut by a much narrower felsic dike of subunit $11a_1$.

Unit 11d: dacite; dikes up to a few metres in width, mainly porphyritic with plagioclase and possibly minor quartz phenocrysts in an aphanitic to very fine grained, light grey to green groundmass.

A few dike swarms of Unit 11 (mainly Unit 11a) cut the older rocks. One swarm is at the north end of the map area. There, numerous dikes trending northeast cut across rocks of the Mount Eaton Group and the northern end of the Tuskwa pluton. Dike swarms and dikes probably were emplaced into tension fractures which developed in response to late tectonic movement after development of the major north-south-trending faults.

2.3 Structure

2.3.1 General Statement

Major north-south-trending faults of unknown displacement and probable Mesozoic age separate tectonic blocks of diverse age and geology (see Figure 5). The major deformation features within each block of Paleozoic rocks (Whitewater, Tulsequah, and Mount Eaton) are considered to have been formed before the blocks were brought together by the Mesozoic faulting. For this reason, the internal structure of each block will be discussed separately.

Deformation events in each block are referred to sequentially as D-1, D-2, etc. To avoid confusion, events in each block are referenced by letter as follows:

Whitewater Group	W	e.g., D-1W, D-2W
Tulsequah Group	T	
Mount Eaton Group	E	

Note that D-1W is a completely different event than D-1T, etc., even though similarities exist between some features of two events with the same numerical designation.

Deformation events in the Paleozoic rocks are summarized in Table 3.

2.3.2 Whitewater Group

During an early deformation event (D-1W?) a metamorphic foliation (S-1W) was developed parallel to bedding (S-0W). The geometry of D-1W is poorly understood.

During a second important deformation event (D-2W), S1-W was deformed into broad warps and isoclinal folds (F-2W). These have amplitudes of a few centimetres to several tens of metres. Parallel to the fold axes was developed a prominent lineation (L-2W).

A third deformation event (D-3W) is inferred by the highly variable orientation of F-2W axes throughout rocks of this group. Some of this variation may be due to late faulting, but in several areas, F-2W axes and L-2W lineations can be followed around broad warps.

A fourth deformation event (D-4W) is developed locally and consists of minor kink folds. These are best developed in micaceous rocks, and are oriented at a large angle to S-1W.

2.3.3 Tulsequah Group

During the major deformation event in these rocks (D-1T), bedding (S-0T) was deformed into tight to isoclinal folds (F-1T). In fold limbs, S-0T was transposed parallel to the prominent axial-planar foliation (S-1T), producing schist, phyllite, and subgneiss. In much of the map area, F-1T axes

Table 3. Summary of Deformation Events

Tectonic Block	Event	Remarks
Whitewater	D-1W?	S-1W parallel to S-0W, geometry uncertain
	D-2W	F-2W folds S-1W in broad warps to isoclinal folds, L-1W parallel to F-1W axes
	D-3W	F-2W axes variable through block, caused by F-3W folds and block faulting (later)
	D-4W	F-4W kink folds at high angle to S-1W
Tulsequah	D-1T	major event, S-0T deformed into tight to isoclinal F-1T; S-0T parallel to S-1T in limbs, L-1T prominent in noses of F-1T folds.
	D-2T	F-2T folds F-1T and L-1T into broad warps
	D-3T	F-3T kink folds at high angle to S-1T; may be same event as D-4W
Mount Eaton	D-1E	major event, tight to isoclinal folds (F-1E) including Mount Eaton Anticline, locally developed shear folds with strong axial-planar S-1E
	D-2E	local event, causes strong variation in F-1E and produces complexly folded geological contacts where it overlaps strong F-1E folds.
	D-3E	F-3E kink folds at high to moderate angle to S-1E; only in rocks with well developed S-1E
All	Faulting	Mesozoic(?) brings together major tectonic blocks along north-south faults of large displacement and possible major strike-slip component
	Faulting	Tertiary, along Taku and possibly Tulsequah Rivers, offsets earlier faults and some Tertiary rocks

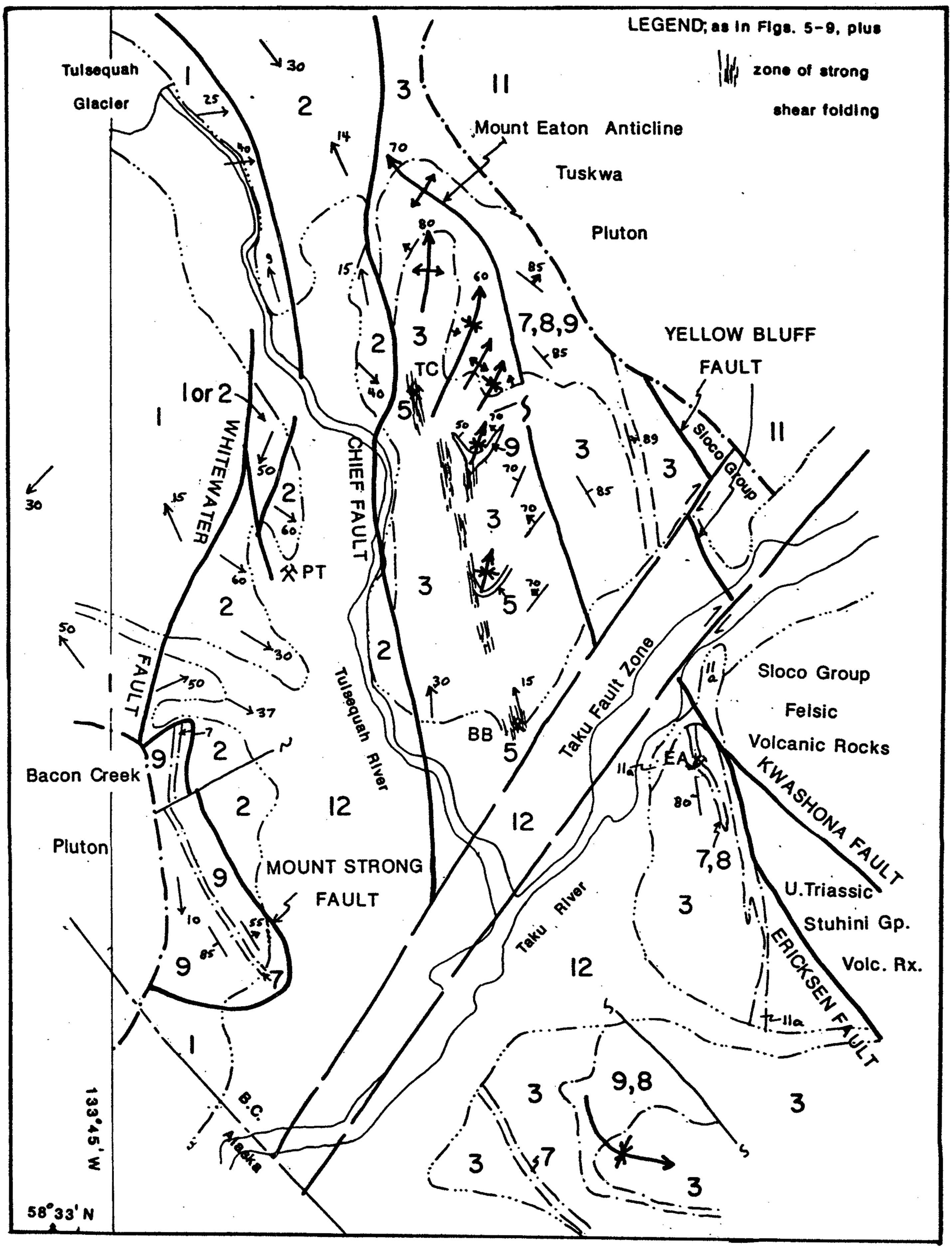


Figure 5 . Regional Structure

plunge moderately to steeply southeast. A lineation (L-1T) is variably developed parallel to F-1T axes, and is most prominent in noses of major folds. Such a fold nose occurs in felsic subgneiss of Unit 2b near the southeast end of Wilms Ridge. F-1T folds are upright to steeply dipping.

A second deformation event (D-2T) was recognized on Wilms Ridge and north of the Tulsequah Chief mine. In both places F-1T axes and L-1T are folded into broad warps.

A third minor deformation event (D-3T) consists of kink folds at moderate to high angles to S-1T. These folds may have been formed during the same event which produced similar folds in the Whitewater Group, i.e., D-4W.

Deformation features are best developed in rocks of Unit 2c and Unit 2d (schist and phyllite), and less well developed in rocks of Unit 2a (subgneiss). Rocks of Unit 2b are partly deformed (Subunit $2b_3$) and partly massive (Subunits $2b_1$, $2b_2$).

2.3.4 Mount Eaton Group

During a major deformation event (D-1E), large-scale, tight to isoclinal folds (F-1E) were formed, the largest of which is the Mount Eaton Anticline. This complex fold contains several subsidiary megascopic folds on its western flank. The main anticlinal axis trends northerly over much of its length along the axes of the Manville and Mount Eaton Glaciers, and at the north end swings to the northwest. Subsidiary folds trend north to northeast. All fold axes plunge moderately to steeply to the north. Axial planes of F-1E strike north to northeast and dip steeply to the west, except on the ridge south of Wendy Lake, where they dip shallowly to the west.

Folds are best represented in sedimentary rocks and felsic tuffs. Structural features are weakly developed or absent in the more massive and competent andesitic volcanic rocks. Two well developed examples of this competency contrast are at the northwest end of Mount Eaton Glacier and on the ridge south of Wendy Lake.

The west limb of the Mount Eaton Anticline exposes a continuous stratigraphic section of at least 3,000 metres thickness from Mount Eaton to the south flank of Mount Manville. West of the ridge, the rocks are folded into a subsidiary syncline or synclines, whose axial planes are displaced in an en echelon manner to the west from south to north. This displacement may be due to northeast-trending faults. On the west limb of the syncline(s), the rocks are tightly folded into F-1E shear folds, and an axial-planar foliation (S-1E) is well developed. This shear zone occurs mainly in dacitic tuffs and clastic sediments of Units 5 and 9. It extends discontinuously from the Big Bull deposit to the Tulsequah Chief deposit.

On Mount Strong and on the west ridge of Sittakanay Mountain, rocks of the Mount Eaton Group are uniformly steeply dipping, and contain numerous tight to isoclinal F-1E folds. S-1E is parallel to S-0E, and L-1E plunges gently to the north or south. Folds are most prominent in and near the main interval of limestone which transects both ridges, and along the contact of the Bacon Creek Pluton and a sattelite body to the east. The latter zone of deformation corresponds to a contact metamorphic aureole bordering the Tertiary intrusions. S-1E trends northerly at the north end of the belt, and swings broadly to the southeast on the southeast slope of Mount Strong. This orientation continues across Sittakanay Mountain.

A second deformation event (D-2E) locally causes strong variation in the orientation of F-1E axes. On the ridge south of Wendy Lake, moderate to tight, asymmetrical F-2E folds have axial planes dipping steeply to the west and fold axes plunging moderately to steeply to the southwest and west. At the north end of Mount Eaton, interbedded sedimentary and volcanic rocks are complexly folded, with fold axes in widely varying orientations, and fold styles changing rapidly. These features are interpreted as having resulted from very inhomogeneous F-1E folding because of the strong competency contrast of the two types of rocks, and by superimposition of F-2E folds of moderate size. The latter event also would have formed irregular fold patterns.

