GEOLOGICAL SURVEY OF CANADA

DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 68-33

MESOZOIC AND CENOZOIC GEOLOGY OF THE NORTHEAST PART OF MOUNT WADDINGTON MAP-AREA (92 N), COAST DISTRICT, BRITISH COLUMBIA

(Report, 8 figures and Map 5-1968)

H. W. Tipper

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Price $2.00 Catalogue No. M44-68-33

Price subject to change without notice

ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, Canada
1969

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ABSTRACT

The northeastern part of Mount Waddington map-area is underlain mainly by Upper Triassic to Tertiary volcanic and sedimentary rocks. The Upper Jurassic and Lower Cretaceous rocks were deposited in the northwest-trending Tyaughton Trough. Small stocks of granitic rocks were emplaced in post-Cenomanian time within the mapped part of the area and to the southwest.

In Late Cretaceous or early Tertiary time the area was disrupted first by northeasterly directed thrust faults, later by repeated movement on northwest-trending, right-lateral transcurrent faults, and finally by northeast-trending normal faults.

Frontispiece: Tatlayoko Lake. View southerly toward Homathko River Valley and the Coast Mountains. (GSC 200776)

MESOZOIC AND CENOZOIC GEOLOGY OF THE NORTHEAST PART OF MOUNT WADDINGTON MAP-AREA (92N), COAST DISTRICT, BRITISH COLUMBIA

INTRODUCTION

Mount Waddington map-area lies between 51° and 52°N and 124° and 126°W, mainly within the eastern part of the Coast Mountain physiographic area (Holland, 1964, pp. 38-39). It is characterized by rugged mountains, many of which exceed 9,000 feet elevation with local relief of 7,000 feet or more and only in the northeast quarter is there subdued topography and moderate relief.

The Chilcotin Highway crosses the northeastern part of the map-area. Williams Lake, 120 miles to the east, is the rail-head and supply centre for the area. Except for the northeast quarter, which has a few secondary and many bush and ranch roads, the map-area is generally inaccessible to motor vehicles.

Only the northeastern part of the area, defined roughly as that area lying northeast of a line drawn from the south end of Chilko Lake northwestward to 52°N, 125°W was studied by the writer. Within this region the sedimentary and volcanic rocks were studied in much greater detail than the plutonic and metamorphic rocks. Some of the sedimentary and volcanic rocks received greater attention than others because of a greater abundance of fossils or more easily recognized lithologic units. For these and other reasons all of the area under consideration did not receive uniform study.

ACKNOWLEDGMENTS

J.A. Jeletzky of the Geological Survey of Canada devoted one month to the study of the Lower Cretaceous and Upper Jurassic sections, particularly the Relay Mountain Group, and contributed greatly to the understanding of these rocks. Many of the ideas and much of the information presented in this report are a result of his work or have evolved through discussion and co-operation in the field and subsequently. The responsibility for the present report, however, lies with the writer. The report was critically read by R.B. Campbell.

Ms received: 21 March, 1968

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Ottawa, Ontario.

Field assistants were James Simpson, David Watkins, James Crawford, Robert Woodsworth, Robert Park, Arthur Mitchell, Kenneth Dahlman, Barry Calder and James Lau and their willing co-operation and conscientious assistance contributed greatly to the success of the project and is gratefully acknowledged.

The project was dependent for support on a Bell 47G3B-1 helicopter supplied by Spartan Air Services, Calgary, Alberta. The pilot, Ralph Hancock, provided capable and efficient service in an area that demanded perfection in flying ability.

The residents of the area extended many courtesies and materially aided to the success of the project. In particular the writer wishes to mention Mr. and Mrs. Ken Haynes and Mr. and Mrs. A. Bracewell of Tatlayoko Lake, Mr. and Mrs. Fred Linder and Mr. and Mrs. William Graham of Tatla Lake and Mrs. A. Nicholson of Tatla Lake who acted as cook.

PREVIOUS WORK

Little geological work had been attempted in the map-area prior to the present study. G.M. Dawson of the Geological Survey of Canada visited the area briefly in 1876 (Dawson, 1877, pp. 233-265) as did J.D. Galloway of the British Columbia Department of Mines in 1916 (Galloway, 1917). V. Dolmage of the Geological Survey of Canada conducted reconnaissance surveys of parts of the area in 1924 and 1925 mainly to define the contact of the Coast Plutonic rocks and to investigate the volcanic and sedimentary sequence (Dolmage, 1925, 1926).

GLACIATION

Drumlins, eskers, striae, moraines and erratics all indicate that the last ice sheet moved northeasterly off the Coast Mountains, glacial debris mantles, the less rugged mountains and low hills around Tatla and Tatlayoko Lakes. The rugged mountains have little glacial debris except in cirques and in valley bottoms; the unconsolidated material of the mountains is mainly talus and felsenmeer.

Apparently the headwaters of the valleys of Homathko River, Moseley Creek and Klinaklini River were initially filled with ice that flowed northeasterly. However, these are southwesterly draining valleys that cross the Coast Mountains from the Interior Plateau to the Pacific Ocean. As the ice thinned these valleys were able to accommodate all of the flow from the adjoining mountains; the direction reversed and glaciers flowed down the mountain valleys to the ocean. At this stage, the ice probably did not extend any great distance beyond the mountains into the Interior Plateau.

That ice moved at some time from the interior of the province into the Coast Mountains is suggested by the distribution of some erratics derived from the Tertiary plateau lavas of the Interior Plateau. Whereas all other erratics with a known source are distributed northeasterly from that source, some erratics of Tertiary basalt are distributed southerly or southwesterly from the known source. On Potato Mountain, and on the mountains at the north end of Chilko Lake and around Tsuniah Lake, well-rounded pebbles and small cobbles of vesicular lavas typical of those underlying the Interior Plateau to the northeast were noted. They are most abundant on the northeastern parts of these mountains and are not found beyond a short distance to the southwest. No similar lavas are known to outcrop to the southwest. The well-rounded condition and small size of the erratics suggest to the writer that they may have been deposited by an earlier glaciation moving southwesterly from the interior across the Coast Mountains.

GENERAL GEOLOGY

GENERAL STATEMENT

The part of Mount Waddington map-area studied is underlain by volcanic and sedimentary rocks of Late Triassic to Miocene age. Upper Triassic basic volcanic, clastic sedimentary and carbonate rocks lie along the southwestern margin of the area in contact with Coast Plutonic rocks. A section of marine shale, siltstone, greywacke and conglomerate of Callovian, Bajocian and possibly Lower Jurassic age, possibly conformable with the Triassic strata is exposed along Tatlayoko Lake Valley and eastward to Mount Nemaia. Northeast of the Yalakom Fault Bajocian and (?)Callovian andesitic and basaltic volcanic rocks and minor sediments represent a completely different facies than the aforementioned Bajocian-Callovian sedimentary rocks.

In early Lake Jurassic time the Tyaughton Trough developed and constituted the depositional site of the Upper Jurassic and Cretaceous volcanic and sedimentary rocks. This northwesterly trending trough extended from the southeast across Taseko Lake map-area into Mount Waddington map-area. The sedimentary rocks of the Relay Mountain Group, exposed mainly in Potato Range, were deposited in Late Jurassic and Early Cretaceous time on the northeasterly side of the trough. The volcanic and sedimentary rocks in the region south and west of Tatlayoko Lake represent Early Cretaceous accumulations on the southwestern side of the trough that, in this instance, rest unconformably on the Triassic sequence.

Sedimentary and volcanic rocks of Aptian(?), Albian and Cenomanian age overlie the Relay Mountain Group and other Cretaceous volcanic and sedimentary rocks, possibly unconformably. These too were deposited in the Tyaughton Trough but also in broad areas beyond the limits of the trough.

Plutonic rocks of granodioritic, quartz dioritic and dioritic composition were emplaced for the most part later than Cenomanian time and probably earlier than the Eocene. They form the main mass of the Coast Mountains and lie mainly to the southwest of the described strata mentioned above. However, many related dykes, sills, stocks and small batholiths intrude the volcanic and sedimentary rocks.

Gneiss, thought to have formed in Middle Jurassic time through the metamorphism of Middle Jurassic volcanic and sedimentary rocks, outcrops near Tatla Lake.

Small patches of Tertiary volcanic rocks rest unconformably on older rocks in the northeast part of the area.

Table I Stages of the Mesozoic Era as used in the report.

CRETACEOUS	Upper	Senon-ian	Maestrichtian Campanian Santonian Coniacian
		Turonian Cenomanian	
	Lower	Albian Aptian Barremian Hauterivian Valanginian Berriasian	
JURASSIC	Upper	Upper Tithonian Portlandian Kimmeridgian Oxfordian	
	Middle	Callovian Bathonian Bajocian	
	Lower	Toarcian Pliensbachian Sinemurian Hettangian	
TRIASSIC	Upper	Rhaetian Norian Karnian	
	Middle	Ladinian Anisian	
	Lower	Spathian Smithian Dienerian Griesbachian	

TABLE OF FORMATIONS

Era	Period or Epoch	Age	Formation and Thickness (feet)	Map-unit	Lithology
Cenozoic	Quaternary	Recent		22	Alluvium, river gravel.
		Pleistocene			Till, outwash sands and gravels, esker sands and gravels.
	Tertiary	Late Miocene and Pliocene		21	Vesicular basalt and andesite flows, related breccia and tuff; gravel and sand.
		Paleocene(?) Eocene and Oligocene(?)		20	Dacite.
Unconformity with A and presumably all pre-Tertiary rocks.					
Cenozoic or Mesozoic	Late Cretaceous and/or Early Tertiary	Cenomanian to Paleocene(?)	Coast Plutonic Rocks	B	Quartz diorite, granodiorite, diorite.
Intrusive or metamorphic contact.					
Mesozoic	Late Cretaceous	Cenomanian and younger	Kingsvale Group: Division B 6,000+	19	Andesitic and basaltic breccia and tuff.
			Kingsvale Group: Division A 3,000+	18	Siltstone, greywacke, conglomerate.
Not in contact in this area; conformable with Taylor Creek Group to the east; fault contact with older rocks.					
	Early Cretaceous	Albian and Aptian(?)	Jackass Mountain Group 6,800+	17	Greywacke, siltstone, conglomerate.
			Taylor Creek Group 3,000+	16	Shale, siltstone, greywacke, pebble conglomerate.
		Probable unconformity with all older rocks.			
		Hauterivian	3,000+	15	Reddish to purplish andesitic breccia and tuff.
			4,000±	14	Siltstone, greywacke, conglomerate, breccia, quartz sandstone, limestone.
			Relation not known; Map-units 15 and 14 in part correlative with Map-units 13 and 12.		
			5,000+	13	Andesitic and basaltic breccia and tuff; minor shale, greywacke and conglomerate.
			10,500+	12	Siltstone, greywacke, conglomerate.
Probable unconformity					

Table of Formations (cont'd)

Era	Period or Epoch	Age	Formation and Thickness (feet)	Map-unit	Lithology
Mesozoic (cont'd)	Late Jurassic	Kimmeridgian or Portlandian	714+	11	Conglomerate, shale, arkose, greywacke, tuff.
	Fault contact.				
	Early Cretaceous	Berriasian to Barremian	Relay Mt. Group: upper unit 3,785	10	Arkose, conglomerate, greywacke, siltstone, coquinoid limestone.
	Late Jurassic	Oxfordian to Berriasian	Relay Mt. Group: lower unit 3,611	9	Siltstone, greywacke, conglomerate, arkose.
	Erosional unconformity				
	Middle and Early Jurassic	Callovian, Bajocian, Sinemurian and (?)Hettangian	2,900+	8	Siltstone, shale, greywacke, grit, conglomerate.
	Relation not known; possibly conformable with Map-unit 6 and probably in part correlative with Map-unit 7.				
	Middle Jurassic	Bathonian(?)		A	Quartz-biotite schist and gneiss, augen gneiss, migmatite, diorite.
		Bajocian and (?)Callovian	2,000+	7	Breccia, conglomerate, tuff.
	Not in contact.				
	Late Triassic	Rhaetian and/or late Norian	3,610+	6	Shale, siltstone, greywacke, conglomerate, volcanic breccia, tuff.
		Late Norian	1,710+	5	Limestone, shale, greywacke.
		Norian	2,900+	4	Basalt, andesite, greywacke, siltstone, conglomerate.
	Relation unknown, possible unconformity.				
		Early Norian and (?)Karnian	2,000+	3	Shale, sandstone, pebble conglomerate, minor shaly limestone.
		Karnian	250-500	2	Limestone, shale, greywacke, tuff and volcanic breccia.
			7,000+	1	Dark green andesitic breccia, tuff and flows, minor shale and limestone.

