TERTIARY STRATIGRAPHY & INDUSTRIAL MINERALS: FRASER RIVER, LYTTON TO GANG RANCH, BRITISH COLUMBIA

OPEN FILE 1988-29

TERTIARY STRATIGRAPHY AND INDUSTRIAL MINERALS, FRASER RIVER: LYTTON TO GANG RANCH, SOUTHWESTERN BRITISH COLUMBIA (92I/5, 92I/12, 92I/13, 92I/16, 92O/1, 92O/8, 92P/4)*

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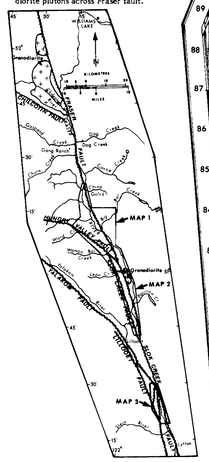
INTRODUCTION

The northerly trending Fraser River Fault System and northwesterly striking Yalakom and subparallel faults slice Eocene and older rocks into fault slivers and wedges ranging from less than a kilometre to more than 50 kilometres in length (Fig. 1). Previous geological investigations by Duffell and McTaggart (1952), Trettin (1961), Tipper (1978), Monger and McMillan (1982), and Mathews and Rouse (1984) have shown differing distributions of the Eocene rocks which are the subject of this investigation. Consequently, rocks shown as Eocene in any of the previous work were mapped and assessed for industrial minerals. Significant areas of rocks previously mapped as Eocene are now re-assigned to the Lower Cretaceous Spences Bridge Group. Such an area lies upstream from Lillooet along the Fraser River between Siok Creek and Fraser faults. Because of the difficulty in distinguishing Eocene from Lower Cretaceous volcanics, four new radiometric dates augment those reported by Mathews and Rouse (1984) and together with field criteria form the basis for separating Eocene from Lower Cretaceous volcanic rocks. In the field, Lower Cretaceous volcanics are selectively amygdaloidal, and complexly jointed and veined in contrast with the vesicular, simply jointed and unveined Eocene rocks. The distinction is important because all occurrences of industrial minerals are in Eocene rocks.

East of Lillooet, two major faults, the eastern Fraser fault and the western Hungry Valley - Siok Creek faults divide the rocks into eastern and western blocks separated by a middle wedge. The eastern block and middle wedge have similar Eocene volcanics and Lower Cretaceous sediments and volcanics, but dissimilar earlier rock units; the western block lacks Eocene rocks and Lower Cretaceous volcanics.

Figure 1:
Regional map showing strands of the Fraser River Fault System, Yalakom and subparallel faults, and the distribution of granodiorite plutons across Fraser fault.



STRATIGRAPHY

(a) Eastern Block

The Pavilion Beds (Trettin, 1961) or western facies of the Cache Creek Complex contains basic flows, breccia and tuff with minor volcaniclastic sediments and rare limestone of unit **PPv**, and a second unit ranging from grey phyllite to ribbon chert (**PPtp**). Deformation and subgreenschist to chlorite zone regional metamorphism affected the complex prior to intrusion of the radiometrically dated metadiorite of the Late Jurassic Tiffin Creek stock (**Ldi**). Undated postkinematic granodiorite to diorite plutons (**gd**) intrude the complex and are shattered adjacent to Fraser fault. Although only plagiphyric flows and breccia (**IKsw**) represent the Spences Bridge Group within the map area, Trettin (1961) included the volcaniclastic sediments lying east of the mouth of Fountain Creek and beyond the map area. A single outcrop of pebble to boulder conglomerate (**mKcg**) lies east of the fault south of Glen Fraser. Although correlated with the mid-Cretaceous conglomerate mapped by Mortimer (1987) near Pavilion Creek, it may lie at the base of the Eocene succession as suggested by Duffell and McTaggart (1952, p. 66). Brownish weathering, Swiss-cheese appearing cliffs of aphanitic grey breccia, bentonitic brown andesite and white rhyolite breccia, and minor flows of dated Middle Eocene age (**Evdx**) comprise a westerly dipping succession locally preserved east of its truncation along Fraser fault.