A third deformation event (D-3E) is a locally developed kink folding, which affected rocks in which a strong foliation (S-1E) had already been formed. Kink folds are at a moderate to high angle to S-1E.

2.3.5 Faults

The major Mesozoic(?) faults which separate tectonic blocks are as follows:

1. Whitewater Fault, separates Whitewater Group to the west from Tulsequah Group to the east.
2. Chief Fault, separates Tulsequah Group to the west from Mount Eaton Group to the east.
3. Ericksen/Yellow Bluff Faults, separate Mount Eaton Group to the west from Stuhini and Sloco Groups to the east. (Note: Yellow Bluff and Kwashona Faults were formed/reactivated as normal faults during time of formation of volcanic rocks of the Sloco Group)
4. Mount Strong Fault, appears to be a thrust fault at the north, steepening to the east; it separates Mount Eaton Group above and to the west from Tulsequah (and possibly Whitewater) Group below and to the east.

The sense and amount of displacement of these faults are unknown. They may have a large component of strike-slip movement, and the amount of displacement probably is of the order of tens of kilometers.

Numerous north-south and north-northwest trending faults cut rocks in the Mount Eaton/Mount Manville block. These include, from west to east, the West Bull, Big Bull, 4000, Eaton, Manville, Roger Lake, and Manville Glacier Faults, as well as several smaller faults and splays from the major faults. Displacements of the order of a few hundred metres were measured on some, with a dextral sense of movement on the 4000 and Manville Faults, and a sinistral sense of movement on the Roger Lake Fault. Because the faults commonly trend subparallel to the regional bedding orientation, and because many occur in dominantly andesitic terrain, the sense and amount of displacement are difficult to determine. Two possible origins are suggested for these faults. Some movement may have occurred during D-1E, with large blocks of andesite acting rigidly and fracturing along limbs of the Mount Eaton Anticline and subsidiary folds, while the more ductile sedimentary and dacitic tuffaceous rocks were complexly folded. Some movement may have occurred during the major Mesozoic(?) faulting event. Both major and minor faults are loci for intrusion of Early Tertiary dikes of Unit 11.

Many other north-south valleys are linear, and from air-photo interpretation appear to be faults. However, they do not show any geological offset. Some are parallel to contacts in bedded rocks and flows. All are interpreted as glacially enhanced features. A good example is on the lower part of Wilms Riges. Rocks of Unit 2a trend east-southeast across the ridge, which trends south-southeast, and numerous linear valleys trend roughly north-south across both these features.

Faulting on Mount Strong is complex. At the north end of the mountain, sedimentary rocks of the Mount Eaton Group dip steeply and strike towards Wilms Creek. At the base of the mountain in the South Fork of Wilms Creek, strongly deformed metasedimentary rocks of Unit 2d trend east-northeast to east. On the east slope of the mountain, rocks of the Mount Eaton Group occupy the upper slope, and are separated along a steep fault from schist and subgneiss of Unit 2. Along this contact are two unusual rocks, a massive andesitic dacite dome(?), possibly of Unit 4b, and a pyroxenite plug of Unit 10c. At the south end of the mountain, the Mount Eaton Group rocks are truncated against a large Tertiary dike, on the south side of which are gneisses of Unit 1. The North Strong Fault cuts across the north end of Mount Strong; it offsets the main limestone unit dextrally by up to a hundred metres, and forms the northern border of the pyroxenite plug. East of the Mount Strong Fault, outcrop zones of mudstones of Unit 9a overlie rocks of Unit 2. Although the contact appears to be conformable, it may be part of the Mount Strong Fault.

Tertiary faults were developed along the Tulsequah and Taku Valleys. The Taku Fault Zone shows a dextral offset of the Ericksen/Yellow Bluff Fault of up to 1 km. The offset of the Mount Strong/Sittakanay Mountain limestone belt appears to be sinistral, but this interpretation does not take into account possible major folding and faulting of this unit beneath Flannigan Slough.

2.4 Economic Geology

Deposits and showings are discussed below according to the major geological group with which each is associated.

2.4.1 Whitewater Group

No deposits of economic interest have been found in this group, nor is it considered to have economic potential.

2.4.2 Tulsequah Group

The Polaris-Taku gold deposit probably is hosted by rocks of this group. Uncertainty as to the host rock is because the mine workings are inaccessible, outcrop near the mine is sparse, and old records are incomplete and of poor quality. A major fault may separate the mine area from rocks of the Tulsequah Group on Wilms Ridge. However, the description of the rocks in the mine as strongly folded andesite flows and pyroclastic rocks, suggests that they are similar to those on the north end of Wilms Ridge. As well, the main vein zones are described as being in the nose and limbs of a major antiform which plunges steeply southeast. This orientation is the same as that of the major folds and fold-axis lineations at the north end of Wilms Ridge. Gold is associated with arsenopyrite, pyrite, and stibnite in a gangue of quartz and carbonate in discontinuous veins.

The Sparling and Banker showings are hosted by andesite and limestone, respectively of the Tulsequah Group. The Sparling showing consists of several discontinuous veins up to 1 metre wide dominated by quartz with lenses and pods of massive sphalerite-galena-pyrite, with silver values up to oz/T. Host rocks include andesite flows (Unit $2b_1$) and subvolcanic diorite to gabbro intrusions (Unit 2bg). The Banker showing contains lenses of similar massive sulfide in a siliceous replacement zone in a thin lens of limestone of Unit 2e. Samples from this zone have been reported to contain as much as 200 oz/T Ag.

No new deposits or showings of economic interest were found in this group.

2.4.3 Mount Eaton Group

The Tulsequah Chief and Big Bull mines and the Ericksen-Ashby prospect are the only deposits of economic interest encountered in this group. The detailed geology of the Big Bull mine is the subject of a concurrent project (Muraro, report in progress), and that of the Tulsequah Chief mine of a second concurrent project (Cassleman, report in progress). These deposits are discussed herein with respect to their relationship to rocks in the surrounding parts of the claim area.

The Big Bull deposit is hosted by felsic volcanic rocks (dacite to rhyodacite tuff and lapilli tuff). The exposures of these rocks are confined to a small region in and to the northeast of the main workings. To the west, they are truncated by the Big Bull Fault, which dips moderately to steeply to the west, and may be curved sharply to the west at its southeastern end. To the north and east, they are folded by a north to northeast plunging F-1E shear fold, and plunge into the slope a few hundred metres above the workings. The zone was traced by drilling a few hundred metres southeastward beneath a thin alluvial cover in the Taku Valley. The felsic volcanic rocks are altered strongly to quartz-sericite-pyrite in the workings, and less strongly to quartz-sericite-(pyrite) outside the workings. The workings also contain rocks dominated by lenses of pyrite-quartz and massive pyrite in a very strongly altered host rock. The massive sulfide zone, which is exposed at the entrance to a caved adit on the southwest corner of the workings, is zoned, with a section of massive galena-sphalerite-barite-pyrite-chalcopyrite, and an adjacent, overlying(?) zone of similar material but with up to 20 per cent fragments of quartz-sericite rock. These fragments average 0.5-1 cm in size, and may represent fragments deposited from sporadic felsic pyroclastic activity during formation of the massive sulfide beds at the sea-water interface with the ascending hydrothermal solutions. The massive sulfide zone is truncated against the Big Bull Fault; west of the fault are unusual andesitic tuffaceous sedimentary rocks showing no effects of the strong alteration in the felsic rocks in the workings. The Big Bull mine appears to be much lower in the stratigraphic section of the Mount Eaton Group than the Tulsequah Chief mine. Higher on the slope above the mine, outcrop is sparse, and is dominated by relatively massive andesite and dacitic andesite of Units 3a and 4a. As well as the Big Bull Fault, other major faults cut the felsic volcanic rocks in the mine. One major fault strikes parallel to the trend of the mine rocks and dips steeply; it is well exposed at the north end of the workings.

The Tulsequah Chief deposit occurs midway through a felsic volcanic pile, being underlain by altered dacite lapilli tuffs, and overlain by generally less altered rhyodacite lapilli tuffs. Beneath the deposit is a thick zone of altered andesite flows containing abundant disseminated pyrite. Alteration and massive sulfides are very similar to those in the Big Bull deposit. The deposit occurs in the nose of a subsidiary anticline on the west flank of the Mount Eaton Anticline. Tight to isoclinal folds were formed in massive sulfide and altered rocks; these are exposed above the 6500 adit. The zone is folded out on surface along Camp Creek just north of the 6500 zone. Underground data indicate that the ore zones and surrounding rocks plunge north to northeast at a moderate angle; this data is consistent with the larger-scale orientation of the F-1E folds in the Mount Eaton block. The ore zones are cut and offset along some of the north-south faults, with the main offset of a few hundred metres being recorded for the 4000 Fault.

Of minor economic interest is a zone just below the nose of the Mount Eaton Glacier in the core of the Mount Eaton Anticline. On the border of a pyritic chert (Unit 8a, 8b) and an overlying purple andesite breccia (Unit $3x_5$) is a thin, relatively continuous zone of altered dacite to rhyodacite tuff, containing moderately abundant pyrite lenses similar to those in the workings of the Big Bull and Tulsequah Chief mines. The thin felsic volcanic unit is a useful marker bed to help understand the complexly folded geology in the nose of the major anticline. This deposit is similar in several respects to the Ericksen-Ashby deposit, which occurs at about the same stratigraphic level further south along the east limb of the major anticline.

The Ericksen-Ashby deposit was mapped by Payne (1979). It consist of several pods and lenses of massive sphalerite-galena and pyrrhotite associated with thin lenses of altered dacite to rhyodacite tuff and lapilli tuff within a sequence of interbedded chert and limestone. As well, other sulfide patches occur in the sedimentary rocks away from the felsic volcanic rocks. Many of these are associated with larger zones of "skarn" containing abundant rhodonite and lesser garnet, clinopyroxene, calcite, and feldspars. Some of these have been interpreted as having formed in a hot-spring or fumarole environment.

2.4.4 Faults

The South Slope deposit is along the Whitewater fault. It is hosted by highly contorted argillites of Unit 2d or Unit 2c near the contact of overlying schists of Unit 2a. A lensy quartz vein up to 1.2 metres wide and Tertiary dike up to 1.8 m are altered and contain very fine grained pyrite. Samples across each yielded 0.36 oz/T gold and 0.12 oz/T gold, respectively (Selby, 1945).

This and other major faults might contain zones of economic interest, probably associated with Tertiary hydrothermal and intrusive events.

3. CONCLUSIONS

3.1. Lithology

The claims are underlain by rocks of three major Paleozoic groups as follows:

Whitewater Group	Pre-Pennsylvanian, probably Early to Middle Paleozoic; quartz-rich and quartzofeldspathic gneisses of sedimentary origin, and feldspar-(quartz) and feldspar-hornblende-chlorite gneisses of probable volcanic origin.
Tulsequah Group	Pre-Pennsylvanian(?), probably Middle to Upper Paleozoic; felsic and intermediate schists, phyllites, subgneisses dominantly of volcanic origin, lesser metasedimentary rocks, and a distinctive basaltic andesite with prominent augite phenocrysts.
Mount Eaton Group	Middle Pennsylvanian to Permian; thick piles of andesite to basaltic andesite flows, flow breccias, and pyroclastic rocks. Scattered felsic volcanic centers host massive sulfide deposits rich in precious metals associated with sphalerite, galena, and chalcopyrite. Such felsic centers are the main target for exploration in the region. Clastic sedimentary rocks, limestone, and chert formed major deposits during periods of volcanic quiescence. Thinner clastic intervals occur throughout the andesitic piles, commonly associated with small volumes of felsic pyroclastic rocks.