ROCKS OF LATE TRIASSIC AGE

Late Triassic rocks extend discontinuously in an irregular area from east of Mount Dartmouth northwestward across Homathko River and from near Blackhorn Mountain northwestward across Mosely Creek to near Miner Lake. Other small areas of Late Triassic rocks occur on the east and west sides of Tatlayoko Lake Valley near the north end. The Triassic rocks are divided into six map-units though the relations between the units, and the true thicknesses, are obscured by faulting. For these reasons the divisions are treated as informal units that may eventually be defined as formations or be further subdivided.

Map-unit 1

Map-unit 1 is essentially a volcanic sequence over 7,000 feet thick but the base is nowhere exposed (Fig. 1). Light to dark green basalt or andesite with phenocrysts of greenish black euhedra of augite up to 1/2 inch diameter, but usually 1/4 inch or less is characteristic. Flow rocks and breccia show the porphyritic texture and tuff commonly has broken fragments of augite as one constituent. The proportion of volcanic rocks types varies greatly from area to area and no generalization is possible.

Any given section may include as much as 1,500 feet of massive flows in which the thickness of individual flows is difficult to estimate. Amygdaloidal, fine-grained lava, although not a major constituent in the map-unit, is widespread and characteristic. The amygdules are commonly chalcedony.

Tuff and coarse volcanic breccia form thick sections on Moore Peak and on the mountain east of Homathko Peak. Breccia, in beds several tens of feet thick, and massive tuff in beds 3 to 4 feet thick are usually greenish grey to dark greyish green, though rarely some beds of tuff are mauve to maroon. Purplish breccia is even less common. Uncommonly black shale is interlayered with the tuff in single beds 4 to 5 feet thick.

Near the top of the unit, interlayering of tuff and fine breccia with laminated shale and beds of limestone represents the transition to map-unit 2; that is, the change from dominantly volcanic to dominantly sedimentary rocks defines the boundary between the two units. The transitional zone may be very narrow as in the Moore Peak area or it may be several hundred feet thick as in the Blackhorn Mountain area.

On a hill about 4 miles northwest of Bluff Lake a section of conglomerate more than 500 feet thick overlies coarse volcanic breccia and flows. A similar, thinner conglomerate outcrops on Blackhorn Mountain. The conglomerate in beds 6 to 8 feet thick is composed exclusively of well-rounded boulders of coarse, dark green volcanic rocks up to 8 inches in

Figure 1. Upper Triassic (Karnian) volcanic rocks in the middle foreground with granitic mountains of the Coast Mountains in the distance, view westerly from range south of Tatloyoko Lake. (H. W. T. 1-1-67)

diameter embedded in a coarse tuffaceous matrix. The rock is truly a volcanic conglomerate. The conglomerate is thought to be a local feature near the top of the unit.

No fossils have been found in map-unit 1 but as it lies directly below map-unit 2, which is possibly Karnian, it too is tentatively considered to be of possible Karnian age.

Map-unit 2

Map-unit 2 is a variable unit characterized by some limestone beds with interlayered volcanic rocks, shale and greywacke. The thickness varies from 250 feet to 500 feet but as no unfaulted section is known, this is at best an estimate that suggests minimum thicknesses.

The limestone of this unit varies greatly. West of Ottarasko Mountain, where it is interlayered with laminated grey shales or argillites, it forms fairly thin, 25- to 50-foot thick units of dark grey coquinoid limestone that weather buff. North of Moore Peak the limestone is both light grey and coarsely crystalline and grey and cryptocrystalline. Northeast of Mount Dartmouth thin beds of limestone 2 to 3 feet thick are interlayered with tuff and fine breccia.

In places, northeast of Moore Peak for example, greywacke and limy siltstone separates the limestone of map-unit 2 from the volcanic rocks of map-unit 1. There grey limestone weathers buff and greywacke predominates in the sections.

The section near the contact with map-unit 1 is not everywhere the same. In most places there is an interlayering of volcanic fragmental rocks with limestone, shale and greywacke but in a few places there is an abrupt change from greywacke and shale to the volcanic rocks. The stratigraphic level of the contact could vary as the fossil evidence is not definitive.

Fossils, collected from several localities were identified by E. T. Tozer. His identifications and comments on some of the more important collections are as follows:

Field No. F4-42TD GSC loc. 79768

Locality: North of Tredcroft Glacier 51°18'N, 124°15'W.

Physocardia sp.

Age: Late Triassic

Field No. F5-53S-TD GSC loc. 79770

Locality: Near Moore Peak in small saddle in ridge 51°21'00"N, 124°22'30"W.

Halobia sp.
Juvavites s.l. ? sp.
'*Arcestes*' sp.
Pleuronautilus ? sp.
Ammonoid indet. with flat ribs

Age: Late Triassic

Field No. F2c-16TD GSC loc. 78636

Locality: North side of Tredcroft Glacier 51°17'N, 124°18'W.

Gryphaea sp.
Halobia? sp. indet.

Age: Probably Late Triassic

The age for map-unit 2 is indicated as Late Triassic. The overlying rocks, map-unit 3, contain early Norian pelecypods near the top of that thick unit. It is not unreasonable to believe that map-unit 2 is Karnian in age although the possibility of a Norian age cannot be ignored.

Map-unit 3

Conformably overlying map-unit 2 is a sequence of shale (map-unit 3). Although an unfaulted section is not known the minimum thickness is not less than 2,000 feet. The contact with the next younger rocks, map-unit 4, has not been observed and the relation of the two is unknown.

Map-unit 3 is made up primarily of grey laminated shale that weathers grey or buff. The laminations vary from 1/8 inch up to beds 6 to 8 inches thick but 1/2 to 1 inch thick is common. Interbedded with the shale in the upper part of the unit are several beds of fine pebble conglomerate, well sorted with chert and volcanic pebbles up to 1/2 inch in diameter. Some irregular lenses of conglomerate are also present. Thin beds of grey quartzose sandstone and impure sandstone, although common throughout the unit, nowhere form a thick section. Pure quartz sandstone was not noted although quartz grains are a major constituent in all sandstones. Greywacke is rare. A few scattered thin beds or lenses of shaly limestone are a minor element in the map-unit.

The unit is very regularly and evenly bedded throughout. Graded bedding was rarely seen except in some of the finer impure sandstone. Cross-bedding was noted in a few places in the sandier rock types.

The shale of this unit yielded an abundance of fossils but unfortunately the preservation is such that specific identification is usually in doubt. The fossils were examined and identified by E.T. Tozer whose identifications and comments for several important collections are as follows:

Field No. F2c-34TD GSC loc. 79734

Locality: South of Tatlayoko Lake, east of Morris Mine 51°23'N, 124°24'W.

Halobia cf. H. rugosa Gümbel
Halobia spp.

Age: Norian or Karnian (Halobia rugosa is most common in Lower Karnian)

Field No. F3a-34TD GSC loc. 79736

Locality: South of Tatlayoko Lake, east of Morris Mine; 51° 23'N, 124° 24'W.

Halobia sp. (*H. zitteli* group)

Age: Norian or Karnian

Field No. F3c-34TD GSC loc. 79767

Locality: South of Tatlayoko Lake, east of Morris Mine; 51° 23'N, 124° 24'W.

Halobia alaskana Smith

Age: Probably lower Norian - Kerri zone

Field No. F3-18c-TD GSC loc. 79735

Locality: 1/2 mile northeast of Bowl Lake near Homathko River; 51° 35'N, 124° 32'W.

Halobia sp.

Age: Norian or Karnian

Field No. F2-56s-TD GSC loc. 79730

Locality: 2 miles northeast of Moore Peak; 51° 23'00"N, 124° 21'30"W.

Halobia cf. *H. alaskana* Smith

Age: Norian or Karnian

Field No. F2-31TD GSC loc. 79728

Locality: 8 miles west of Bluff Lake; 51° 47'N, 124° 54'W.

Halobia cf. *H. rugosa* Gümbel

Age: Norian or Karnian

Field No. F1-52s-TD GSC loc. 79687

Locality: 3 miles south of Tatlayoko Lake; 51° 23'N, 124° 24'W.

Halobia cf. *H. alaskana* Smith

Age: Probably Lower Norian - Kerri zone

Many other collections of fossils from map-unit 3 usually are specifically indeterminate Halobia or indeterminate pelecypods, gastropods and corals. Any one locality usually presents a large number of specimens but poor preservation or distortion makes identification difficult.

The paleontological evidence is conflicting. The presence of Halobia alaskana Smith indicates lower Norian strata. Several of the Halobia are compared to Halobia rugosa which is common in lower Karnian rocks. These species here are in a reversed stratigraphic order and field evidence indicates they probably occur together. The only certain specific identification is that of Halobia alaskana Smith and therefore the map-unit probably includes lower Norian rocks. As this collection lies high in the thick section the lower part of the unit is tentatively assigned to the Karnian. The age of the map-unit is therefore considered to be early Norian and (?)Karnian.

Map-unit 4

The relation of map-unit 4 to map-unit 3 is unknown as their contact is not exposed. Map-unit 4 underlies late Norian map-unit 5 apparently conformably and if this interpretation is correct, then map-unit 4 is probably younger than the early Norian map-unit 3. Conceivably the late Norian carbonate unit (map-unit 5) could be resting directly on the Karnian map-unit 1 if map-units 2 and 3 were missing, in which case the mainly volcanic map-units 1 and 4 would be equivalent. This is not considered likely because (a) the sediments interlayered with the volcanic rocks of map-units 1 and 4 show little or no similarity; (b) the limestone lenses and the limestone pebbles of map-unit 4 resemble the overlying Norian limestone (map-unit 5) more closely than the limestone of the Karnian map-units 1 and 2; and (c) map-unit 3, although not in contact with map-unit 4, is present in a nearby fault slice and if younger than map-unit 4, would be expected in the unfaulted section where map-units 4 and 5 are exposed together.

Map-unit 4 includes volcanic rocks like those of map-unit 1, greywacke, siltstone, limestone pebble conglomerate, minor chert pebble conglomerate and limestone lenses. The unit is only poorly exposed in fault slices west of Bluff Lake so that the thickness and detailed stratigraphy are imperfectly known.

The lowest rocks in the unit are dark green, fine-grained to finely porphyritic basalt and andesite. The porphyritic rocks are of two types, one that has dark green augite phenocrysts and one that has dull grey plagioclase phenocrysts. Whether or not the bulk of the rocks are flows or coarse breccia is not known. Tuff is not a predominant part of the section. The volcanic rocks have a minimum thickness of 2, 000 feet and the base is not exposed.