(b) Middle Wedge

The oldest rocks are Lower Cretaceous conglomerate to argillite (**IKss**) which underlie volcanics (**IKsw**) and together compose the Spences Bridge Group. These rocks probably represent part of the faulted transition from the sediments of the Jackass Mountain Group to the west, which do not contain flows or volcanic breccias, and the contemporaneously deposited but volcanic-dominated Spences Bridge Group to the east. The Eocene succession consists mainly of varicoloured aphanitic volcanics ranging from andesite to rhyolite flows, breccia and tuff and local tuffaceous sediments all underlying a distinctive volcanic conglomerate (**Ecg**), which ranges from 200 to 400 metres in thickness, and bentonitic siltstone and shale (**Ep**). The rhyolite and rhyodacite units (**Evr, Evo,** and **Evox**) are common throughout the succession only on the east side of the wedge where they are intercalated with grey, brown and maroon andesite and dacite breccias (**Evdx**). All of these rock units diminish westward at the expense of widespread grey aphanitic andesite and dacite flows (**Evd**). The thickness of Eocene rocks ranges widely from 200 metres, north of Crows Bar Creek to more than 1500 metres in Ward and French Bar creeks where the base of Eocene rocks is not exposed. The extent to which post-Eocene faulting or relief on the basal Eocene unconformity controls the thickness of the Eocene is unknown.

(c) Western Block

An undetermined but great thickness of volcaniclastic sediments of the Jackass Mountain Group (**IKJM**) forms the western block.

Dated Pliocene basalt flows (**Pvb**) and fluviatile conglomerate (**Ps**) of the Chilcotin Group (Bevier, 1983) form an undisturbed cap across the Siok Creek and Fraser faults south of Leon Creek. Along Big Bar Creek remnants of Miocene basalt flows (**Mvb** and fluviatile sediments (**Ms**) overlie the Cache Creek Complex (Mathews, in press). Close to the present course of the Fraser River, from north of Crows Bar Creek to Leon Creek, undated basalt flows (**MPvb**) and local sediments (**MPs**) form erosional remnants lapped against the old valley walls. The age subdivisions of the Chilcotin Group exist because rocks of Pliocene and Miocene ages cannot be distinguished except by dating.

FRASER RIVER FAULT SYSTEM: AGE & MAGNITUDE OF DISPLACEMENT

Subhorizontal slickensides on Fraser and Siok Creek faults indicate that the last movements were strike-slip. The occurrence of similar Lower Cretaceous sediments and volcanics of the Spences Bridge Group and rocks of Eocene age on both sides of Fraser fault restricts significant strike-slip displacement on the fault to pre-late Early Cretaceous. The fault truncates an undated Jura-Cretaceous granodiorite pluton near the mouth of Leon Creek east of the fault and an apparently similar pluton, mapped by Tipper (1959, 1978) immediately west of the fault, near and north of the mouth of Chilcotin River (Fig. 1). If these plutons are faulted portions of a former single body, then the displaced southern contact of the pluton against the Triassic wallrocks records a dextral strike-slip fault displacement of 90 kilometres since intrusion. If the wallrocks differ, as Tipper suggests (pers. comm. 1988), then pre-intrusion, post-Late Triassic displacement is also significant. Because the southern limit of Eocene rocks on both side of the fault shows little difference, the post-Eocene portion of displacement need not exceed a few tens of kilometres.

Eocene rocks and Lower Cretaceous volcanics are absent west of Siok Creek fault where the Lower Cretaceous strata are sediments of the Jackass Mountain Group. The distribution of rock units across Siok Creek Fault implies post-Eocene movement which is probably dextral strike-slip but is of unknown magnitude. The apparently different ages of fault movement on two faults of the Fraser River Fault System, suggest that a fault solution for one is not necessarily applicable to the others. Siok Creek and Fraser faults join southeast of Lillooet. Because the rock unit distribution south of the junction is similar to that across Siok Creek fault north of the junction, namely Jackass Mountain Group without Eocene rock units underlies the western block and Spences Bridge Group and other rock units comprise the eastern block, Siok Creek fault continues south of the junction.

INDUSTRIAL MINERALS

Within the map area, industrial minerals are present in Eocene rocks and absent from Cretaceous units (Table 1).

(a) Perlite

At EM0554550mE, EM5669450mN and 5225 feet (1595 m) on the ridge northwest of Moore Lake, flow-layered perlite (**P1**) outcrops over a minimum thickness of 10 metres with top and bottom contacts unexposed. In a blow torch test of a sample from this locality, it expanded to about 50% of the volume attained by expanding perlite from Aurun Mines Ltd. property near Higginbottom Creek north of the map area (Table 2).