Minor Mesozoic(?) plutons are exposed in the claim area in rocks of the Mount Eaton Group. These include granodiorite, diorite, and pyroxenite intrusions.

Early Tertiary felsic and intermediate dikes and dike swarms crosscut all three Paleozoic geological groups. They commonly are concentrated along major faults and tension fracture zones. Coarser grained plutons, genetically related to the dikes, outcrop just beyond the eastern and western margins of the map area. These rocks are related genetically to the Sloco Group volcanic rocks, which form a major belt east and northeast of the map area.

3.2 Structure

The three Paleozoic groups each were affected by at least three recognizable phases of deformation prior to the major Mesozoic(?) faulting. Deformation events in one group are not correlatable with events in other groups, except possibly the minor, late kink-folding see in all groups.

The important regional fold-generation events were an early, tight to isoclinal folding in the Tulsequah Group (D-1T), and a similar but less intensely developed event in the Mount Eaton Group (D-1E). Major recognizable fold features in the map area belong to these events. The largest and most important fold in the region is the Mount Eaton Anticline, which was formed during D-1E. In all Paleozoic rocks, later folding events were noted to locally deform the earlier, major structures.

Major faults during the Mesozoic brought together the large blocks of different geological age and structure. The amount of displacement is unknown, but probably of the order of tens of kilometres with a large strike-slip component on each of the major faults. Smaller faults in the Mount Eaton Group, which are subparallel to the major faults, were formed in part during D-1E folding, and in part as subsidiaries to the major faults. Tertiary faulting displaced earlier features by up to 1 km along the Taku Valley, and by an unknown amount along the Tulsequah Valley. Many earlier formed linear features were enhanced during Pleistocene and Recent glaciation.

3.3 Economic Geology

The Mount Eaton Group contains two important massive sulfide deposits, Tulsequah Chief and Big Bull. They are genetically related to felsic volcanic centers in dominantly andesitic island-arc sequences. The deposits consist of massive sphalerite-galena-barite-chalcopyrite-pyrite zones in fragmental felsic tuffs, which are altered strongly to quarz-sericite-pyrite. Both are past-producers, with exploration potential for extensions of known ore zones. The Ericksen-Ashby showing contains sphalerite-galena pods in and near felsic volcanic lenses in a chert-limestone sequence between andesites.

The Tulsequah Group contains the Polaris-Taku gold deposit hosted in strongly distorted andesite volcanic rocks. Discontinouous quartz-carbonate containing arsenopyrite, pyrite, stibnite, and native gold occupy the main zone of mineralization in a major antiform structure. It is a past-producer. The Tulsequah Group also hosts the Banker and Sparling showings, which contain galena-sphalerite lenses with high contents of silver.

The Whitewater Group contains no known deposits or showings of economic value.

Major faults may be loci for gold deposits associated with Tertiary intrusive and hydrothermal events. The South Slope showing is of this type.

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Souther, J.G., 1971. Geology and mineral deposits of the Tulsequah map-area, British Columbia. Geol. Surv. Can., Mem. 362.

5. QUALIFICATIONS OF AUTHORS

John G. Payne

BSc (1961), Queen's University, Kingston, Ontario, (Geological Engineering)

PhD (1966), McMaster University, Hamilton, Ontario (Geochemistry)

Experience in Industry: 20 years from 1967 to present, mainly in base- and precious-metal exploration in the North American Cordillera.

Wendy G. Sisson

BSc (1986), University of British Columbia, Vancouver, B.C. (Geology)

Experience in Industry: 7 years in mineral exploration in Western and Northern Canada

Report by: "John G. Payne"

"W.G. Sisson"

Endorsed by: M.J. Casselman,
Project Geologist

Approved for
Release by: W.J. Wolfe,
Manager, Exploration-
Western Canada.

APPENDIX "A"

EXPLORATION | WESTERN CANADA

STATEMENT OF EXPENDITURES

Salaries J.Payne	- June 22-July 31	$ 12,000
W. Sisson	- June 22-July 31	6,000
Supervision M.J. Casselman - 5 days		1,150
Domicile - 40 days @ $100/day		4,000
Helicopter - 35hrs @ $425/hour		14,850
Fuel		1,620
Fixed Wing		5,680
Drafting and Report Writing	- J. Payne - 10 days	2,000
	- W. Sisson- 10 days	1,500
		$48,800

APPENDIX "B"

EXPLORATION | WESTERN CANADA

IN THE MATTER OF THE B.C. MINERAL ACT AND
IN THE MATTER OF A GEOLOGICAL MAPPING PROGRAM
CARRIED OUT ON THE TULSEQUAH PROPERTY
LOCATED IN THE ATLIN MINING DIVISION OF THE PROVINCE OF
BRITISH COLUMBIA - MORE PARTICULARLY N.T.S. 104K/11,12

A F F I D A V I T

I, MICHAEL J. CASSELMAN, OF THE CITY OF DELTA, IN THE PROVINCE OF BRITISH COLUMBIA, MAKE OATH AND SAY:

1. THAT I AM EMPLOYED AS A PROJECT GEOLOGIST BY COMINCO LTD. AND AS SUCH HAVE A PERSONAL KNOWLEDGE OF THE FACTS TO WHICH I HEREINAFTER DEPOSE:

2. THAT ANNEXED HERETO AND MARKED AS "APPENDIX A" TO THIS REPORT IS A TRUE COPY OF EXPENDITURE OF A GEOLOGICAL MAPPING PROGRAM CARRIED OUT ON THE TULSEQUAH PROPERTY:

3. THAT THE SAID EXPENDITURES WERE INCURRED BETWEEN THE 22 DAY OF JUNE 1987 AND THE 31 DAY OF JULY 1987 FOR THE PURPOSE OF MINERAL EXPLORATION ON THE ABOVE NOTED PROPERTY.

MICHAEL J. CASSELMAN, M.Sc.

APPENDIX "C"

EXPLORATION

WESTERN CANADA

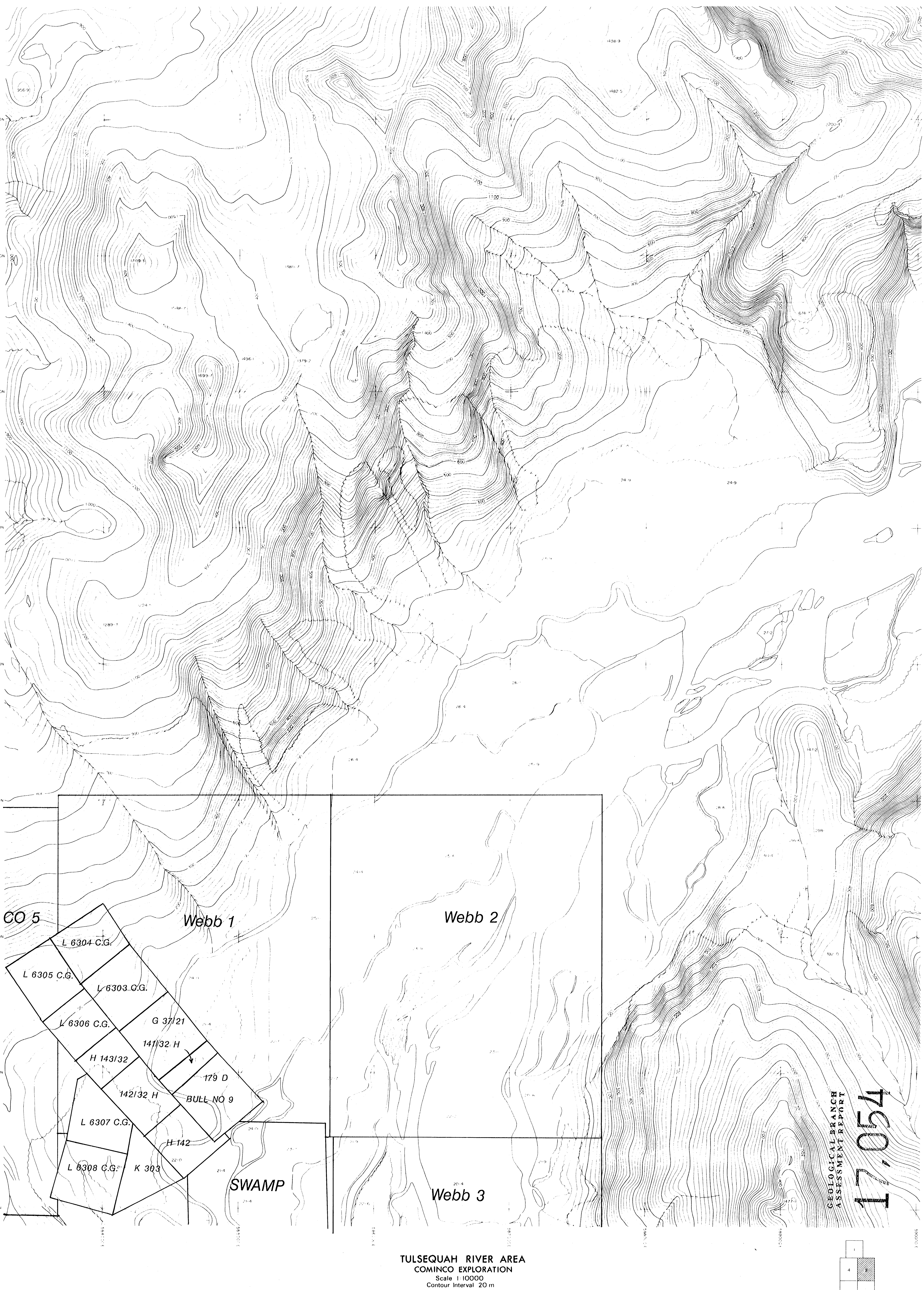
STATEMENT OF QUALIFICATIONS

I, MICHAEL J. CASSELMAN, OF THE CITY OF DELTA, BRITISH COLUMBIA, HEREBY CERTIFY:

- THAT I AM A GEOLOGIST, RESIDING AT 5989 BRIARWOOD CRESCENT, DELTA, BRITISH COLUMBIA, WITH A BUSINESS ADDRESS AT 700-409 GRANVILLE STREET, VANCOUVER, BRITISH COLUMBIA.
- THAT I GRADUATED WITH B.Sc.AND M.Sc. DEGREES IN GEOLOGY FROM THE UNIVERSITY OF BRITISH COLUMBIA IN 1969 AND CARELTON UNIVERSITY IN 1977.
- THAT I HAVE PRACTISED GEOLOGY WITH COMINCO LTD. FROM 1969 TO PRESENT.

DATED THIS 29 DAY OF JANUARY 1988 AT VANCOUVER, BRITISH COLUMBIA.

MICHAEL J. CASSELMAN, M.Sc.