Overlying the volcanic rocks is limestone pebble conglomerate in which angular grey limestone pebbles up to 3 inches in diameter are enclosed

in a greywacke matrix. The matrix makes up 50 per cent of the rock. Similar dark green greywacke forms important interbeds in the section. Fine pebble conglomerate with pebbles of volcanic rock and chert occur near the base of the conglomeratic sections. These interbedded greywacke and conglomerate beds comprise over 300 feet of section.

Overlying the conglomeratic rocks are 600 feet or more of dark green, massive greywacke. These beds are similar to coarse tuff and they appear to be sorted and waterlain. Near the top of the section are lenses of shaly and arenaceous limestone. These are in an apparently conformable relation with the overlying limestone of map-unit 5. The contact is marked in places by a few thin beds of reddish siltstone.

The age of map-unit 4 is believed to be Norian because of Norian strata above and presumably below. No fossils were found in the unit.

Map-unit 5

Carbonate is the dominant lithology of map-unit 5. The best exposed section of the unit was measured on a ridge 5 1/2 miles west of Sapeye Lake (51°47'40"N, 124°52'0"W). Fossils were identified by E.T. Tozer.

Unit	Lithology	Thickness (feet) Unit	Total from base
17	Limestone, light bluish grey, buff weathering, massive	10	1710
16	Interbedded grey-green and maroon shale, greywacke and conglomerate with pebbles to 2 inches in diameter. Beds 10 to 12 feet thick	200	1700
15	Interbedded limestone, shale, and greywacke in beds 2 to 4 feet thick	125	1500
14	Greywacke	20	1375
13	Blue-grey limestone, massive, with ceroid and phaceloid hexacorals	65	1355
12	Dark blue-grey limestone, grey weathering; small shear at base of unit	30	1290

Unit	Lithology	Thickness (feet) Unit	Total from base
11	Interbedded limestone, shale, and greywacke in beds 2 to 3 feet thick; poorly exposed . . .	50	1260
10	Interbedded purplish maroon shale and greenish shale in beds 2 to 3 feet thick	150	1210
9	Interbedded blue silty limestone, green greywacke, and massive shale or fine greywacke in beds 1 foot to 2 feet thick. Predominantly limestone. Base covered, may be faulted.	110	1060
8	Massive beds of greywacke with a few limestone beds and limestone pebble conglomerate	225	950
7	Grey limestone, fine grained, weathering dark blue-grey	20	725
6	Buff-weathering greywacke, fine grained, massive beds, a few interbedded shale beds near base. Septocardia sp. (GSC loc. 79726).	20	705
5	Dark blue-grey to blue-black shaly limestone weathering light grey; a few thin interbeds of greywacke. cf. Astarte incae Jaworski (GSC loc. 79725) 100 feet above base. Monotis subcircularis Gabb and Pecten ('Variamussium') sp. (GSC loc. 79723) 45 feet above base	185	685
4	Light grey limestone with minor greenish greywacke interbeds; contains many impressions and sections of Megalodontidae	45	500
3	Dark blue limestone weathering grey; in places almost shaly. Contains Septocardia sp., Alectryonia sp. indet., 'Megalodus n. sp.' of Lees, 1934 (GSC loc. 79049)	150	455
2	Grey limestone, very fossiliferous, in places coquinoid. Indeterminate hexacorals near top of unit and near base 'Myophoria' cf. M. adornata McLearn (GSC loc. 79046)	155	305

Unit	Lithology	Thickness (feet) Unit	Total from base
1	Grey massive limestone, dark grey weathering light grey, rubbly weathering, poorly exposed. Contains Pecten ('Variamussium') sp. (GSC loc. 79043)	150	150

Map-unit 5 is late Norian and the beds with Monotis subcircularis Gabb represent the Lower Suessi zone (Tozer, 1967, p. 75). Cassianella lingulata Gabb was not found in this section nor many of the genera usually associated with the Cassionella beds of the Tyaughton Creek area and hence evidence of any beds representing the Upper Suessi zone is lacking. The unfossiliferous or poorly fossiliferous beds above Monotis may, however, represent this zone.

Exposures of map-unit 5 are few. Aside from the section measured, there is another about 2 miles southeast. The unit is also exposed on the north end of and on the mountains east of Blackhorn Mountain where the rocks are intensely deformed with a prominent bedding cleavage.

Map-unit 6

Map-unit 6 overlies the late Norian carbonate unit (map-unit 5) with apparent conformity but with a marked lithologic change. The unit is composed mainly of clastic sedimentary and fragmental volcanic rocks. Two partial sections were measured and are presented here as typical of the rocks of this unit.

The following section was measured 6 miles west of Bluff Lake at 51°43'30"N, 124°46'00"W.

Unit	Lithology	Thickness (feet) Unit	Total from base
16	Shale and siltstone, red-brown to maroon in colour, in massive beds with irregular greywacke interbeds	45	855
15	Limestone, grey, finely crystalline, intensely fractured, poorly exposed	40	810
14	Red-brown siltstone, massive	30	770

Unit	Lithology	Thickness (feet) Unit	Total from base
13	Greywacke, greenish to reddish in colour, slightly limy	15	740
12	Red-brown siltstone with interbeds of limy green siltstone, fine greywacke, and pebbly greywacke, irregular bedding	70	725
11	Covered interval	40	655
10	Red-brown siltstone	100	615
9	Greywacke	10	515
8	Red-brown siltstone	25	505
7	Red-brown conglomerate with volcanic pebbles up to 1 inch in diameter	25	480
6	Red-brown siltstone	5	455
5	Green siltstone	5	450
4	Red-brown siltstone with a few interbeds of reddish conglomerate	35	445
3	Red-brown siltstone	165	410
2	Conglomerate, with grey volcanic pebbles and red siltstone pebbles up to 2 inches in diameter	5	245
1	Red-brown to maroon siltstone with interbeds of greenish greywacke and arkose ...	240	240

The foregoing is not in contact with the following section but is thought to overlie it and a gap of unknown magnitude may exist between these sections.

The following section was measured 6 miles west of the south end of Sapeye Lake at 51° 46'15"N, 124° 46'00"W.

Unit	Lithology	Thickness (feet) Unit	Total from base
24	Greywacke, mostly fine to medium grained, finely laminated, light green; some limy pebbles to 2 inches in diameter, lower part of unit somewhat coarser, almost a grit	335	2760
23	Arkose with thin interbeds of siltstone and gritty greywacke, mainly greenish white, medium grained, laminated in part, many 2 inches in diameter limestone pebbles, weathers white	35	2425
22	Greywacke, fine grained, laminated, various shades of green, some beds weather reddish brown but most weather greenish; possibly faulted	95	2390
21	Conglomerate; small 1/8 inch in diameter volcanic pebbles in a dark grey, fine-grained matrix; abundant limestone pebbles	70	2295
20	Greywacke, fine to medium grained, light green, weathering light greenish grey, in massive beds; in places conglomeratic; contacts gradational	70	2225
19	Limestone pebble conglomerate, pebbles up to 3 inches in diameter, closely packed, little matrix; interlayered with greywacke; contacts gradational	25	2155
18	Limestone pebble conglomerate, pebbles up to 4 inches in diameter, weathers bluish grey	25	2130
17	Shale, reddish purple colour on fresh and weathered surfaces, hackly weathering, fine-grained	35	2105
16	Conglomerate, 1/4 inch to 2 inches in diameter, mainly fine volcanic pebbles, dull greenish grey weathering to a light green grey, some limestone pebbles; sharp contact below	55	2070

Unit	Lithology	Thickness (feet) Unit	Total from base
15	Volcanic breccia, angular volcanic fragment in a medium-grained, purplish brown or light green matrix, fragments are generally fine (1/16 to 1/4 inch in diameter). Some interbedded conglomerate in beds to 5 feet thick	150	2015
14	Conglomerate, volcanic pebbles up to 4 inches in diameter, average 3/4 inch in diameter, pebbles are generally elongate and oriented parallel to bedding. Rock is generally light green. Contact gradational and interlayered below	30	1865
13	Volcanic breccia, angular fragments up to 1/8 inch in diameter in a purplish brown matrix; weathers hackly to massive; laminated in places, a few limestone pebbles up to 1 inch in diameter; lower contact poorly exposed	55	1835
12	Interbedded greywacke and volcanic breccia like units 11 and 13	20	1780
11	Greywacke, medium-grained, green, weathering light greenish grey; resistant ..	25	1760
10	Interbedded red-brown tuffs and shales in beds 4 feet to 20 feet thick; poorly exposed	100+	1735
9	Maroon coloured tuffs and purplish volcanic breccias	100	1635
8	Covered interval	100	1535
7	Dark blue-grey limestone weathering light grey; sheared	20	1435
6	Reddish, maroon, or purplish tuff with a few interbeds of greenish tuff or shale	380	1415
5	Interbedded tuff and greywacke with a few limestone pebbles on boulder conglomeratic		

Unit	Lithology	Thickness (feet) Unit	Total from base
	lenses and a considerable section of purplish volcanic breccia. Generally the rocks are greenish	250	1035
4	Interbedded red and green shale with limestone bands up to 1 foot thick. Poorly exposed but a varied unit	275	785
3	Massive beds of red-brown to maroon tuff ..	175	510
2	Dark grey limestone weathering blue-grey in beds 3 to 4 feet thick interlayered with greenish limy shale. Some of the beds are coarse pebble or boulder conglomerate with boulder to 6 inches in diameter in a greywacke matrix	110	335
1	Volcanic breccia, tuff and greywacke, dark greenish grey to blue-grey weathering to dull buff-grey, limy, top 20 to 25 feet is more a conglomerate than a breccia	225	225

From the foregoing sections it is apparent that map-unit 6 is lithologically varied. It has a prominent red bed sequence of reddish coloured shale, siltstone and conglomerate. The few limestone units indicate probable marine conditions during part of the depositional period although much or most of the unit may be non-marine. The coarseness of some of the conglomerate suggests a nearby source area, the red beds indicate rapid erosion, transport and burial of the detritus (Van Houten, 1948, pp. 2083-2126), but the direction of transport and the source area is not known. The volcanic rocks indicate active volcanism in or near the basin of deposition.

The original areal extent of map-unit 6 is not known as the unit outcrops only as a few fault slices west of Bluff Lake. No fossils were found in this unit but as it overlies map-unit 5, it must be late Norian or younger.

A sub-unit (6a) of map-unit 6 provides some suggestions for the age of the map-unit as a whole. Two small areas of sedimentary rocks, apparently overlain by Jurassic shale and greywacke, outcrop near the northern end of Tatlayoko Lake, one on the west side and one on the east side. The former is coarse, greenish pebble conglomerate and pebbly greywacke in beds several feet thick. The pebbles are mainly of chert and volcanic rocks. On the east side of Tatlayoko Lake, about 3 miles from the north end,

a section of interbedded grey to blue-grey limestone, limy granule conglomerate, limy greywacke and pebbly greywacke conglomerate has an exposed thickness of about 250 feet. The limestone beds are 1 foot to 3 feet thick and the greywacke and conglomerate beds are up to 20 feet thick. These rocks as well as those on the west side of the lake are apparently structurally conformable with overlying Jurassic (Early?) sedimentary rocks.

One collection was made on the east side of the lake and the fossils were identified by E.T. Tozer.

Field No. F2-2TD GSC loc. 78685

Locality: On east shore of Tatlayoko Lake, 3 miles from north end; 51° 37'N, 124° 23'W.