(b) Volcanic glass

The remainder of materials collected as possible perlite showed no expansion upon heating with a blow torch, and are reported as volcanic glass localities. On the southwest face of the ridge northeast of Moore Lake between 4950 and 5300 feet (1510 to 1615 metres) and a generalized location of EM0555900mE, EM5667925mN (**G1**) are outcrops of medium to dark grey, flow layered volcanic glass. The attitudes of the flow layering on the ridge north of Moore Lake suggest that the volcanic glass and perlite localities may lie at the same horizon which outlines a northwesterly trending and horizontally plunging, upright syncline with a preserved hinge line 2500 metres long. The volcanic glass and perlite near Moore Lake probably lies at a stratigraphically deeper level than the glass near Mooney's Ranch. On a unused portion of the farm road descending to Mooney's Ranch, a small roadcut exposes medium to dark grey volcanic glass (**G2**) at EM0562800mE, EM5663750mN and 3550 feet (1080 metres). At 1.4 kilometres to the southeast on the ridge crest on the north side of Ward Creek (EM0563700mE, EM5664700mN), a subvertical volcanic glass (**G3**) of unknown thickness outcrops for 45 metres along strike before passing northwestward beneath overburden. The latter two glass localities may connect in subcrop to yield a steeply dipping body of 1300 metres strike length but unknown thickness.

(c) Bentonite

Bentonite-rich rocks subcrop at several localities within the middle wedge north of Watson Bar Creek, and in the southwest-dipping succession of Eocene rocks in the east block near Fraser fault. Most bentonite probably developed as lenses within fine, locally waterlain, andesite breccia. Within the middle wedge, the most extensive areas of bentonite lie along the northeastern side between Big Bar and Crows Bar creeks. Straddling Crows Bar Creek is a northwesterly elongate area (**B1**), 500 by 1500 metres, centred at EM0556300mE, EM5683650mN and 2100 feet elevation (640 metres). The rounded hills expose slumped bentonite with bentonitic shale, siltstone, maroon and brown andesite breccia, and rhyolite tephra. Southeastward an 8-kilometre-long outcrop gap, probably underlain by bentonitic rocks, separates locality **B1** from **B2** where bentonite subcrops in a northwesterly elongate area, 300 by 2500 metres, of rounded hills and landslides best displayed at EM0560700mE, EM5674000mN and 2450 feet (745 metres) elevation. Some cream-weathering rhyolite tephra and brown- and maroon-weathering, fine andesite breccia layers and lenses lie within the bentonite. This bentonite-rich area is the source of debris flows and a block slide which flowed through a breach in the volcanic conglomerate cliffs and dropped nearly 300 metres to the Fraser River. The two bentonite-rich areas lie either immediately above or below the volcanic conglomerate. To the southeast, between Big Bar Ferry and Watson Bar Creek, bentonitic rocks lie lower in the stratigraphy beneath andesite breccia and acid flows and tephra. In a northwesterly elongate area about 1 by 3 kilometres, straddling Ward Creek, bentonite lenses up to a few metres in thickness are scattered through fine, varicoloured andesite breccia, acid tephra, and bedded volcaniclastic sediments. Exposures centred at EM0562500mE, EM5664900mN and 3300 feet (1005 metres) (**B3**), and EM0564400mE, EM5662100mN and 3400 feet (1035 metres) (**B4**) typify the fenticular and impure nature of the bentonite. The southernmost occurrence of bentonite (**B7**), northwest of Glen Fraser at EM0580100mE, EM5631100mN and 1600 feet (490 metres), has similar host rocks.

Of the two bentonite localities northeast of Fraser fault, the bentonite (**B5**) at EM0578100mE, EM5638350mN and 1850 feet (565 metres), is spatially related to cream-weathering acid tephra, and maroon- and brown-weathering andesite breccia. The bentonite slope (**B6**) at EM0579400mE, EM5638100mN and 1500 feet (455 metres) appears free of intercalated volcanic breccia.