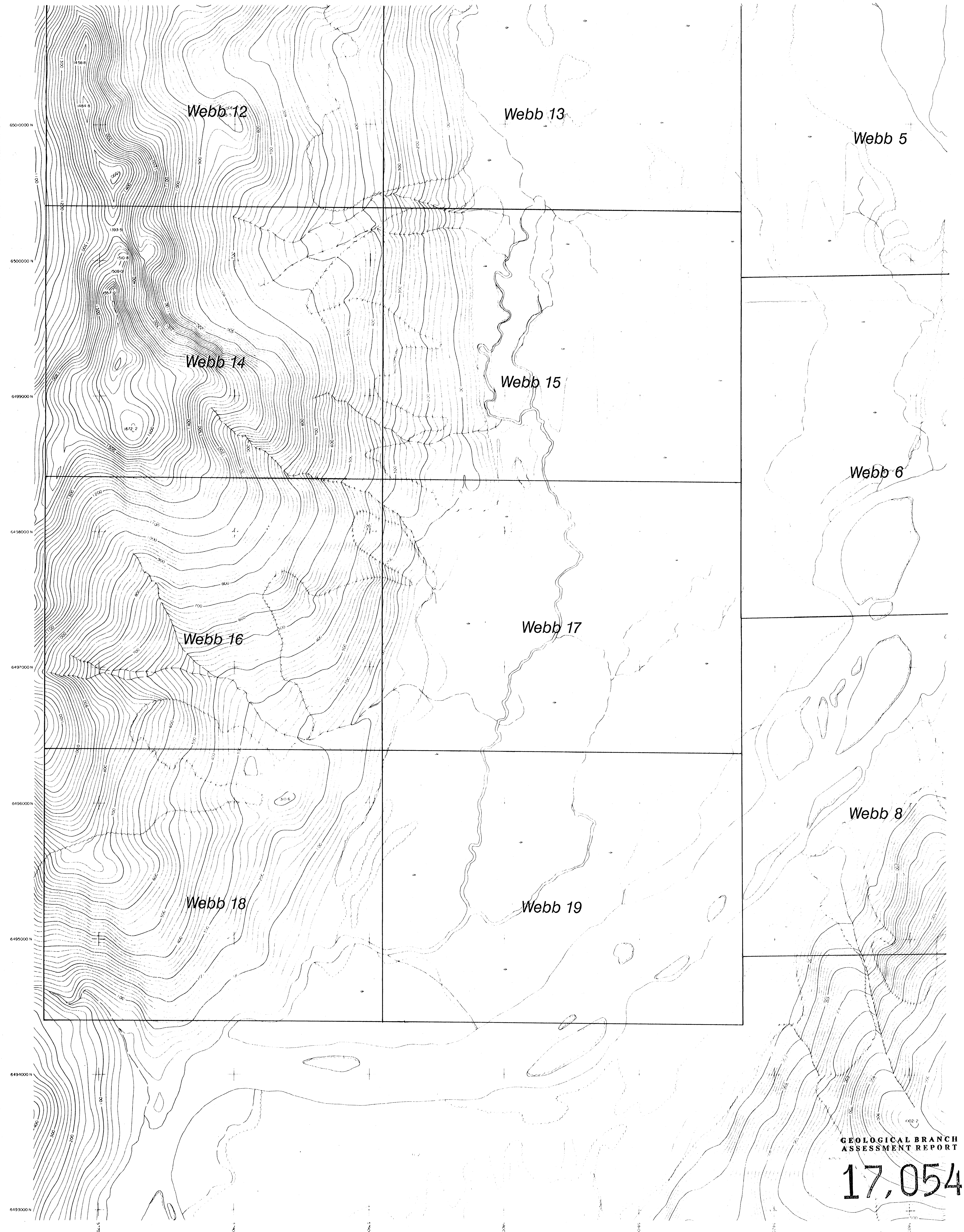


TULSEQUAH RIVER AREA
COMINCO EXPLORATION
Scale 1:10000
Contour Interval 20 m

TRIATHLON MAPPING CORPORATION COM 106

KEY PLAN

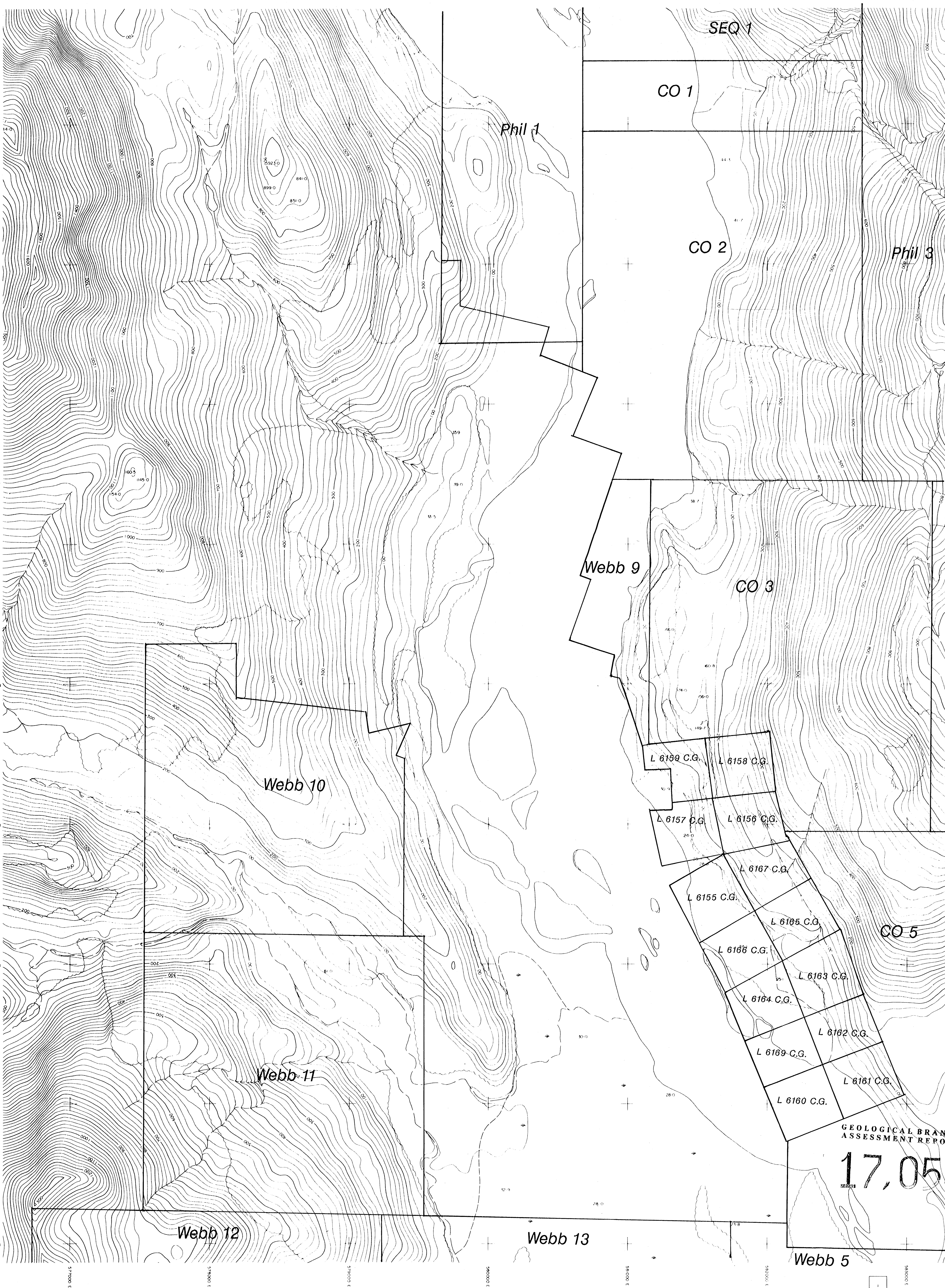
Plate 87-2



TULSEQUAH RIVER AREA
COMINCO EXPLORATION
Scale 1:10000
Contour Interval 20 m

TRIATHLON MAPPING CORPORATION COM 106

Plate 87-5



TULSEQUAH RIVER AREA
COMINCO EXPLORATION
Scale 1:10000
Contour Interval 20 m

Plate 87-4

LEGEND

12 QUATERNARY
- alluvium

11 EARLY TERTIARY INTRUSIONS
(in part equivalent to Sloco Group Volcanic Rocks)
- 11a felsite dikes (undifferentiated)
  - $11a_1$ aphanitic, in part flow banded
  - $11a_2$ plagioclase phenocrysts, vfgr groundmass
  - $11a_3$ quartz ± plagioclase phenocrysts, vfgr groundmass
- 11b quartz monzonite, granodiorite
  - $11b_1$ fine grained, commonly porphyritic
  - $11b_2$ medium to coarse grained
- 11c andesite, diorite dike, sill : aphanitic to fgr
- 11d dacite dike, sill : plagioclase phenocrysts

——— INTRUSIVE CONTACT WITH OLDER ROCKS ———

10 MESOZOIC(?) INTRUSIONS (in part Coast Plutonic Complex)
- 10a granodiorite, quartz monzonite : mgr to cgr
- 10b diorite
  - 10bz with epidote-actinolite alteration
- 10c pyroxenite, biotite pyroxenite
  - 10cz serpentine-carbonate alteration along fault

——— INTRUSIVE CONTACT WITH OLDER ROCKS ———

3-9 PENNSYLVANIAN-PERMIAN (MOUNT EATON GROUP)
(subdivisions are lithological, not stratigraphic)

SEDIMENTARY ROCKS

9 CLASTIC SEDIMENTARY ROCKS
- 9a mudstone, siltstone, ± tuffs, tuffaceous sediments
- 9b siliceous mudstone, siltstone; in part gradational to Subunit 5ts
- 9c interbedded greywacke and mudstone/siltstone, commonly graded beds, possibly AE turbidite sequence

8 CHERT, CALCAREOUS CHERT
- 8a thick bedded to massive
- 8b thin to medium bedded with limestone interlayers, in part rhythmic interlayering
- 8c medium bedded with andesite lenses, inclusions, and irregular dikes and sills

7 LIMESTONE, SILICEOUS LIMESTONE
- 7a thin to thick bedded
- 7b thin to medium bedded with chert interlayers, in part rhythmic interlayering
- 7c thin bedded with mudstone interlayers
- 7d limestone breccia, fragments of limestone and andesite or only andesite in an abundant limestone groundmass
- 7e dolomite

SUFFIXES FOR UNITS 7-9
- f fossiliferous (Unit 7a, 7c)
- m metamorphosed more strongly than normal in contact metamorphic aureole

VOLCANIC, VOLCANOCLASTIC ROCKS, SUBVOLCANIC INTRUSIONS

6 RHYODACITE, RHYOLITE
5 DACITE
4 ANDESITIC DACITE, DACITIC ANDESITE
3 ANDESITE, BASALTIC ANDESITE

SUBSCRIPTS FOR VOLCANIC AND RELATED ROCKS

A. MAGMATIC ROCKS
- a flow, undifferentiated
- ax flow breccia, undifferentiated

(for Unit 3a, 3ax the following subdivisions)
- 3a, 3ax no dominant phenocrysts
- $3a_1$, $3ax_1$ plagioclase phenocrysts prominent
- $3a_2$, $3ax_2$ augite phenocrysts prominent
- $3a_3$, $3ax_3$ plagioclase and augite phenocrysts prominent
- b intrusion (dike, sill, dome)
  - 3bg diabase, gabbro

B PYROCLASTIC ROCKS
- x breccia
- L lapillistone
- Lt lapilli tuff
- Ltx lapilli tuff with prominent breccia-sized fragments
- t tuff
- tx tuff with prominent breccia-sized fragments
- ts tuffaceous sediment, very fine tuff, mainly well and thinly bedded

SUFFIXES FOR UNIT 3
- p pillowed
- v amygdular, vesicular
- c calcareous groundmass (in pyroclastic rocks)