Pecten ('*Variamussium*') sp.
Neomegalodon (=*Neomegalodus*) cf. *N. canadensis* Shimer
Plicatula cf. *P. perimbricata* Gabb
'*Pinna*' sp.
Cassianella cf. *C. lingulata* Gabb
Pleuronautilus? sp.

Age: Late Triassic, probably late Norian

North and east of Mount Skinner rocks included with map-unit 6 are indicated on the map as 6b. These are mainly or entirely sedimentary, consisting of reddish conglomerate or breccia, greenish greywacke, and thin laminated grey argillite. Fragments in the conglomerate or breccia are mainly volcanic, are angular to subrounded, and vary in size to 2 inches in diameter. The rock is poorly sorted and stratified but is generally well indurated. The greywacke is a nondescript greenish grey colour, massive, and apparently forms thick beds. The argillite is hard, siliceous, thinly bedded or laminated, and not common in the section. The rocks are poorly exposed and are greatly altered as they are within the metamorphic aureole of the plutonic rocks of Mount Skinner. Many dykes cut the rocks and small shear zones are common.

The age of these rocks is unknown. No fossils are known from the unit and contacts with other groups are faulted or unexposed. Lithologically they are not identical with any known group but do bear some similarity to rocks of map-unit 6. Tentatively they are included with that unit although they may be younger.

The age of map-unit 6 is late Norian, Rhaetian(?) and later(?) because this unit overlies map-unit 5 which yielded fossils referable to the Lower Suessi zone it can be no older than late Norian. Sub-unit 6a is probably late Norian and the conglomerates within it suggest a closer lithologic similarity to map-unit 6 than to map-unit 5. The fossils collected from unit

6a are probably late Norian and resemble the Cassianella fauna of the Tyaughton Creek area to the east (Tozer, 1967, pp. 75-78). If such be the case then these fossils represent the Upper Suessi zone and are younger than the fauna of map-unit 5, the Lower Suessi zone. Furthermore, the great thickness of map-unit 6, suggests that the unit may also be Rhaetian and even Early Jurassic (Hettangian) in age. In the Tyaughton Creek area, Rhaetian and Hettangian rocks are conglomeratic (Tozer, 1967, p. 76; Frebold, 1967, pp. 3-9) and overlying Sinemurian rocks are characteristically shale, siltstone, and greywacke with no conglomerate whatever. An age younger than Hettangian therefore is not considered probable.

Metamorphism

The Upper Triassic strata on Blackhorn Mountain and south to the junction of Moseley Creek and Homathko River have been metamorphosed. The rocks south of Homathko River and around Reliance Mountain and Homathko Peak also have been altered. The sediments east of Blackhorn Mountain (map-unit 4) are phyllitic as are the volcanic rocks of map-unit 1 in this area. Southward the metamorphic grade increases and garnetiferous schist and gneiss are exposed on the mountains between Moseley Creek and Homathko River near their junction. The age of this metamorphism, as discussed later, is suggested as Middle Jurassic.

MESOZOIC ROCKS NORTHEAST OF YALAKOM FAULT

In the northeastern part of the map-area volcanic rocks (map-unit 7) and gneissic rocks (map-unit A) are believed to be Middle Jurassic. These rocks, not known southwest of Yalakom Fault, underlie an extensive area in adjoining map-areas to the northwest and southeast.

Map-unit 7

The volcanic rocks north of Choelquoit Lake (map-unit 7) are poorly exposed and imperfectly known. They outcrop in an area of low, glaciated, rounded hills that are largely drift-covered and forest-clad. No section is well exposed and only a generalized impression of the lithology can be offered.

Map-unit 7 is made up of volcanic breccia, tuff, and flows with minor waterlain shale or shaly tuff. The most widespread rock type is dark green to grey volcanic breccia with fragments of fine-grained feldspathic porphyry in which the phenocrysts commonly are slender laths of plagioclase, probably andesine, in a glassy or cryptocrystalline matrix. Some breccia particularly east and northeast of Eagle Lake is coarse with fragments up to 4 or 5 inches in diameter.

North of Choelquoit Lake is a section of interbedded reddish conglomerate or breccia with greenish breccia, tuff and a few flows. The conglomerate or breccia is made up of angular to subrounded fragments of chert, volcanics and feldspar. Hematite coats the fragments and fills the interstices. Crude layering and some rough sorting is present. In places the breccia has a calcareous cement. The tuff is composed mainly of poorly sorted and unstratified broken feldspar fragments and dark volcanic material possibly in part glass. A few flows are finely crystalline or porphyritic with phenocrysts of small feldspar laths. Augite phenocrysts were rarely noted. Poor exposure prevented certain recognition of these rocks as flows; they could be dykes or sills.

For the most part, the volcanic rocks of map-unit 7 are believed to be andesitic or basaltic in composition but which is the more abundant rock type is open to question. In a few places rocks of dacitic composition are present but these are rare. Poorly defined stratification in the fragmental rocks suggests nonaqueous deposition, but the presence of marine fossils just north of the map-area indicates that parts of the group are waterlain.

The structure of the group is practically unknown. In the hills north of Choelquoit Lake the map-unit can be no less than 2,000 feet thick and the true thickness is probably several thousand feet greater. Whether or not the rocks have been regionally folded could not be determined but dips up to 45 degrees were noted and the trend of the group is generally northwest. Near the contact with the Mesozoic gneiss of map-unit A the rocks of map-unit 7 possess a pronounced foliation that coincides with the foliation of the gneiss.

Within the map-area this group of rocks yielded no fossils, but to the north in Anahim Lake map-area fossils were found in 1967. On the north shore of Puntzi Lake (52°12'48"N, 124°00'42"W; GSC loc. 79765) a poorly preserved Sphaeroceratid ammonite was found in some waterlain tuffaceous rocks. According to H. Frebold a probable Bajocian age is indicated. These rocks are undoubtedly correlative with part of map-unit 7. Farther northwest another collection was made from similar volcanic rocks northwest of Hotnarko Lake and these were examined by J.A. Jeletzky.

Field No. F-An-100TP GSC loc. 79739

Locality: Little Rainbow Mountains, Anahim Lake 52°29'N, 125°42'W.

Cylindroteuthis (Cylindroteuthis?) sp. indet.
Trigonia (Haidaia?) ex. aff. packardi Crickmay
cf. Lopha sp. indet.
Pleuromya sp. indet.
pelecypods and gastropods, genus and species indet.

Age and correlation: Probably Bathonian to lower Oxfordian. Dating is tentative because of poor preservation.

From the foregoing it is apparent that map-unit 7 is probably Bajocian and possibly in part late Middle Jurassic (Callovian?) or earliest Late Jurassic. A Bathonian age cannot be excluded but is unlikely as Bathonian rocks are unknown in British Columbia. In Bella Coola map-area (93D) to the northwest, Middle Jurassic volcanic rocks (Baer, 1967) are believed to be correlative as a whole or in part with map-unit 7. These rocks contain middle Bajocian fossils as well as a fauna similar to that at GSC loc. 79739 near Anahim Lake. Presumably therefore, volcanic rocks of different ages occur in Bella Coola map-area but are difficult or impossible to separate lithologically (Baer, pers. comm.). Thus in Mount Waddington map-area, map-unit 7 is probably Bajocian but slightly younger Jurassic volcanic rocks may also be included.

Map-unit A

A group comprising gneiss, augen gneiss, and migmatite (map-unit A) outcrops to the west of map-unit 7 on Tatla and Splinter Hills, around Tatla Lake and westward to One Eye Lake. The metamorphic complex is exposed only in the low, drift covered and wooded areas of the northeast part of the area.

The gneiss ranges from phyllitic volcanic rocks and foliated greenstone through quartz-biotite schist and gneiss to hornblende gneiss and migmatite. The migmatite commonly contains biotite-rich irregular bands in a more granitic-looking rock. Coarsely banded gneiss contains biotite and hornblende in discrete bands. Commonly the gneiss shows a strong lineation with little or no foliation. Some gneiss has a well developed augen structure.

Across the area of outcrop from east to west the rocks of map-unit A change from phyllite and greenstone through quartz-biotite or quartz-hornblende gneiss and migmatite to a distinctive belt of similar gneiss and migmatite with several minor diorite bodies. The area around Splinter Hill consists mainly of slightly foliated and altered rocks of volcanic origin. Near Tatla Hill quartz-biotite schist and gneiss appears to be overlain by quartz-hornblende gneiss. North and west of Tatla Lake, southwest plunging quartz-biotite gneiss is bounded on the north by banded gneiss and augen gneiss. The group of hills lying between One Eye Lake and a creek 5 miles to the east is made up of a westerly plunging complex of migmatite and quartz-biotite-hornblende gneiss with minor bodies of diorite and quartz diorite. The abrupt southeasterly trending lineament followed by the aforementioned creek on the east side of these hills probably represents a structural break between these rocks and the biotite and augen-gneiss to the east.

Structural trends are mainly east-west but swing northeasterly along the north shore of Tatla Lake. Foliation commonly dips southerly but poor exposure and conflicting dips prevent any generalization.

The metamorphic rocks are part of an igneous and metamorphic belt that extends northwesterly across the Anahim Lake map-area (Tipper, 1957, map-unit 3b) and southeasterly across the Taseko Lakes map-area (Tipper, 1963, map-unit 4). Middle Jurassic rocks, equivalent to map-unit 7 in Mount Waddington map-area, where the rocks metamorphosed but presumably older strata were also involved. The age of the metamorphism is believed to be Middle Jurassic, possibly Bathonian or Callovian. Unquestionably it is younger than map-unit 7, at least in part, and is therefore no older than Bajocian. Within Mount Waddington map-area it is only possible to say that it is no younger than early Tertiary but in Taseko Lakes area to the east it is believed to be no younger than Oxfordian and probably no younger than Callovian.

In Taseko Lakes map-area recent work has indicated that this belt of rocks is the product of a Middle Jurassic orogeny that subsequently formed the northeastern side of the Lake Jurassic and Early Cretaceous Tyaughton Trough (Jeletzky and Tipper, 1968). This orogenic belt was the northeastern source of the detritus being carried into the trough. Igneous rock detritus, believed to have been derived from the orogenic belt, first appears in the sedimentary sequence in Oxfordian time and for this reason the metamorphic and igneous rocks of this belt are believed to be, in part at least, of pre-Late Jurassic age. Therefore the metamorphism that produced map-unit A is considered to be Middle Jurassic (Bathonian or Callovian).

LOWER JURASSIC (HETTANGIAN OR SINEMURIAN) TO LOWER CRETACEOUS (BARREMIAN) ROCKS BETWEEN YALAKOM AND NIUT-TCHAIKAZAN FAULTS

In Potato Range, in the range to the east and on Mount Nemaia are rocks ranging in age from Early Jurassic (Hettangian or Sinemurian) to Early Cretaceous (Barremian) (Fig. 2). These form a monotonous succession that, except for the fossils preserved therein, would be difficult to subdivide satisfactorily. Three units (8, 9, 10) have been established that are lithologically somewhat distinct and have, on the whole, abundant and diagnotic fossil faunas. Map-units 9 and 10 constitute the Relay Mountain Group and are here informally divided into the upper Relay Mountain Group (most of the Lower Cretaceous rocks of the group) and the lower Relay Mountain Group (mainly the Upper Jurassic rocks).

Map-unit 8

Map-unit 8 is a group of siltstone, shale, greywacke, and conglomerate that outcrops on either side of Tatlayoko Lake, on the mountain east of Cheshi Creek, on Mount Nemaia and along the valley to the south, and along the southwest side of Yalakom Fault at the north end of Chilko Lake. The rocks are invariably well indurated and near several small intrusions are baked hard and brittle.