(d) Zeolites

Zeolitized wahlerite rhyolite ash occurs in intercalated rhyolite and andesite tephra up to 1000 metres beneath the volcanic conglomerate. At locality **Z1**, 3.2 kilometres north-northwest of the mouth of Crows Bar Creek at EM0554000mE, EM5685430mN and 1900 feet (580 metres), samples from the north end of a more than 700-metre-long lens of bedded rhyolite tephra contain intermediate compositions in the heulandite group. At locality **Z2**, 1.3 kilometres northwest of Mooney's Ranch at EM0563800mE, EM5667250mN and 2950 feet (900 metres), a poorly exposed bedded tephra layer over 5 metres thick, with neither top nor bottom contact exposed, contains a clinoptilolite-rich intermediate member of the heulandite group. Although all seven samples from these localities yield heulandite-clinoptilolite, both localities require detailed sampling. Locality **Z3**, 2.2 kilometres southeast of Mooney's Ranch at EM0564000mE, EM5665350mN and 3350 feet (1020 metres), a hundred-metre-thick rhyolite tephra is variably zeolitized with clinoptilolite. Other clinoptilolite-bearing tephra occurrences are at EM0563900mE, EM5664000mN and 2925 feet (890 metres) (**Z4**), and EM0566350mE, EM5660900mN and 2100 feet (640 metres) (**Z5**). Within and up to 100 metres beneath the volcanic conglomerate, local tuffaceous arenite layers are weakly zeolitized with clinoptilolite. X-ray diffraction and thermal stability investigations of Boles (1972), form the basis for the heulandite to clinoptilolite designations within the heulandite group, but the materials await analyses for exchangeable cations and cation exchange capacity.

TABLE 1
INDUSTRIAL MINERALS NEAR THE FRASER RIVER: FOUNTAIN CREEK TO CHINA GULCH

Loc #	Property	Commodity	Status	Location Easting	Location Northing	Cert	Minfile Number
CROWS BAR TO BIG BAR CREEK:							
B1	Crows Bar	Bentonite	Showing	EM0556300	EM5683650	1	092OSE098
B2	French Bar	Bentonite	Showing	EM0560700	EM5674000	1	092OSE099
Z1	L3155	Zeolite	Showing	EM0554000	EM5685450	1	092OSE100
WARD CREEK TO WATSON BAR CREEK:							
B3	N. Ward Creek	Bentonite	Showing	EM0562300	EM5664900	1	092OSE101
B4	S. Ward Creek	Bentonite	Showing	EM0564400	EM5662100	1	092OSE102
G1	Moore Lake	Volcanic glass	Showing	EM0555900	EM5667925	1	092OSE103
G2	Mooney's Ranch	Volcanic glass	Showing	EM0562800	EM5663750	1	092OSE104
G3	Ward Creek	Volcanic glass	Showing	EM0563700	EM5664700	1	092OSE105
P1	French Bar Creek	Perlite	Showing	EM0554550	EM5669450	1	092OSE106
Z2	North Mooney's	Zeolite	Showing	EM0563800	EM5667250	1	092OSE107
Z3	South Mooney's	Zeolite	Showing	EM0564000	EM5664550	1	092OSE108
Z4	Ward Canyon	Zeolite	Showing	EM0563900	EM5664000	1	092OSE109
Z5	Watson Bar	Zeolite	Showing	EM0566350	EM5660900	1	092OSE110
McKAY CREEK TO GLEN FRASER:							
B5	W. Blue Ridge	Bentonite	Showing	EM0578100	EM5638350	1	092INW092
B6	E. Blue Ridge	Bentonite	Showing	EM0579400	EM5638100	1	092INW093
B7	Glen Fraser	Bentonite	Showing	EM0580100	EM5631100	1	092INW094

TABLE 2
PERLITE AND VOLCANIC GLASS: BLOW TORCH EXPANSION DATA

Loc #	Property	Commodity	Location Easting	Location Northing	Expansion*	Comments
	Aurun Mine	Perlite	EM0545250	EM5687900	100%	all expanded
P1	French Bar Creek	Perlite	EM0554550	EM5669450	50	some unexpanded inclusions
G1	Moore Lake	Volcanic glass	EM0555800	EM5668300	0	no expansion
G1	Moore Lake	Volcanic glass	EM0560930	EM5667580	0	no expansion
G1	Moore Lake	Volcanic glass	EM0555850	EM5668330	0	no expansion
G2	Mooney's Ranch	Volcanic glass	EM0562800	EM5663750	0	no expansion
G3	Ward Creek	Volcanic glass	EM0563700	EM5664700	0	no expansion

* Percentage of expansion relative to Aurun Mine Ltd. perlite taken as 100% expansion.