(for andesite fragmental units, the following subdivisions based on nature of fragments

subdivision	fragment type(s)
$3x_1$, $3Lt_1$, $3Ltx_1$	andesite
$3x_2$, etc.	andesite, minor dacite
$3x_3$, etc.	andesite, moderate to abundant dacite
$3x_4$, etc.	andesite, minor to abundant limestone
$3x_5$, etc.	purple andesite, locally abundant limestone; commonly calcareous groundmass

——— FAULT CONTACT ———

2 PRE-PENNSYLVANIAN(?) METAMORPHIC ROCKS (TULSEQUAH GROUP)
(possibly in part equivalent to Mount Eaton group)
(dominantly schist, phyllite, subgneiss; greenschist facies)
- 2a felsic schist, subgneiss, origin uncertain
  - $2a_1$ cataclastically deformed quartz diorite, granodiorite
  - $2a_2$ relatively massive, possibly younger intrusion
- 2b andesite flow, tuff; characterized in most subunits by coarse augite phenocrysts
  - $2b_1$ massive, augite phenocrysts abundant
  - $2b_2$ massive, plagioclase phenocrysts abundant
  - $2b_3$ schistose, augite phenocrysts common
  - $2b_4$ well bedded tuff, lapilli tuff, tuffaceous sediments
  - 2bg gabbro, diorite: coarser variety of $2b_1$ or subvolcanic intrusion; in part porphyritic
- 2c andesite/dacite tuffaceous sediments, tuff, argillitic in part, in part with mudstone/siltstone interlayers; commonly strongly folded
- 2d mudstone, greywacke, siltstone, in part gradational to Unit 2c; in part difficult to distinguish from Unit 9
- 2e limestone, commonly sheared and recrystallized; difficult to distinguish from Unit 7am

——— FAULT CONTACT ———

1 PRE-PENNSYLVANIAN METAMORPHIC ROCKS (WHITEWATER GROUP)
(gneiss, schist, minor phyllite; upper greenschist to amphibolite facies metamorphism)
- 1a felsic gneiss: plagioclase-quartz-biotite-muscovite
- 1b quartz-biotite-muscovite gneiss, quartzite
- 1c intermediate gneiss: plagioclase-quartz-chlorite-biotite-(hornblende-muscovite)
- 1d mafic gneiss: plagioclase-hornblende-chlorite
- 1e argillite, phyllite; in part carbonaceous, graphitic
- 1f tremolite/actinolite-rich lenses (possibly tectonic after alpine peridotite)

ALTERATION AND HYDROTHERMAL MINERALIZATION TYPES
- z quartz-pyrite-sericite (mainly in felsic volcanic rocks near massive sulfide deposits)
- qz quartz
- se sericite
- py pyrite
- cp chalcopyrite
- sl sphalerite
- gl galena
- ap arsenopyrite
- ct calcite
- do dolomite
- ak ankerite
- cl chlorite
- ma mariposite, fuchsite

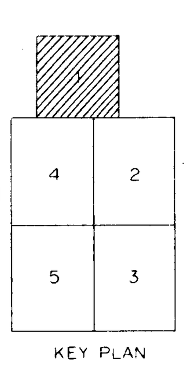
VEIN TYPES
- Qv quartz
- Cv carbonate (calcite, dolomite)
- Ev epidote
- Hv specular hematite
- Pv pyrite
- Av ankerite
- QECv quartz-epidote-carbonate (example of combination)

SYMBOLS
- outcrop border, small outcrop
- geological contact: defined, approximate
- bedding (S_0): tops unknown, known
- trace of S_0 away from traverse line, dip not measured
- foliation (S_1)
- foliation (S_2)
- anticline, showing plunge of fold axis
- syncline, showing plunge of fold axis
- axial plane of minor fold
- minor fold axis, lineation (mainly parallel to minor fold axis)
- joint
- fault: width of line indicates relative importance
- linear depression, possible fault or glacial valley
- border of Quaternary-Recent features: alluvium (Unit 12), glacier, moraine (where these features border on outcrop, the outcrop symbol predominates)
- M moraine
- stream

GEOLOGICAL BRANCH
ASSESSMENT REPORT

17,054

TULSEQUAH RIVER AREA
COMINCO EXPLORATION
Scale 1:10000
Contour Interval 20 m



KEY PLAN

Figure 5. Geology, Mount Eaton Area

TRIATHLON MAPPING CORPORATION COM 106

Plate 87-6

LEGEND

12 QUATERNARY
alluvium

11 EARLY TERTIARY INTRUSIONS
(in part equivalent to Sloco Group Volcanic Rocks)

- 11a felsite dikes (undifferentiated)
  - $11a_1$ aphanitic, in part flow banded
  - $11a_2$ plagioclase phenocrysts, vfgr groundmass
  - $11a_3$ quartz ± plagioclase phenocrysts, vfgr groundmass
- 11b quartz monzonite, granodiorite
  - $11b_1$ fine grained, commonly porphyritic
  - $11b_2$ medium to coarse grained
- 11c andesite, diorite dike, sill : aphanitic to fgr
- 11d dacite dike, sill : plagioclase phenocrysts

——— INTRUSIVE CONTACT WITH OLDER ROCKS ———

10 MESOZOIC(?) INTRUSIONS (in part Coast Plutonic Complex)

- 10a granodiorite, quartz monzonite : mgr to cgr
- 10b diorite
  - 10bz with epidote-actinolite alteration
- 10c pyroxenite, biotite pyroxenite
  - 10cz serpentine-carbonate alteration along fault

——— INTRUSIVE CONTACT WITH OLDER ROCKS ———

3-9 PENNSYLVANIAN-PERMIAN (MOUNT EATON GROUP)
(subdivisions are lithological, not stratigraphic)

SEDIMENTARY ROCKS

9 CLASTIC SEDIMENTARY ROCKS

- 9a mudstone, siltstone, ± tuffs, tuffaceous sediments
- 9b siliceous mudstone, siltstone; in part gradational to Subunit 5ts
- 9c interbedded greywacke and mudstone/siltstone, commonly graded beds, possibly AE turbidite sequence

8 CHERT, CALCAREOUS CHERT

- 8a thick bedded to massive
- 8b thin to medium bedded with limestone interlayers, in part rhythmic interlayering
- 8c medium bedded with andesite lenses, inclusions, and irregular dikes and sills

7 LIMESTONE, SILICEOUS LIMESTONE

- 7a thin to thick bedded
- 7b thin to medium bedded with chert interlayers, in part rhythmic interlayering
- 7c thin bedded with mudstone interlayers
- 7d limestone breccia, fragments of limestone and andesite or only andesite in an abundant limestone groundmass
- 7e dolomite

SUFFIXES FOR UNITS 7-9

- f fossiliferous (Unit 7a, 7c)
- m metamorphosed more strongly than normal in contact metamorphic aureole

VOLCANIC, VOLCANOCLASTIC ROCKS, SUBVOLCANIC INTRUSIONS

- **6** RHYODACITE, RHYOLITE
- **5** DACITE
- **4** ANDESITIC DACITE, DACITIC ANDESITE
- **3** ANDESITE, BASALTIC ANDESITE

SUBSCRIPTS FOR VOLCANIC AND RELATED ROCKS

A MAGMATIC ROCKS

- a flow, undifferentiated
- ax flow breccia, undifferentiated

(for Unit 3a,3ax the following subdivisions)

- 3a, 3ax no dominant phenocrysts
- $3a_1$, $3ax_1$ plagioclase phenocrysts prominent
- $3a_2$, $3ax_2$ augite phenocrysts prominent
- $3a_3$, $3ax_3$ plagioclase and augite phenocrysts prominent
- b intrusion (dike, sill, dome)
  - 3bg diabase, gabbro

B PYROCLASTIC ROCKS

- x breccia
- L lapillistone
- Lt lapilli tuff
- Ltx lapilli tuff with prominent breccia-sized fragments
- t tuff
- tx tuff with prominent breccia-sized fragments
- ts tuffaceous sediment, very fine tuff, mainly well and thinly bedded

SUFFIXES FOR UNIT 3

- p pillowed
- v amygdular, vesicular
- c calcareous groundmass (in pyroclastic rocks)

(for andesite fragmental units, the following subdivisions based on nature of fragments

subdivision	fragment type(s)
$3x_1$, $3Lt_1$, $3Ltx_1$	andesite
$3x_2$, etc.	andesite, minor dacite
$3x_3$, etc.	andesite, moderate to abundant dacite
$3x_4$, etc.	andesite, minor to abundant limestone
$3x_5$, etc.	purple andesite, locally abundant limestone; commonly calcareous groundmass

——— FAULT CONTACT ———

2 PRE-PENNSYLVANIAN(?) METAMORPHIC ROCKS (TULSEQUAH GROUP)
(possibly in part equivalent to Mount Eaton group)
(dominantly schist, phyllite, subgneiss; greenschist facies)

- 2a felsic schist, subgneiss, origin uncertain
  - $2a_1$ cataclastically deformed quartz diorite, granodiorite
  - $2a_2$ relatively massive, possibly younger intrusion
- 2b andesite flow, tuff; characterized in most subunits by coarse augite phenocrysts
  - $2b_1$ massive, augite phenocrysts abundant
  - $2b_2$ massive, plagioclase phenocrysts abundant
  - $2b_3$ schistose, augite phenocrysts common
  - $2b_4$ well bedded tuff, lapilli tuff, tuffaceous sediments
  - 2bg gabbro, diorite: coarser variety of $2b_1$ or subvolcanic intrusion; in part porphyritic
- 2c andesite/dacite tuffaceous sediments, tuff, argillitic in part, in part with mudstone/siltstone interlayers; commonly strongly folded
- 2d mudstone, greywacke, siltstone, in part gradational to Unit 2c; in part difficult to distinguish from Unit 9
- 2e limestone, commonly sheared and recrystallized; difficult to distinguish from Unit 7am

——— FAULT CONTACT ———

1 PRE-PENNSYLVANIAN METAMORPHIC ROCKS (WHITEWATER GROUP)
(gneiss, schist, minor phyllite; upper greenschist to amphibolite facies metamorphism)

- 1a felsic gneiss: plagioclase-quartz-biotite-muscovite
- 1b quartz-biotite-muscovite gneiss, quartzite
- 1c intermediate gneiss: plagioclase-quartz-chlorite-biotite-(hornblende-muscovite)
- 1d mafic gneiss: plagioclase-hornblende-chlorite
- 1e argillite, phyllite; in part carbonaceous, graphitic
- 1f tremolite/actinolite-rich lenses (possibly tectonic after alpine peridotite)

ALTERATION AND HYDROTHERMAL MINERALIZATION TYPES

- z quartz-pyrite-sericite (mainly in felsic volcanic rocks near massive sulfide deposits)
- qz quartz
- se sericite
- py pyrite
- cp chalcopyrite
- sl sphalerite
- gl galena
- ap arsenopyrite
- ct calcite
- do dolomite
- ak ankerite
- cl chlorite
- ma mariposite, fuchsite

VEIN TYPES

- Qv quartz
- Cv carbonate (calcite, dolomite)
- Ev epidote
- Hv specular hematite
- Pv pyrite
- Av ankerite
- QECv quartz-epidote-carbonate (example of combination)