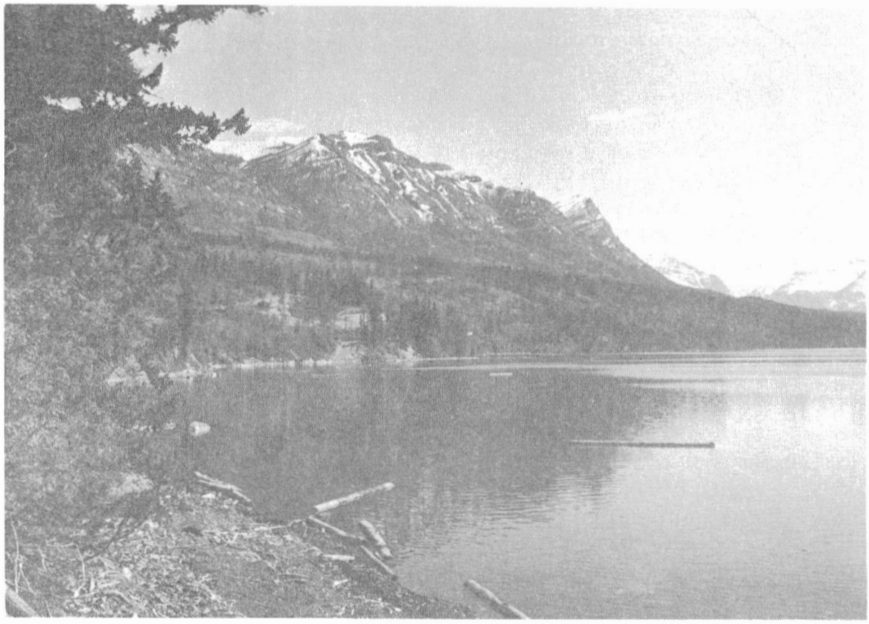

Figure 2. Potato Range from north end of Tatlayoko Lake. Rocks on the upper half of the slope are Relay Mountain Group, the rocks near the lake are Middle Jurassic. (J. A. J. 1-1-67)

Shale or argillite and siltstone, the most abundant rock types in the unit, occur throughout but are most abundant in the lower part. The rocks are light grey to dark grey and black and weather grey or buff; where pyritized they weather reddish brown. The sequence consists of interbedded shale, siltstone and greywacke in bands 1/4 inch to 10 feet or more in thickness. The thicker beds are usually greywacke. Shale and siltstone commonly form beds 2 to 18 inches thick. The even and regular bedding and the common, fine laminated nature of most shale is characteristic of the map-unit. Finely laminated shales are not unique to this map-unit but do constitute an almost ubiquitous characteristic. Graded bedding on a fine scale is common and here and there fine crossbedding was noted. In many places differential weathering gives the rocks a ribbed appearance on a fine or coarse scale.

The greywacke is light to dark green or grey, commonly coarse-grained, poorly sorted, and in fairly massive beds 6 inches to several feet thick. Clasts are commonly volcanic rock detritus, feldspar fragments, and minor chert. Calcite is the common cementing material. These rocks are rarely siliceous and vary greatly in feldspar content. In places the arkosic

greywacke is light in colour. Greywacke does not occur alone in thick sections but invariably is interlayered with shale, siltstone, or conglomerate.

Pebble conglomerate is common in the upper part of the map-unit in well sorted, even beds 4 or 5 feet thick, rarely thicker, interlayered with shale, siltstone, and greywacke. The pebbles, usually 1 inch or less in diameter, are well rounded and closely packed. Conglomerate with pea-sized closely packed pebbles, with a minimum of matrix is characteristic. The composition of the pebbles is varied but volcanic rocks similar to those of map-unit 7 are abundant. Chert, shale, and feldspar are also common. In general volcanic pebbles and feldspar fragments become predominant in younger beds. Limestone pebble conglomerate was noted in a few places at or near the base of the section.

Another rock type is fine-grained grey limestone in beds 6 to 8 inches thick. North of Mount Nemaia a few beds of waterlain tuff 3 to 4 feet thick are associated with limestone in the upper part of the section.

Fossil collections were obtained from this map-unit at several localities. The fossils were examined by Hans Frebold of the Geological Survey and his identifications and comments are as follows.

Field No. JA-F67-7/2 GSC loc. 78804

Locality: Mount Waddington area, British Columbia. A prominent north-northwest trending shoulder of a nameless ±7, 350 feet high mountain, the top of which is situated about 3 miles directly west of Mount Nemaia.

Lilloettia sp.

Age: Middle Callovian

Field No. JA-F67-7/2a GSC loc. 78805

Locality: As above.

Lilloettia spp.
Cadoceratinae? sp. indet.

Age: Middle Callovian

Field No. JA-F67-7/2b GSC loc. 78806

Locality: As above.

Pseudocadoceras sp. aff. *P. crassicostatum* Imlay

Age: Middle Callovian

Field No. F3-37-S-TD GSC loc. 79021

Locality: Between south end of Potato Range and Chilko Lake 124°17'00"W, 51°28'30"N.

Kepplerites? sp. indet.

Age: Lower Callovian?

Field No. F3-1D-TD GSC loc. 78603

Locality: Northeast end of Tatlayoko Lake 124°23'W, 51°39'N.

'*Ludwigia*'? gen. et sp. indet.

Age: Middle Bajocian?

Field No. F3-7L-TD GSC loc. 79707

Locality: About 1 1/4 miles south of Fossil Creek along the road 124°23'30"W, 51°32'00"N.

Oppelia stantoni Imlay
Stephanoceratids

Age: Middle Bajocian. *Oppelia* new for British Columbia.

Field No. F1-8P-TD GSC loc. 79003

Locality: South side of Road 10 yards east of rail fence at Fossil Creek 124°23'W, 51°33'N.

Oppelia aff. *O. stantoni* Imlay
Stephanoceratids gen. et sp. indet.
Sphaeroceratid gen. et sp. indet.

Age: Middle Bajocian

Field No. F7-1D-TD GSC loc. 78602

Locality: Northeast end of Tatlayoko Lake 124°23'W, 51°39'N.

'Ludwigia'? gen. et sp. indet.
Stephanoceratidae gen. et sp. indet.

Age: Middle Bajocian?

Field No. F-1c-9-TD GSC loc. 78688

Locality: Ridge north of Mount Nemaia (north of F-1b-2-TD).

Poorly preserved ammonites -
Chondroceras?
Stephanoceratids?

Age: Probably Bajocian

Field No. F3-12W-TD GSC loc. 78647

Locality: North of Stikelan Pass 124°17'W, 51°27'N.

Tmetoceras? gen. et sp. indet.

Age: Lower Bajocian?

Field No. JA-F67-4/3 GSC loc. 78798

Locality: Taseko Lakes map-area. Northern shore of Konni Lake about 150 feet above the water level and some 3,500 feet west from northeast corner of the lake (just east of Mount Waddington map-area).

Tmetoceras? sp. indet.
Oxytoma sp.

Age: Probably lower Bajocian

Field No. F-1-10P-TD GSC loc. 79004

Locality: 3/4 mile east of road and Gymkana Grounds.

Schlotheimiidae gen. et species still to be identified
Weyla?

Age: Lower Jurassic. Hettangian or Sinemurian, depending on identification of Schlotheimiidae.

From the foregoing it is apparent that the map-unit includes rocks of Hettangian or Sinemurian, lower and middle Bajocian, and lower and middle Callovian age. In Taseko Lakes map-area (92O) a collection was made about 10 miles southeast of Mount Nemaia, from the same group of rocks.

This includes the Sinemurian ammonite Arniotites cf. kwakiutlanus Crickmay and supports the identification of Lower Jurassic strata mentioned above. When all collections have been thoroughly examined the map-unit may be found to encompass much of Early Jurassic and most of Middle Jurassic time.

No section was measured in detail but the following summation indicates the major lithologic characteristic and the variations to be expected. The best exposed sections of the middle Bajocian and older rocks are on the southeast slopes of Mount Nemaia and on the east side of Tatlayoko Lake near the south end of Potato Range. Callovian rocks are best exposed on the northwest ridge of Mount Nemaia. The following summation is not applicable to any one section:

Unit	Lithology	Minimum thickness (feet)
5	The middle Callovian rocks are mainly black shale, greywacke, pebbly conglomerate and concretionary shale	1000+
4	The lower Callovian rocks are mainly greywacke and fine pebble conglomerate. They are not unlike the middle Callovian except that they lack any thick shale sections	500+
3	Middle Bajocian rocks are mainly greywacke (70%) and conglomeratic greywacke, less shale and a few conglomerate bands. Greywacke is coarse, feldspathic, greenish to blue-green in colour, and in massive beds 6 to 8 feet thick. Shale is in massive beds 3 to 4 feet thick and it as well as the greywacke, may be finely laminated. Greywacke decreases in abundance down-section. This unit in several localities yields Stephanoceratid and other middle Bajocian ammonites	400+
2	Rocks of map-unit 8 below Stephanoceras-bearing beds are dominantly shale or argillite. Greywacke bands, although prominent, are not as abundant nor as thick. The lower part of the section is almost devoid of greywacke. The shale or argillite is, for the most part, laminated in distinct bands 1/4 to 1/2 inch wide. Some shale bands are limy and weather dark brown. Lenses and thin beds of brownish weathering dark grey	

Unit	Lithology	Minimum thickness (feet)
	limestone occur low in the section. Conglomerate is absent from this section. Rare pebbles of argillite are seen in greywacke. Near the base of the unit in Taseko Lakes map-area, Sinemurian fossils were found .	1000+
1	Near the base of map-unit 8 light-grey limestone pebble conglomerate was noted with pebbles to 3 inches in diameter. Thickness varies from as much as 30 feet thick to as little as 1 foot. Below the conglomerate is greywacke, pebble conglomerate, and subordinate shale. Conglomerate contains fine pebbles of volcanic rocks. This unit was noted only on the south side of Mount Nemaia. Lithologically the unit is similar to Upper Triassic rocks (map-unit 6a) and may, perhaps be correlated with them ...	

The rocks of map-unit 8 are grouped together in Mount Waddington map-area because fossil control is insufficient to allow division on the basis of faunal zones and none of the possible divisions is distinctly recognizable with respect to lithology and lithification. These factors render subdivision at the present scale of mapping difficult or impossible. This is not meant to imply, however, that the unit represents a single conformable sequence of uniform lithology. On the contrary, the lithology is varied and the strata encompass one or more unconformities.

Middle and lower Callovian, middle Bajocian, and Sinemurian or Hettangian rocks are included in this group. Several stages and part stages between Hettangian and Callovian are not recognized but this may be simply a result of gaps in the fossil record. However the absence of Bathonian and upper Bajocian fossils is probably a result of non-deposition or erosion for nowhere in the western Cordillera in British Columbia are rocks of this age known. This apparently was a time of orogeny, uplift, and erosion during which middle Bajocian and Callovian conglomerate was shed from an emergent area.

The relation of map-unit 8 to units above and below is imperfectly known. Apparently the strata rest on unit 6 without angular discordance but with a marked change of lithology. Lack of diagnostic fossils prevents any estimation of the completeness of the sedimentary section. An apparent time gap (upper Callovian and lower Oxfordian) and a change of lithology indicate an erosional unconformity between map-unit 8 and the overlying Relay Mountain Group (Jeletzky, 1968).