TABLE 3A
PALYNOLOGY, LYTTON TO GANG RANCH

Map No.*	UTM Coordinates Easting	Northing	Elev. Feet	Rock Unit	Age & (Reference)
CHILCOTIN GROUP					
F5	EM0568000	EM5661700	1300	**Mvb**	Middle Miocene (Mathews & Rouse, 1984)
Unnamed Eocene Units:					
F1	EM0563550	EM5683830	2100	**Eeg**	Middle Eocene (Mathews & Rouse, 1984)
F2	EM0561150	EM5671600	1950	**Eeg**	probably Eocene (Trettin, 1961)
F3	EM0560750	EM5671650	1500	**Eeg**	Middle Eocene (Mathews & Rouse, 1984)
F4	EM0562230	EM5664840	3300	**Eefs**	Eocene (this study)
SPENCES BRIDGE GROUP					
F7	EM0579500	EM5632070	800	**IKsss**	indeterminate (this study)
F8	EM0571900	EM5630530	775	**IKsss**	Albian (Trettin, 1961)
JACKASS MOUNTAIN GROUP					
F6	EM0563330	EM5638270	2150	**IKJm**	probably Albian (this study)

TABLE 3B
RADIOMETRIC DATING, LYTTON TO GANG RANCH

Map No.*	UTM Coordinates Easting	Northing	Elev. Feet	Rock Unit	Age & (Reference)
CHILCOTIN GROUP					
R6	EM0575600	EM5646700	4000	**Pvb**	2.2±0.3 Ma (Bevier, 1983)
Unnamed Eocene Units:					
R2	EM0561400	EM5671900	2000	**Evdx**	52.0±1.8 Ma (Mathews & Rouse, 1984)
R3	EM0560700	EM5667750	2050	**Evdx**	39.8±1.5 Ma (Mathews & Rouse, 1984)
R4	EM0561675	EM5662750	1850	**Evr**	47.3±1.7 Ma (Mathews & Rouse, 1984)
R7	EM0579500	EM5638090	1400	**Evdx**	48.1±1.7 Ma (this study)
R9	EM0580360	EM5631070	1700	**Evdx**	49.4±2.1 Ma (Monger & McMillan, 1982)
R10	EM0582005	EM5629980	1350	**Evr**	46.4±1.6 Ma (this study)
SPENCES BRIDGE GROUP					
R1	EM0553180	EM5688060	2050	**IKsw**	90.0±3.2 Ma (Mathews & Rouse, 1984)
R5	EM0570850	EM5650150	3800	**IKsw**	89.7±3.1 Ma (this study)
R8	EM0577170	EM5634900	2275	**IKsw**	81.0±2.4 Ma (this study)

*Map Numbers are assigned to fossil and radiometric dating collections in order of increasing number and letter for decreasing UTM northings.

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* This project is a contribution to the Canada/British Columbia Mineral Development Agreement.

Geological boundary (defined; approximate; assumed)

Fault (defined, with slickensides; approximate; assumed; dip of fault plane inclined; reverse fault, peg side down; strike-slip fault; (beneath bedrock units)

Bedding (inclined; vertical)

Flow layering (inclined; vertical)

Foliation (inclined; vertical)

Trace of axial surface (syncline or synform; anticline or antiform; (beneath bedrock units); (upright (phase determined); inclined (phase undetermined); upright (phase undetermined); inclined (phase determined))

Surface trace of base of slide block

Movement direction of slide block

Zeolite-bearing (minor component; major component) (Z4)

Bentonite-bearing (minor component; major component) (B5)

Perlite (P3)

Volcanic glass (G4)

Radiometric date

location and rock type	material or mineral	method	46 age in millions of years
● igneous	h amphibole	K potassium-argon	
◇ sedimentary	b biotite		
	f plagioclase		
	s sanidine		
	w whole-rock		

Limit of mapping

Geology: Geotex Consultants Limited: P.B. Read 1987

1:50000

LEGEND (MAP 3)

CRETACEOUS OR EOCENE

KTs Granitic pebble to boulder conglomerate, arkose; rare grey siltstone, shale; maroon sedimentary breccia at north end