SYMBOLS

- outcrop border, small outcrop
- geological contact: defined, approximate
- bedding (S_0): tops unknown, known
- trace of S_0 away from traverse line, dip not measured
- foliation (S_1)
- foliation (S_2)
- anticline, showing plunge of fold axis
- syncline, showing plunge of fold axis
- axial plane of minor fold
- minor fold axis, lineation (mainly parallel to minor fold axis)
- joint
- fault: width of line indicates relative importance
- linear depression, possible fault or glacial valley
- border of Quaternary-Recent features: alluvium (Unit 12), glacier, moraine (where these features border on outcrop, the outcrop symbol predominates)
- moraine
- stream

GEOLOGICAL BRANCH
ASSESSMENT REPORT
17,054

TULSEQUAH RIVER AREA
COMINCO EXPLORATION
Scale 1:10000
Contour Interval 20 m

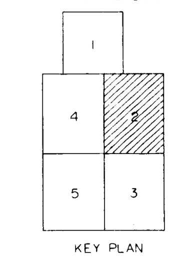

KEY PLAN

Figure 6. Geology, Mount Manville Area

Plate 87-7

TRIATHLON MAPPING CORPORATION COM-106

LEGEND

12 QUATERNARY
alluvium

11 EARLY TERTIARY INTRUSIONS
(in part equivalent to Sloco Group Volcanic Rocks)

- 11a felsite dikes (undifferentiated)
  - $11a_1$ aphanitic, in part flow banded
  - $11a_2$ plagioclase phenocrysts, vfgr groundmass
  - $11a_3$ quartz ± plagioclase phenocrysts, vfgr groundmass
- 11b quartz monzonite, granodiorite
  - $11b_1$ fine grained, commonly porphyritic
  - $11b_2$ medium to coarse grained
- 11c andesite, diorite dike, sill : aphanitic to fgr
- 11d dacite dike, sill : plagioclase phenocrysts

INTRUSIVE CONTACT WITH OLDER ROCKS

10 MESOZOIC(?) INTRUSIONS (in part Coast Plutonic Complex)

- 10a granodiorite, quartz monzonite : mgr to cgr
- 10b diorite
  - 10bz with epidote-actinolite alteration
- 10c pyroxenite, biotite pyroxenite
  - 10cz serpentine-carbonate alteration along fault

INTRUSIVE CONTACT WITH OLDER ROCKS

3-9 PENNSYLVANIAN-PERMIAN (MOUNT EATON GROUP)
(subdivisions are lithological, not stratigraphic)

SEDIMENTARY ROCKS

9 CLASTIC SEDIMENTARY ROCKS

- 9a mudstone, siltstone, ± tuffs, tuffaceous sediments
- 9b siliceous mudstone, siltstone; in part gradational to Subunit 5ts
- 9c interbedded greywacke and mudstone/siltstone, commonly graded beds, possibly AE turbidite sequence

8 CHERT, CALCAREOUS CHERT

- 8a thick bedded to massive
- 8b thin to medium bedded with limestone interlayers, in part rhythmic interlayering
- 8c medium bedded with andesite lenses, inclusions, and irregular dikes and sills

7 LIMESTONE, SILICEOUS LIMESTONE

- 7a thin to thick bedded
- 7b thin to medium bedded with chert interlayers, in part rhythmic interlayering
- 7c thin bedded with mudstone interlayers
- 7d limestone breccia, fragments of limestone and andesite or only andesite in an abundant limestone groundmass
- 7e dolomite

SUFFIXES FOR UNITS 7-9

- f fossiliferous (Unit 7a, 7c)
- m metamorphosed more strongly than normal in contact metamorphic aureole

VOLCANIC, VOLCANOCLASTIC ROCKS, SUBVOLCANIC INTRUSIONS

- **6** RHYODACITE, RHYOLITE
- **5** DACITE
- **4** ANDESITIC DACITE, DACITIC ANDESITE
- **3** ANDESITE, BASALTIC ANDESITE

SUBSCRIPTS FOR VOLCANIC AND RELATED ROCKS

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- a flow, undifferentiated
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(for Unit 3a, 3ax the following subdivisions)

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- $3a_2$, $3ax_2$ augite phenocrysts prominent
- $3a_3$, $3ax_3$ plagioclase and augite phenocrysts prominent
- b intrusion (dike, sill, dome)
  - 3bg diabase, gabbro

B PYROCLASTIC ROCKS

- x breccia
- L lapillistone
- Lt lapilli tuff
- Ltx lapilli tuff with prominent breccia-sized fragments
- t tuff
- tx tuff with prominent breccia-sized fragments
- ts tuffaceous sediment, very fine tuff, mainly well and thinly bedded

SUFFIXES FOR UNIT 3

- p pillowed
- v amygdular, vesicular
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(for andesite fragmental units, the following subdivisions based on nature of fragments

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$3x_4$, etc.	andesite, minor to abundant limestone
$3x_5$, etc.	purple andesite, locally abundant limestone; commonly calcareous groundmass

FAULT CONTACT

2 PRE-PENNSYLVANIAN(?) METAMORPHIC ROCKS (TULSEQUAH GROUP)
(possibly in part equivalent to Mount Eaton group)
(dominantly schist, phyllite, subgneiss; greenschist facies)

- 2a felsic schist, subgneiss, origin uncertain
  - $2a_1$ cataclastically deformed quartz diorite, granodiorite
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  - $2b_1$ massive, augite phenocrysts abundant
  - $2b_2$ massive, plagioclase phenocrysts abundant
  - $2b_3$ schistose, augite phenocrysts common
  - $2b_4$ well bedded tuff, lapilli tuff, tuffaceous sediments
  - 2bg gabbro, diorite: coarser variety of $2b_1$ or subvolcanic intrusion; in part porphyritic
- 2c andesite/dacite tuffaceous sediments, tuff, argillitic in part, in part with mudstone/siltstone interlayers; commonly strongly folded
- 2d mudstone, greywacke, siltstone, in part gradational to Unit 2c; in part difficult to distinguish from Unit 9
- 2e limestone, commonly sheared and recrystallized; difficult to distinguish from Unit 7am

FAULT CONTACT

1 PRE-PENNSYLVANIAN METAMORPHIC ROCKS (WHITEWATER GROUP)
(gneiss, schist, minor phyllite; upper greenschist to amphibolite facies metamorphism)

- 1a felsic gneiss: plagioclase-quartz-biotite-muscovite
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- 1c intermediate gneiss: plagioclase-quartz-chlorite-biotite-(hornblende-muscovite)
- 1d mafic gneiss: plagioclase-hornblende-chlorite
- 1e argillite, phyllite; in part carbonaceous, graphitic
- 1f tremolite/actinolite-rich lenses (possibly tectonic after alpine peridotite)

ALTERATION AND HYDROTHERMAL MINERALIZATION TYPES

- z quartz-pyrite-sericite (mainly in felsic volcanic rocks near massive sulfide deposits)
- qz quartz
- se sericite
- py pyrite
- cp chalcopyrite
- sl sphalerite
- gl galena
- ap arsenopyrite
- ct calcite
- do dolomite
- ak ankerite
- cl chlorite
- ma mariposite, fuchsite

VEIN TYPES

- Qv quartz
- Cv carbonate (calcite, dolomite)
- Ev epidote
- Hv specular hematite
- Pv pyrite
- Av ankerite
- QECv quartz-epidote-carbonate (example of combination)

SYMBOLS

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- trace of S_0 away from traverse line, dip not measured
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- foliation (S_2)
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- minor fold axis, lineation (mainly parallel to minor fold axis)
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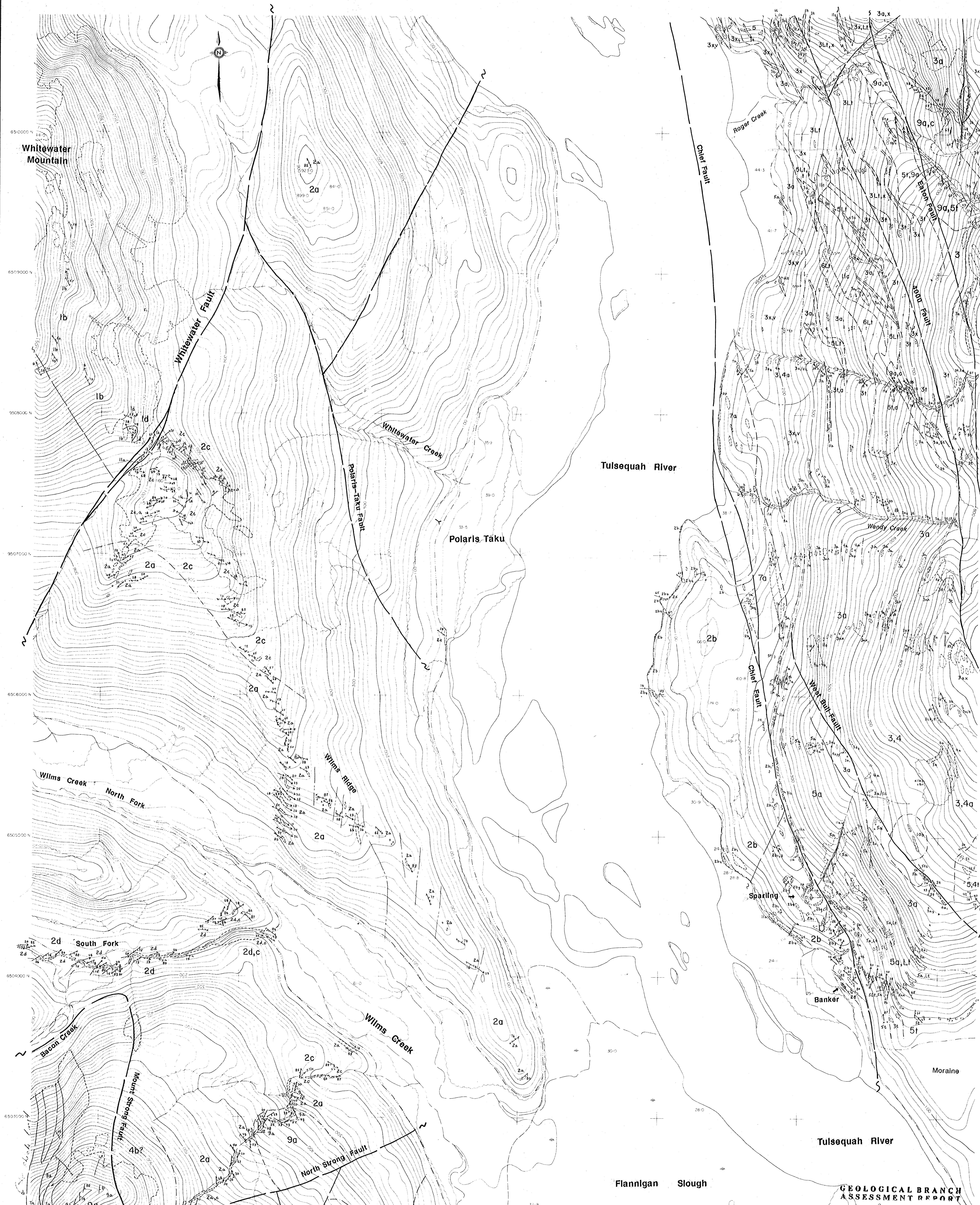
- fault: width of line indicates relative importance
- linear depression, possible fault or glacial valley
- border of Quaternary-Recent features: alluvium (Unit 12), glacier, moraine (where these features border on outcrop, the outcrop symbol predominates)
- M moraine
- stream