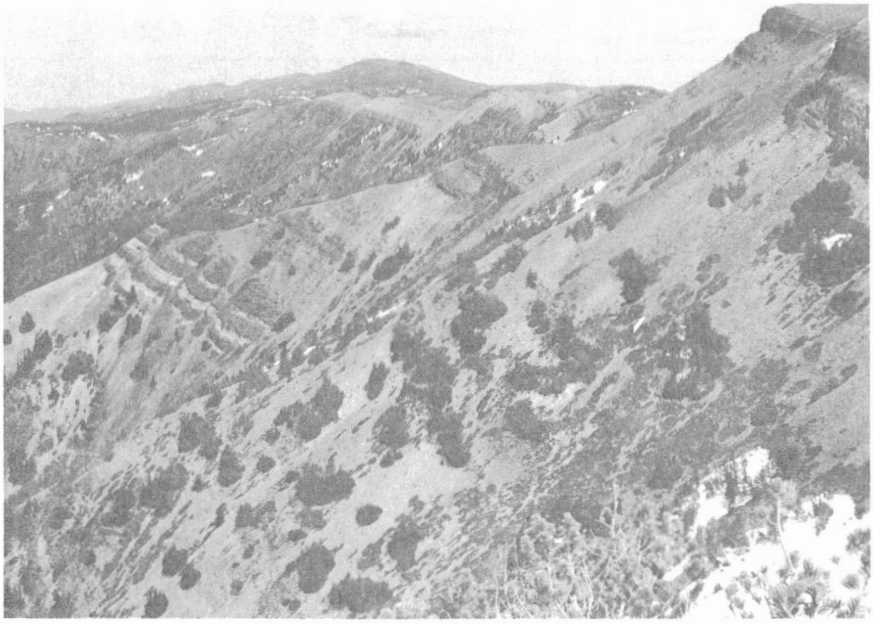

Figure 3. View northerly along west side of Potato Range showing Lower Cretaceous Relay Mountain Group sediments. Light coloured beds are mainly arkose.
(Photo by J.A. Jeletzky)

Relay Mountain Group (map-units 9 and 10)

In Taseko Lakes map-area a sequence of Late Jurassic and Lower Cretaceous greywacke, shale, siltstone, conglomerate and arkose has been named the Relay Mountain Group (Jeletzky and Tipper, 1968). The group extends across the area in a northwesterly direction and in Mount Waddington area, sections of similar lithology and the same age are considered the extension of the group.

The Relay Mountain Group is exposed on Potato Range, on the range east of Potato Range, on Tullin Mountain, and on the west end of Mount Nemaia. It is a section of interbedded greywacke, conglomerate, arkose, shale, and siltstone of Late Jurassic (Oxfordian) to Early Cretaceous (Barremian) age (Fig. 3). For the most part it contains abundant diagnostic fossils that serve to distinguish it from several other rock groups of different age but similar lithology. The following typical sections, here presented in abbreviated form were measured by J.A. Jeletzky.

Section JA-F67-4 across top of Potato Range in a northwesterly direction near spot elevation 7,200 feet, 51°35'N, 124°20'W.

Unit	Lithology	Thickness (feet) Unit	Total from base
	Barremian(?)		
13	Greywacke, dull greenish grey on fresh surface, weathers dull brownish grey; mainly fine grained, thin-bedded to laminated....	130+	1422+
12	Greywacke, dark greenish grey to dull greenish grey on fresh surface, weathers to speckled green and rust; mostly coarse to very coarse grained, in places grit or pebbly greywacke.....	250	1292
11	Greywacke, dull greenish grey on fresh surface, weathers dull brownish grey; mainly fine grained, thin-bedded to laminated, crossbedded in places; resistant forming steep cliffs.....	265	1042
10	Interbedded dull brownish grey greywacke, minor beds of grit and fine to medium pebble conglomerate 6 to 18 inches thick and beds of dark grey siltstone 3 to 6 feet thick	250	777
9	Dark brownish grey sandy siltstone interfingered with greenish grey greywacke; some clay ironstone bands 3 to 4 inches thick rarely containing carbonized wood fragments	35	527
8	Greywacke, dull brown-grey on fresh surface, weathers dark rusty brown or speckled brown; mostly fine grained but some interbeds of medium-grained greywacke near top; friable, commonly weathering spheroidally; gradational contact above and below.....	80	492
7	Subgreywacke, light greenish grey to whitish grey on both fresh and weathered surface; mostly medium grained, poorly sorted and rounded; some arkose interbeds, grit and pebble conglomerate bed 35 feet from base;		

Unit	Lithology	Thickness (feet) Unit	Total from base
	mostly massive but includes thinly bedded to laminated beds in places; unit thins southerly and is replaced by units above and below with which contacts are gradational	66	412
6	Interfingered green-grey greywacke and fine to very fine silty greywacke and sandy siltstone; greywacke thins and pinches out southward	86	346
5	Greywacke, green-grey on fresh surface weathering brownish green to dull brown; medium to fine grained; friable and weathers spheroidally; poorly sorted and rounded; some 1- to 5-foot lenses of very fine, chocolate brown to dark grey silty greywacke or sandy siltstone	35	260
4	Siltstone, dark grey and sandy commonly grading into dark greenish grey very fine silty greywacke; some interbeds of fine to coarse sandstone, unit pinches out southward	63	225
3	Coarse to fine pebbly feldspathic sandstone and greywacke; speckled green-grey weathering dull grey or green; weathers spheroidally; in massive and resistant beds; numerous interbeds and lenses of grit and pebble conglomerate to 3 feet thick; interfingers with overlying siltstone and pinches out southward	123	162
2	Covered interval	35	39
1	Arkose, buff to beige coloured; medium grained weathering rust-coloured	4+	4

The above section presumably conformably overlies Section JA-F67-2 described below. The rocks of the foregoing section are believed to be Barremian (see subsequent discussion).

Section JA-F67-2 on the western slope of Potato Range measured along north northwesterly trending ridge about 1/2 mile north of spot elevation 7,200 feet, 51° 36'N, 124° 20'W.

Unit	Lithology	Thickness (feet) Unit	Total from base
64	Irregular interbeds of arkose and subgreywacke, mainly light greenish grey weathering whitish grey or buff; medium grained to gritty and pebbly (rarely); carbonized plant remains	64	4296
63	Pebble conglomerate, fine, dull greenish grey; closely packed pebbles 1/4 to 1/2 inch in diameter, gritty and coarse sandy matrix, rounded pebbles of a buff intrusive porphyry	19	4232
62	Thinly interbedded greenish grey, speckled, fine-grained subgreywacke and light grey feldspathic sandstone; lenses of buff siltstone and pebble conglomerate; crossbedded, carbonized plant remains; gradational contact below	100	4213
61	Siltstone, dark green-grey to brown-grey weathering dull brown-grey; sandy grading into silty greywacke; recessive	70	4113
	Hauterivian		
60	Greywacke, fine grained, dark brown-grey weathering dark coffee brown with rusty specks; contains abundant Inoceramus colonicus Anderson; Simbirskites (Simbirskites) cf. kleini (Newmayr and Uhlig) in upper part; gradational lower contact	100	4043
59	Greywacke, as in above unit but is harder; scattered pebbles and gritty greywacke beds; lenses of pebble conglomerate; 1- to 3-inch concretions in lower 10 feet; contains rare Acroteuthis ex gr. impressa Gabb and Pleuromya cf. vancouverensis Whiteaves; lower contact is uneven and sharp.....	22	3943

Unit	Lithology	Thickness (feet) Unit	Total from base
	Valanginian		
58	Interbedded light greenish grey to light grey, fine to coarse arkose and pebbly grit; cross-bedding and laminations occur locally in fine greywacke interbeds; arkose predominates; lenticular bed of conglomerate occurs locally in top part of unit; Buchia sp. indet. found in float from the upper and middle part of the unit	73	3921
57	Greywacke, dull grey weathering coffee brown to greenish brown; fine grained but may have scattered pebbles; massive and resistant; contains rare Buchia ex gr. crassicollis (Keyserling) and B. ex gr. keyserlingi (Lahusen) 4.5 feet below top of unit; gradational contact below	24	3848
56	Arkose as in unit 58 but almost exclusively fine-grained and slabby; buff to yellowish white coloured; gradational contact below .	52	3824
55	Greywacke as in unit 57; fragment of Buchia sp. in talus apparently locally derived	57	3772
54	Arkose as in unit 58; considerable medium-grained arkose; numerous 1- to 3-inch inclusions of dusky-white arkose in middle part; massive and friable	30	3715
53	Subgreywacke, buff with rusty specks; carbonaceous specks, massive; poorly cemented; grades downward to next unit ...	30	3685
52	Subgreywacke or greywacke as in unit 30 but dull greenish brown weathering rust-brown; nodules of white kaolinitic(?) and arkosic fine-grained sandstone	58	3655
51	Greywacke, dull brownish grey weathering dull brown; weathers spheroidally; massive; mostly fine-grained but some		

Unit	Lithology	Thickness (feet) Unit	Total from base
	interbeds of coarser greywacke; contains Buchia inflata (Toula)-Buchia keyserlingi (Lahusen) fauna with admixture of B. pacifica Jeletzky and B. crassicollis (Keyserling) s. str.	50	3597
50	Arkose, light greenish grey; fine grained, indistinctly and thinly bedded, crossbedded, resistant; coaly laminae near base; grades to next lower unit	7	3547
49	Pebble conglomerate, light brown-grey with rust specks; pebbles 1 to 3 inches predominate of acid porphyry intrusive; lower contact sharp and uneven; channelling of lower unit	25	3540
48	Medium- to coarse-grained arkose and arkosic grit as in unit 58; in middle part of unit lenses of pebbles	64.5	3515
47	Covered interval	45	3450.5
46	Greywacke, fine grained as in unit 61, poorly exposed	35	3405.5
45	Arkoses and arkosic grits with interbeds of plant-bearing beige to cream coloured kaolinitic and arkosic sandstone in middle of unit	41	3370.5
44	Arkose, blue-grey medium to fine grained thinly bedded with laminae of carbonaceous to coaly greywacke	1.5	3329.5
43	Covered interval	2	3328
42	Arkoses and arkosic grits with interbeds of beige to cream coloured greywacke and siltstone; carbonaceous greywacke interbeds	90	3326
41	Medium- to coarse-grained arkose and arkosic grit with several 1- to 3-foot interbeds of pebble conglomerate	91	3236

Unit	Lithology	Thickness (feet) Unit	Total from base
40	Arkose, white to buff coloured with rusty specks; recessive; contains Buchia pacifica Jeletzky and Inoceramus sp.; grades to next lower unit	85	3145
39	Arkose and subgreywacke, light green-grey to light grey with interbeds of fine-grained coffee coloured greywacke; contains Buchia pacifica Jeletzky; lower half of unit is a thick Buchia coquina limestone	185	3060
38	Arkose, very kaolinitic, includes 20 to 30 per cent of Buchia pacifica Jeletzky coquina limestone as in above unit but a dirty white colour	80	2875
37	Arkose or subgreywacke and arkose interbedded with interbeds of Buchia pacifica-coquina limestone; rocks become darker green-grey and dark brown weathering downward in section; downward section becomes more a greywacke with interbeds of coquina limestones with Buchia fauna; typical Buchia pacifica Jeletzky in upper 105 feet of unit, a mixed fauna in next 24 feet, and typical Buchia tolmatschowi (Sokolov) in basal 41 feet of unit	170	2795
36	Pebble conglomerate, medium to coarse; granitic pebbles well rounded predominate	5	2625
35	Interbedded fine to coarse pebbly grit with crossbedded grey weathering greywacke; some lenses of conglomerate	12	2620
34	Covered interval; probably like above unit ..	80	2608
33	Arkose with interbeds of carbonaceous to coaly greywacke and sandy siltstone; resistant unit	170	2528
32	Covered interval	55	2358