KTv Maroon basalt flows and breccia

SLOK CREEK, CANTILEVER & LILLOOET FAULTS

CRETACEOUS
LOWER CRETACEOUS
JACKASS MOUNTAIN GROUP
IKJm Feldspathic wacke, grey-green siltstone and argillite; minor conglomerate

CRETACEOUS AND(?) JURASSIC
LOWER CRETACEOUS AND(?) OLDER
RELAY MOUNTAIN GROUP
JKsm Argillite, siltstone, sandstone; local conglomerate

TRIASSIC AND(?) JURASSIC
MOUNT LYTTON PLUTONIC COMPLEX
gJgd Granodiorite, quartz monzonite
LJdi Diorite; minor amphibolite
LJm Layered amphibolite, quartzofeldspathic rocks; rare mylonite

PERMIAN TO JURASSIC
BRIDGE RIVER COMPLEX
PJss Phyllitic greenstone; minor tuffaceous wacke, grey phyllite

LEGEND (MAPS 1 & 2)

QUATERNARY
PLEISTOCENE AND RECENT
Qal(Ecg) Unconsolidated sediments; glacial deposits, colluvium and alluvium; few if any outcrops; probable subcrop unit within parentheses

TERTIARY
PLIOCENE
CHILCOTIN GROUP
Pvb Vesicular and amygdaloidal basalt flows
Ps Pebble and cobble conglomerate; minor sandstone

MIOCENE
CHILCOTIN GROUP
Mvb Vesicular and amygdaloidal basalt flows
Ms Pebble and cobble conglomerate; minor sandstone

MIOCENE AND/OR PLIOCENE
CHILCOTIN GROUP
MPvb Vesicular and amygdaloidal basalt flows
MPs Pebble and cobble conglomerate; minor sandstone

MIDDLE WEDGE

TERTIARY
MIDDLE EOCENE

Ecg Volcanic pebble to cobble conglomerate; minor sandstone
Ep Brown-weathering bentonitic shale and siltstone
Ef Fine porphyritic (biotite, hornblende, quartz feldspar) quartz monzonite and granodiorite dikes
Evr White-weathering, aphanitic to porphyritic (quartz, feldspar) rhyolite flows
Evo Flow-layered feldspar-phyric rhyolite and rhyodacite flows, locally perlitic; breccia
Evox White-weathering, locally zeolitized, layered rhyolite and rhyodacite tuff and breccia; bentonite-rich where intercalated with
E-vdx Grey, brown and maroon-weathering aphanitic and plagiphyric dacite and andesite breccia, minor flows; minor white rhyolite tuff and breccia
Evd Grey and maroon aphanitic and plagiphyric andesite and dacite flows
Eefs Tuffaceous wacke, lithic tuff; minor brown, grey and maroon volcanic breccia; rare quartz sandstone

CRETACEOUS

LOWER CRETACEOUS
SPENCES BRIDGE GROUP
IKsv Grey and maroon plagiphyric dacite, andesite; minor basalt flows
IKss Volcanic arenite, conglomerate; minor siltstone, phyllitic argillite; rare carbonaceous shale

EASTERN BLOCK

TERTIARY
MIDDLE EOCENE

Evdx Grey, brown and maroon-weathering aphanitic and plagiphyric dacite and andesite breccia, minor flows; minor white rhyolite tuff and breccia

CRETACEOUS
MIDDLE CRETACEOUS
mKcg Pebble to boulder conglomerate

LOWER CRETACEOUS
SPENCES BRIDGE GROUP
IKsw Grey and maroon plagiphyric dacite, andesite; minor basalt flows

EARLY CRETACEOUS OR OLDER
gd Granodiorite, quartz diorite, diorite

JURASSIC
LATE JURASSIC
LJdi **Tiffin Creek stock:** Hornblende metadiorite

PENNSYLVANIAN TO TRIASSIC
CACHE CREEK COMPLEX
PPv Massive greenstone and green phyllite; rare light grey limestone
PPtp Grey phyllite and siliceous phyllite, ribbon chert and massive chert

Province of British Columbia — Ministry of Energy, Mines and Petroleum Resources

Energy, Mines and Resources Canada — Énergie, Mines et Ressources Canada

This project is a contribution to the Canada – British Columbia Mineral Development Agreement, 1985 – 1990