GEOLOGICAL BRANCH
ASSESSMENT REPORT
17,054

TULSEQUAH RIVER AREA
COMINCO EXPLORATION
Scale 1:10000
Contour Interval 20 m

Figure 8. Geology, Tulsequah River Area

TRIATHLON MAPPING CORPORATION COM 106

KEY PLAN

Plate 87-9

LEGEND

12 QUATERNARY
alluvium

11 EARLY TERTIARY INTRUSIONS
(in part equivalent to Sloco Group Volcanic Rocks)

- 11a felsite dikes (undifferentiated)
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  - $11a_2$ plagioclase phenocrysts, vfgr groundmass
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- 11b quartz monzonite, granodiorite
  - $11b_1$ fine grained, commonly porphyritic
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- 11c andesite, diorite dike, sill : aphanitic to fgr
- 11d dacite dike, sill : plagioclase phenocrysts

INTRUSIVE CONTACT WITH OLDER ROCKS

10 MESOZOIC(?) INTRUSIONS (in part Coast Plutonic Complex)

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INTRUSIVE CONTACT WITH OLDER ROCKS

3-9 PENNSYLVANIAN-PERMIAN (MOUNT EATON GROUP)
(subdivisions are lithological, not stratigraphic)

SEDIMENTARY ROCKS

9 CLASTIC SEDIMENTARY ROCKS

- 9a mudstone, siltstone, ± tuffs, tuffaceous sediments
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- 7d limestone breccia, fragments of limestone and andesite or only andesite in an abundant limestone groundmass
- 7e dolomite

SUFFIXES FOR UNITS 7-9

- f fossiliferous (Unit 7a, 7c)
- m metamorphosed more strongly than normal in contact metamorphic aureole

VOLCANIC, VOLCANOCLASTIC ROCKS, SUBVOLCANIC INTRUSIONS

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FAULT CONTACT

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  - $2b_3$ schistose, augite phenocrysts common
  - $2b_4$ well bedded tuff, lapilli tuff, tuffaceous sediments
  - 2bg gabbro, diorite: coarser variety of $2b_1$ or subvolcanic intrusion; in part porphyritic
- 2c andesite/dacite tuffaceous sediments, tuff, argillitic in part, in part with mudstone/siltstone interlayers; commonly strongly folded
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- 1f tremolite/actinolite-rich lenses (possibly tectonic after alpine peridotite)

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- sl sphalerite
- gl galena
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- cl chlorite
- ma mariposite, fuchsite

VEIN TYPES

- Qv quartz
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- QECv quartz-epidote-carbonate (example of combination)

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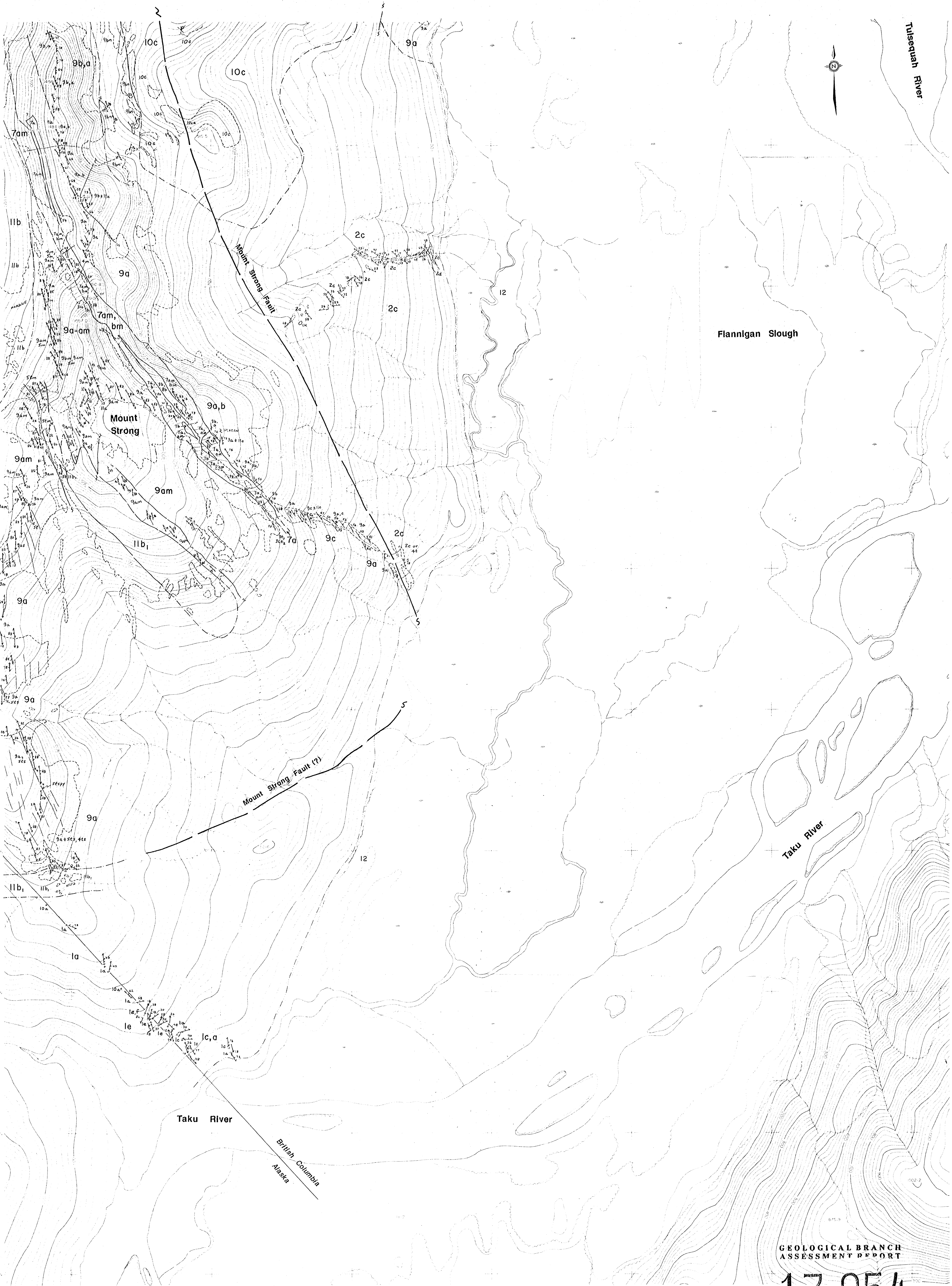

TULSEQUAH RIVER AREA
COMINCO EXPLORATION
Scale 1:10000
Contour Interval 20 m

Figure 9. Geology, Mount Strong Area

KEY PLAN

Plate 87-10

TRIATHLON MAPPING CORPORATION COM 108

LEGEND

12 QUATERNARY
alluvium

11 EARLY TERTIARY INTRUSIONS
(in part equivalent to Sloco Group Volcanic Rocks)
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- 11b quartz monzonite, granodiorite
  - $11b_1$ fine grained, commonly porphyritic
  - $11b_2$ medium to coarse grained
- 11c andesite, diorite dike, sill : aphanitic to fgr
- 11d dacite dike, sill : plagioclase phenocrysts

INTRUSIVE CONTACT WITH OLDER ROCKS

10 MESOZOIC(?) INTRUSIONS (in part Coast Plutonic Complex)
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INTRUSIVE CONTACT WITH OLDER ROCKS

3-9 PENNSYLVANIAN-PERMIAN (MOUNT EATON GROUP)
(subdivisions are lithological, not stratigraphic)

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- f fossiliferous (Unit 7a, 7c)
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$3x_5$, etc.	purple andesite, locally abundant limestone; commonly calcareous groundmass

FAULT CONTACT

2 PRE-PENNSYLVANIAN(?) METAMORPHIC ROCKS (TULSEQUAH GROUP)
(possibly in part equivalent to Mount Eaton group)
(dominantly schist, phyllite, subgneiss; greenschist facies)
- 2a felsic schist, subgneiss, origin uncertain
  - $2a_1$ cataclastically deformed quartz diorite, granodiorite
  - $2a_2$ relatively massive, possibly younger intrusion
- 2b andesite flow, tuff; characterized in most subunits by coarse augite phenocrysts
  - $2b_1$ massive, augite phenocrysts abundant
  - $2b_2$ massive, plagioclase phenocrysts abundant
  - $2b_3$ schistose, augite phenocrysts common
  - $2b_4$ well bedded tuff, lapilli tuff, tuffaceous sediments
  - 2bg gabbro, diorite: coarser variety of $2b_1$ or subvolcanic intrusion; in part porphyritic
- 2c andesite/dacite tuffaceous sediments, tuff, argillitic in part, in part with mudstone/siltstone interlayers; commonly strongly folded
- 2d mudstone, greywacke, siltstone, in part gradational to Unit 2c; in part difficult to distinguish from Unit 9
- 2e limestone, commonly sheared and recrystallized; difficult to distinguish from Unit 7am