Unit	Lithology	Thickness (feet) Unit	Total from base
31	Pebble conglomerate with interbeds of grit and siltstone; abrupt contact with underlying unit	60	2303
30	Siltstone, dark grey weathering brown-grey, massive; contains carbonized plant remains	7	2243
29	Subgreywacke, coarse grained, light rusty colour, massive, friable	5+	2236
28	Covered interval	60	2231
27	Arkose and very fine greywacke	10	2171
26	Siltstone, buff to light grey; locally grades to fine silty greywacke; carbonized plant fragments and coaly siltstone	40	2161
25	Arkose with interbeds of coaly greywacke and siltstone; recessive	95	2121
24	Covered interval	30	2026
23	Irregular alternation of dirty white to dull grey and brown-grey arkosic sandstone; massive; medium to fine grained; friable ..	35	1996
22	Arkose, buff to dirty white with interbeds of greenish grey arkose; fine to medium grained, 'peper and salt' colour; mainly massive to indistinctly bedded; friable	21	1961
	Berriasian		
21	Coquina limestone, light grey; weathering a speckled greenish yellow and dark brown; thin bedded to laminated, locally pebbly; coquina consists of squashed and closely packed fragments and shells of Buchia uncitoides (Pavlow s. lato)	14	1940
20	Greywacke, bluish grey weathering brown-orange with dark grey specks; mostly		

Unit	Lithology	Thickness (feet) Unit	Total from base
	fine-grained but locally pebbly, interbedded with thin (3- to 10-inch) beds of pebble conglomerate with granitic pebbles; contains in uppermost beds rare Buchia uncitoides (Pavlow) and small forms of B. okensis (Pavlow)	16	1926
	Berriasian to Portlandian		
19	Arkose, whitish yellow to buff or green-grey; medium grained, friable, slabby ...	14	1910
18	Greywacke as in unit 20 with same conglomerate interbeds	25	1896
17	Greywacke, resistant forming a cliff; interbeds of greywacke, grit and fine pebble conglomerate	60	1871
16	Arkose, fine to medium grained; whitish yellow to buff or green-grey; some carbonized wood	80	1811
15	Arkose, dirty white to greenish white or buff, weathering yellowish white; mostly coarse grained, locally gritty and pebbly; thinly and indistinctly bedded and crossbedded; contains carbonized plant remains	20	1731
14	Covered interval	70	1711
13	Siltstone, dull grey or dark-grey to greenish grey; weathering light brown or buff; a few interbeds of carbonaceous greywacke; friable and recessive; about 70 feet from top of unit a locality of well-preserved plant fossils ..	118	1641
12	Arkose, dirty white to greenish white with interbeds of dark grey and rusty arkose or subgreywacke in upper part	100	1523

Unit	Lithology	Thickness (feet) Unit	Total from base
	Portlandian		
11	Arkose, fine to medium grained with interbeds of greywacke; contains a pelecypod fauna Trigonia sp., Pleuromya sp. Buchia n. sp. aff. piochii (Gabb) in the 15- to 40-foot interval from the top; lower in the unit the same fauna occurs again but with some B. cf. mosquensis (Buch)	230	1423
10	Covered interval	140	1193
9	Arkose with interbedded arkose and greywacke; hard, dense, light grey	75	1053
8	Greywacke, dull greenish grey weathering light brown-grey to grey with rusty specks; fine grained; massive	90	978
7	Covered interval	30	888
6	Greywacke as in unit 8 but fossilliferous; near top contains late forms of Buchia mosquensis (Buch) or early forms of Buchia n. sp. aff. piochii (Gabb); lower in the unit another occurrence of B. mosquensis (Buch) and B. n. sp. aff. piochii (Gabb)	180	858
5	Covered interval	45	678
4	Greywacke, dull greenish grey; sheared and prominently jointed	135	633
3	Covered interval	128	498
2	Greywacke, dull greenish grey with irregular pods of pebbly coquina limestone; fossils collected were typical Buchia mosquensis (Buch), B. mosquensis var. rugosa (Fischer) Cylindroteuthis-like belemnites and unidentified pelecypods; pebbles were of an intrusive rock	30+	370

Unit	Lithology	Thickness (feet) Unit	Total from base
	Basal Portlandian and Kimmeridgian		
1	Greywacke as in unit 6; massive and dense in upper 220 feet below top greywacke is ferruginous and contains carbonized wood and typical Buchia mosquensis (Buch); 245 to 250 feet from top a brown weathering calcareous greywacke with early forms of Buchia mosquensis (Buch), B. lindstroemi (Sokolov) and other invertebrates including fragments of ammonites	340	340
	Base covered.		

The preceding section does not include the base of the Relay Mountain Group but the following one does. A small gap may or may not separate the two sections. The section is about 18 miles southeast of the foregoing and is fairly typical of the basal parts of the group. It illustrates the relationship of the group to the underlying rocks.

Section JA-F67-7 (in part) on the west-northwest shoulder of ridge extending west from Mount Nemaia 51°28'45"N, 124°9'10"W.

Unit	Lithology	Thickness (feet) Unit	Total from base
	Fault contact with Albian-Aptian rocks.		
	Kimmeridgian(?)		
7	Siltstone dark to blackish grey, weathering lighter grey, hard and massive	600	1701.5
6	Greywacke, dark, mottled brown, fine grained, friable; contains 2- to 4-inch limestone nodules in lower half of unit	31.5	1101.5
5	Greywacke, dense, massive, fine grained; some interbeds of coarser greywacke; sharp but irregular upper contact	120	1070
4	Siltstone, dark grey to black, weathering yellow-brown and rusty; contains some		

Unit	Lithology	Thickness (feet) Unit	Total from base
	interbeds of similar silty greywacke in basal 35 to 40 feet	240	950
3	Greywacke, light greenish grey to light bluish grey, weathering dull brownish grey; fine grained and well-sorted; massive; contains poorly preserved fossils Buchia ex. gr. mosquensis (Buch); Trigonia sp., Grammatodon sp.	337	710
	Early Kimmeridgian and late Oxfordian		
2	Greywacke, rusty weathering; contains many concretions and lenses of calcareous and ferruginous greywacke; one bed contains abundant Buchia concentrica (Sowerby) and B. lindstroemi (Sokolov)	62	373
1	Greywacke, dark grey-green to dark green, weathering dark brown to rust brown; the base of unit contains coarse gritty greywacke or fine grit in lenses up to 50 feet long; lower contact erosionally disconformable; fossils at the base include Buchia concentrica (Sowerby) and Cylindroteuthis (Cylindroteuthis) sp.	311	311
	Dark grey and ash grey soft shales with limestone concretions; contains the mid-Callovian ammonite Lilloettia sp.		

In Taseko Lakes map-area (92O) to the east Jeletzky and Tipper (in press) designated the Tyaughton Trough as the basin of deposition of Upper Jurassic and Lower Cretaceous sedimentary and volcanic rocks. The trough is trending northwesterly, subparallel or parallel to the trend of the Yalakom Fault. It was flanked on the northeast by the Pinchi Geanticline (Wheeler, 1967, p. 6) or Nelson uplift (Rudkin, 1965, p. 159) from which sedimentary material was carried southwesterly to the site of deposition. A source area to the southwest featured volcanic activity from which the trough intermittently received volcanic fragmental material together with other detritus. In Mount Waddington map-area the sediments of the Relay Mountain Group were derived from the north and northwest and thus may lie near the northwesterly end of the trough. The strata cannot be traced continuously to the type locality of the group in Taseko Lakes map-area (Jeletzky and Tipper,

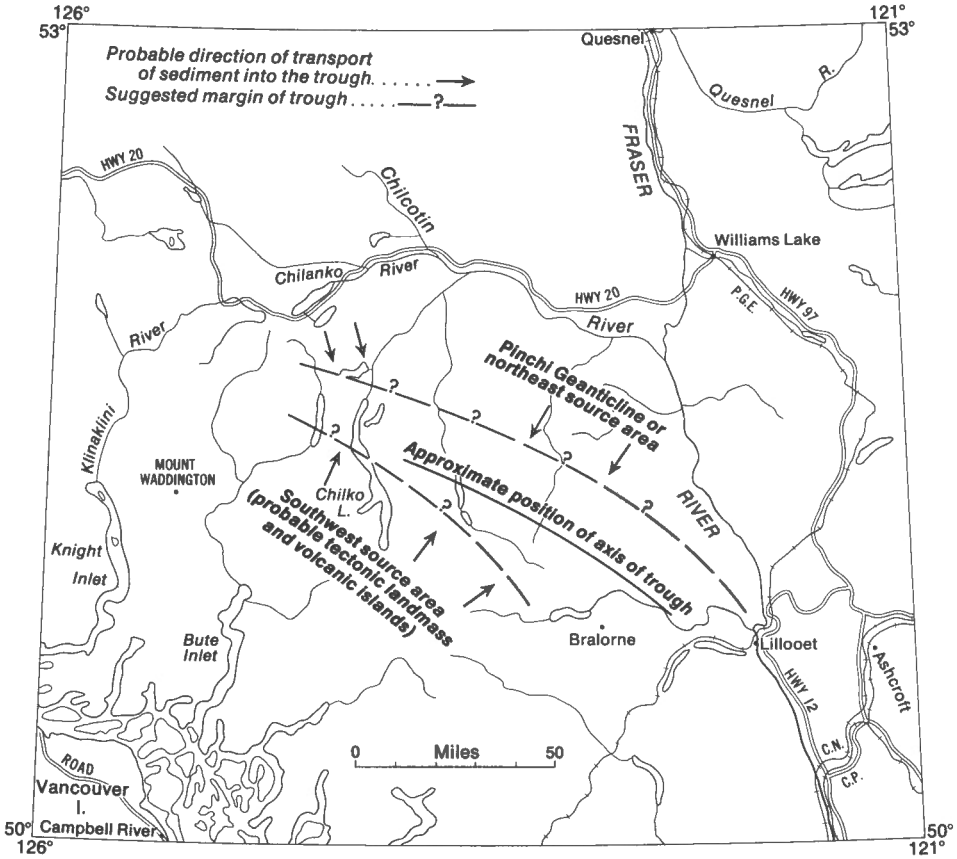

Figure 4. Position of Tyaughton Trough during Valanginian time

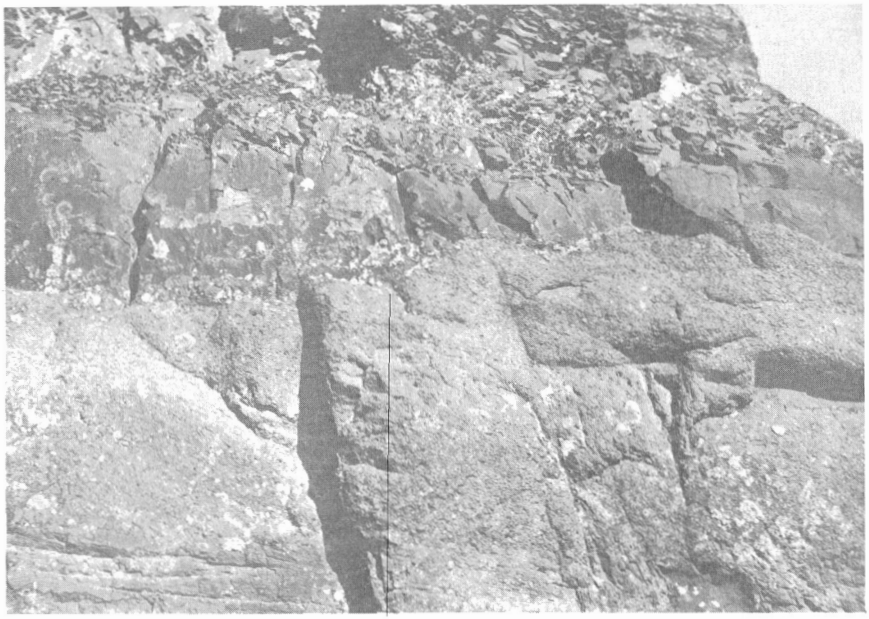

Figure 5. Disconformable contact between upper(?) Hauterivian and upper Valanginian rocks of Relay Mountain Group, west slope of Potato Range. (J.A.J. 2-5-67)

1968) but they span the same time interval and are lithologically similar though generally coarser grained.