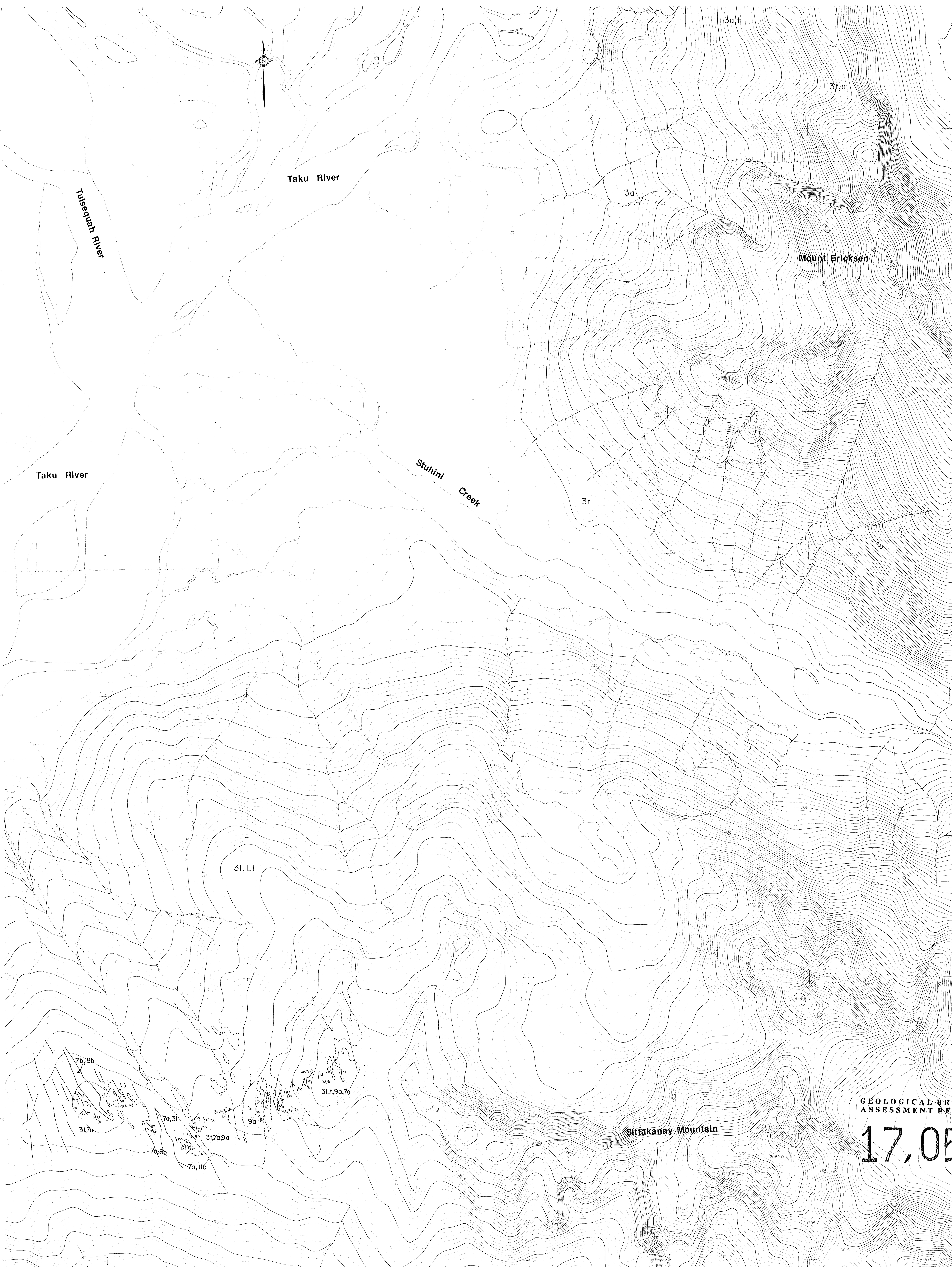
FAULT CONTACT

1 PRE-PENNSYLVANIAN METAMORPHIC ROCKS (WHITEWATER GROUP)
(gneiss, schist, minor phyllite; upper greenschist to amphibolite facies metamorphism)
- 1a felsic gneiss: plagioclase-quartz-biotite-muscovite
- 1b quartz-biotite-muscovite gneiss, quartzite
- 1c intermediate gneiss: plagioclase-quartz-chlorite-biotite-(hornblende-muscovite)
- 1d mafic gneiss: plagioclase-hornblende-chlorite
- 1e argillite, phyllite; in part carbonaceous, graphitic
- 1f tremolite/actinolite-rich lenses (possibly tectonic after alpine peridotite)

ALTERATION AND HYDROTHERMAL MINERALIZATION TYPES
- z quartz-pyrite-sericite (mainly in felsic volcanic rocks near massive sulfide deposits)
- qz quartz
- se sericite
- py pyrite
- cp chalcopyrite
- sl sphalerite
- gl galena
- ap arsenopyrite
- ct calcite
- do dolomite
- ak ankerite
- cl chlorite
- ma mariposite, fuchsite

VEIN TYPES
- Qv quartz
- Cv carbonate (calcite, dolomite)
- Ev epidote
- Hv specular hematite
- Pv pyrite
- Av ankerite
- QECv quartz-epidote-carbonate (example of combination)

SYMBOLS
- outcrop border, small outcrop
- geological contact: defined, approximate
- bedding (S_0): tops unknown, known
- trace of S_0 away from traverse line, dip not measured
- foliation (S_1)
- foliation (S_2)
- anticline, showing plunge of fold axis
- syncline, showing plunge of fold axis
- axial plane of minor fold
- minor fold axis, lineation (mainly parallel to minor fold axis)
- joint
- fault: width of line indicates relative importance
- linear depression, possible fault or glacial valley
- border of Quaternary-Recent features: alluvium (Unit 12), glacier, moraine (where these features border on outcrop, the outcrop symbol predominates)
- moraine
- stream



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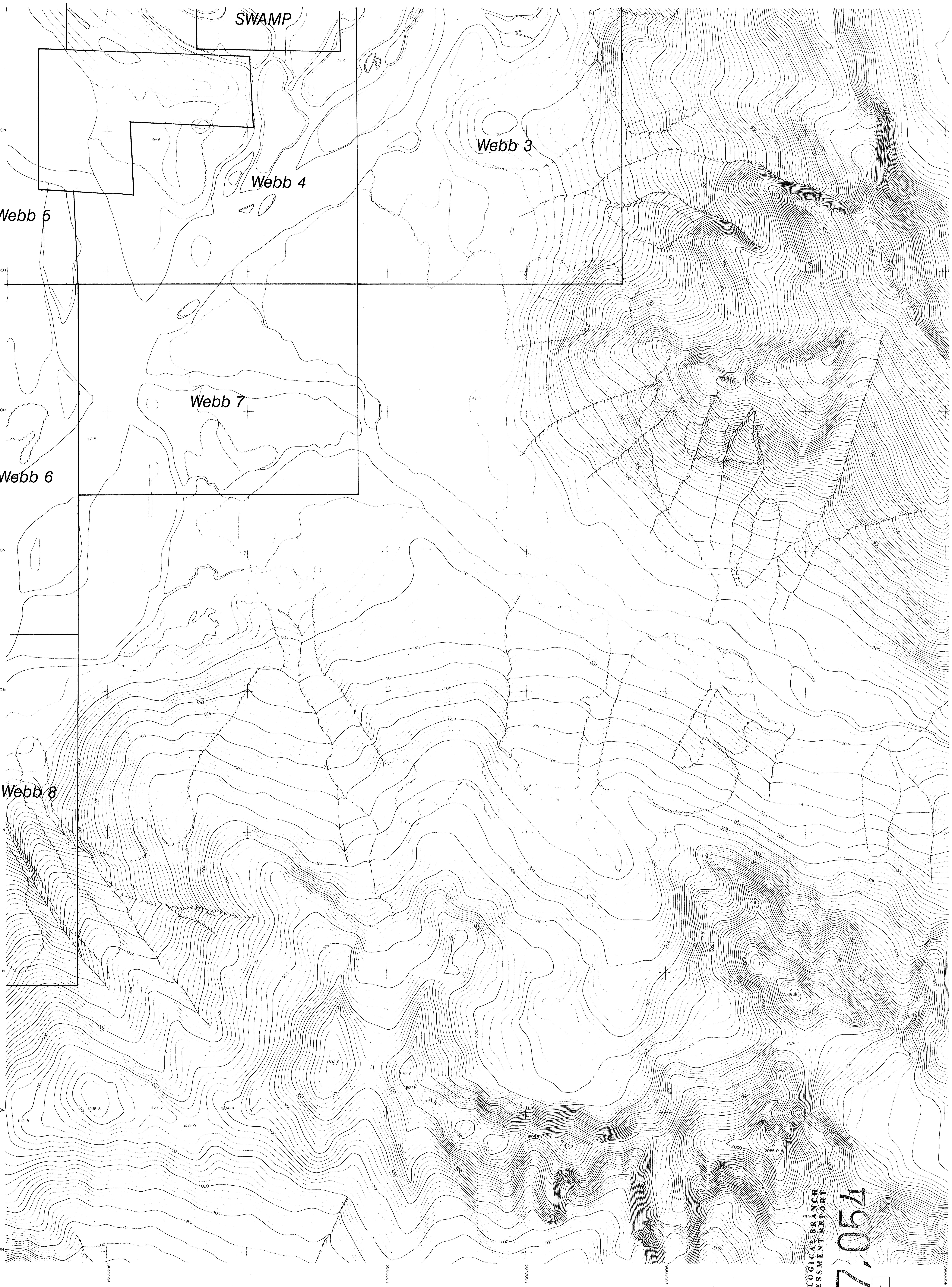
TULSEQUAH RIVER AREA
COMINCO EXPLORATION
Scale 1:10000
Contour Interval 20 m

Figure 7. Geology, Sittakanay Mountain Area

KEY PLAN

Plate 87-8

TRIATHLON MAPPING CORPORATION COM 108



TULSEQUAH RIVER AREA
COMINCO EXPLORATION
Scale 1:10000
Contour Interval 20 m

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KEY PLAN

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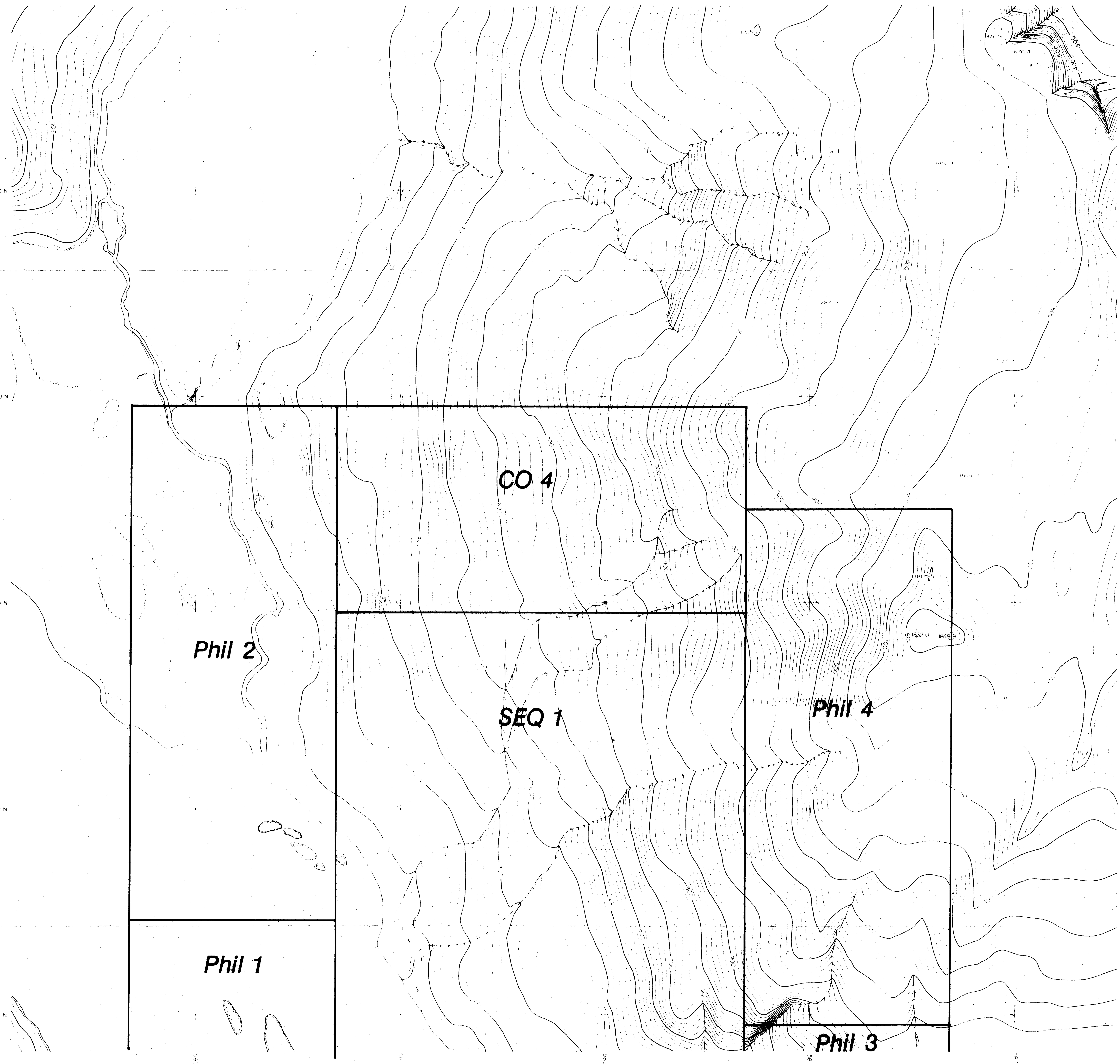
Plate 87-3



TULSEQUAH RIVER AREA
COMINCO EXPLORATION
Scale 1:10000
Contour Interval 20 m

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4	2
5	3

KEY PLAN

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Plate 87-1