In Mount Waddington map-area the Relay Mountain Group can be separated into upper and lower divisions (map-units 10 and 9 respectively). The upper division is characterized by thick beds of coarse arkose, conglomerate, and coquina limestone. The lower division has less conglomerate, finer grained and less abundant arkose, thinner and fewer coquinoid limestone bands, more greywacke, and fewer fossils than the upper division. The contact between the two divisions is drawn below the oldest bed with a Cretaceous fauna (e.g. below unit 20 in Section JA-F67-2). Definite recognition of the divisions usually depends on diagnostic fossils which are commonly present.

The rocks of the Relay Mountain Group are probably primarily intercalated deltaic and neritic deposits. Crossbedding, channelling, plant remains, and the lens-like character of many beds support this contention and suggest that material accumulated rapidly. The abundance of arkose indicates proximity to granitic terrane which lay to the north and slightly west of north judging from crossbedding. From a distance, the west face near the northern

end of Potato Range clearly displays thick beds of arkose that thin rapidly southward to interfinger with greywacke bands. This is true of the upper Relay Mountain Group and the Valanginian rocks in particular. The lower Relay Mountain Group is not as well exposed but the proportion of siltstone and fine greywacke seems to increase toward the south.

The external structural relations are only partly known. Section JA-F67-7 rests disconformably on middle Callovian shale with the ammonite Lilloettia sp. The basal unit of the section contains Buchia concentrica Sowerby and so is of early Kimmeridgian or Oxfordian age, and may be as old as latest early Oxfordian. The contact marks an abrupt lithological and faunal change and a time gap is indicated. Late Callovian and most of early Oxfordian time is not represented in the faunal succession and because there are no beds to represent this interval, it is assumed that rocks of this age were never deposited or have been eroded. The upper contact relations are not known in the map-area but the group is believed to lie unconformably below Aptian or Albian strata (see below).

Internally the group is structurally conformable and contains few known disconformities. In Section JA-F67-2 unit 60 contains upper Hauterivian fossils and the underlying unit (59) rests with an uneven contact on unit 58 which is believed to carry Valanginian Buchias. Apparently middle and lower Hauterivian fossils are missing and an erosional interval is suggested by the irregular contact at the base of unit 59 (Fig. 5). Lower in the section there is no faunal record for rocks of late Portlandian to early Berriasian age but rocks deposited in this time span are units 12 to 19 of Section JA-F67-2, a total of 487 feet of section. These rocks contain abundant plant remains but show no evidence of an erosional interval and for these reasons this part of the section is believed to be non-marine. Other minor irregularities and channelling suggest erosional intervals but not of sufficient duration to be reflected in gaps in the faunal succession.

The age of the Relay Mountain Group is Oxfordian to Barremian. As indicated in the sections, the lower division contains Buchia fauna of latest early Oxfordian to mid-Portlandian age. Elsewhere in the area a few ammonites were collected from Oxfordian beds and were identified by H. Frebold as Cardioceras spp. The non-marine beds probably are partly Berriasian and as they are part of the lower Relay Mountain Group, this division is of Late Jurassic and earliest Early Cretaceous age. The upper part of the group is entirely Early Cretaceous and the fossils indicated in the section are typical of the group. The uppermost part of the group, Section JA-F67-4, is believed to be Barremian in age but did not yield fossils. These rocks must be no older than Barremian as they overlie those containing an uppermost Hauterivian fauna. Furthermore, to the south of the measured section, two localities yielded ammonite faunas that are most likely Barremian, probably as young as late Barremian or, less likely, Aptian (Jeletzky, 1968). The age of the upper Relay Mountain Group is therefore late Berriasian to late Barremian.

UPPER JURASSIC (KIMMERIDGIAN OR PORTLANDIAN) AND MID-LOWER CRETACEOUS (HAUTERIVIAN AND ?YOUNGER) ROCKS SOUTHWEST OF NIUT-TCHAIKAZAN FAULTS

The Relay Mountain Group, in Mount Waddington map-area was deposited along the northerly and northwesterly margin of the Tyaughton Trough, a northwesterly-trending elongate basin of deposition. The rocks described below (map-units 11 to 15 inclusive), are believed to have accumulated along the southwesterly part of the trough. They are contemporaneous with part of the sedimentary Relay Mountain Group but the section is much less complete and is dominantly volcanic.

Map-unit 11

Upper Jurassic rocks in a northwest-trending fault slice about 4 miles southwest of the north end of Tatlayoko Lake on Niut Mountain are lithologically unique in the map-area. No satisfactory section is known hence detailed stratigraphic information is lacking.

The rocks of this unit are mainly conglomerate, silty arkose, greywacke, tuff, and volcanic breccia. A partial section summarizes available data.

Unit	Lithology	Minimum thickness (feet)
15	Massive pebble and boulder conglomerate with boulders of hornblende granodiorite to 4 feet	50
14	Thin bed of coquinoid limestone with *Buchia mosquensis* (Buch) (identified by J.A. Jeletzky)	4
13	Covered interval	200
12	Silty arkose	150
11	Dark grey shale with small concretions	50
10	Arkose	60
9	Silty shale	10

Unit	Lithology	Minimum thickness (feet)
8	Conglomerate with many quartz pebbles and large irregular boulders of grey chloritized hornblende granodiorite up to 5 feet in diameter, poorly sorted	40
7	Shale	25
6	Arkose with scattered pebbles	25
5	Dark grey shale	5
4	Dark grey to black speckled tuff	20
3	Grey to greenish greywacke	15
2	Covered	50+
1	Arkose	10
	Fault Total	714 feet

Separate from this section are similar sedimentary rocks with interbedded green to purplish andesitic and basaltic breccia of unknown thickness. Numerous faults cut the strata and possibly rocks of diverse ages are included in the unit; for example the volcanic breccia could be younger than the sedimentary rocks. However the coarse-grained boulder and pebble conglomerate is definitely Late Jurassic and probably the tuff is also of this age.

One collection of fossils from rocks of the unit were identified by J.A. Jeletzky.

Field No. F4c-23S-TD GSC loc. 78623

Locality: Near Niut Mountain 124°28'W, 51°37'N.

Buchia mosquensis (Buch) sensu lato

Age and correlation: Mid-Kimmeridgian to early Portlandian senso stricto. Some part of *Buchia mosquensis* zone.

Although these rocks are poorly known and of limited extent they are important in structural and paleogeographical interpretation. In lithology they contrast sharply with the finer-grained Kimmeridgian sedimentary rocks 6 miles to the east in the Relay Mountain Group. The latter group does not contain coarse conglomerate nor Late Jurassic volcanic rocks. The strata

of map-unit 11 reflect a very difficult provenance as compared to those of the Relay Mountain Group though they were deposited in the same trough at the same time.

Hauterivian and ? younger rocks (map-units 12 and 13)

A group of mid-Early Cretaceous (Hauterivian and ? younger) sedimentary and volcanic rocks, derived from the southwest side of Tyaughton Trough, underlies the area between Perkins Peak and Tatlayoko Lake, northwest of Homathko River Valley. They are also exposed in a small area near Mount Dartmouth north of Tredcroft Glacier and volcanic rocks on Mount Good Hope and in the Nine Mile Creek area are included in map-unit 13.

The two map-units occur together in most areas and the thickness of one relative to the other varies greatly from place to place. Map-unit 12 is mainly shale, siltstone, greywacke and conglomerate and map-unit 13 is mainly pyroclastic rocks, volcanic breccia and tuff, with a few interbeds of siltstone or tuffaceous siltstone. Rare fragments of Inoceramus and other pelecypods are the only fossils found in map-unit 13. Map-unit 12 contains many fragmentary ammonites and non-diagnostic pelecypods but few are useful in dating the rocks or in aiding in interpretation of the complex structure.

The finer sediments of map-unit 12 are mainly dark grey to light grey siltstone, usually in massive beds 40 to 50 feet thick that rarely show laminations. These rocks locally are baked hard and brittle but otherwise are soft and friable and commonly have small fragments of prismatic shell material of the pelecypod Inoceramus. In places they are tuffaceous. Other fine-grained sediments are laminated shales or laminated argillites with vari-coloured laminae and bands from 1/16 inch to 2 inches thick, rarely up to 5 or 6 inches thick. Some of the bands show fine-scale graded bedding. Beds of carbonaceous shale are common in the upper parts of several sections, commonly just below the overlying volcanic rocks of map-unit 13. Usually thin or thick interbeds of greywacke are found in any dominantly shale-siltstone section. The arenaceous rocks of the map-unit are commonly greywacke or rarely thin quartz sandstone. Dark grey to greenish grey, well-sorted greywacke in beds 2 to 3 feet and up to 15 feet thick is common but varies to both poorly sorted pebbly greywacke and silty varieties. Arkosic rocks are rare. Interlayered with these rocks are thin bands of conglomerate with well rounded pebbles of chert, limestone, and volcanic rocks embedded in a greywacke matrix. Beds of pebble to cobble conglomerate up to 150 feet thick are locally present but these thin rapidly and do not form persistent markers. Clasts up to 5 inches of well rounded fragments of chloritized hornblende granodiorite are common particularly north of Homathko River. Fossil plant fragments, abundant in the upper part, are distributed throughout the unit.

The volcanic rocks of map-unit 13 are mainly pyroclastic. Flows were not definitely recognized but many dykes and sills are present and some of these may in fact be flows. The breccia varies from dark to light green, grey, light grey, and light mauve-grey. In places dark red-brown breccia-conglomerate or purplish breccia is interbedded. The angular fragments of the breccia average 1/2 inch and rarely exceed 3 inches in diameter. They are green, grey, and less commonly maroon, feldspar porphyry with stubby feldspar phenocrysts. Some are fine-grained non-porphyritic and rarely vesicular and amygdaloidal volcanic rocks. The breccia is fresh and unaltered except near intrusions and faults where they are characteristically altered to dull green or grey rocks in which the fragmental nature is obscure. Interlayered with the breccia are fine well sorted, green to grey or dark grey massive tuff beds. In a few places, laminated waterlain tuffs show cross-bedding on a fine scale but commonly the tuffs are in massive beds 10 to 20 feet thick or thicker. Rare beds of white weathering dark grey siltstone are interlayered with the tuff, but coarser sediments are not associated with them. The volcanic rocks are apparently mainly andesite with minor dacite and basalt. Along the contact of the Coast Plutonic Complex between Perkins Peak and Middle Lake altered volcanic rocks of the map-unit are epidotized and chloritized and cut by a stockwork of granitic and volcanic dykes so that their original character is obscured.

Sections of map-units 12 and 13 have not been satisfactorily measured because of complexities introduced by folding, faulting, and intrusion; abrupt lateral thinning and facies changes are also believed to be complicating factors. Any one section does not necessarily characterize the units as a whole; the history of deposition must be inferred from a composite of all data.

In the area of Perkins Peak-upper Klinaklini River Valley both map-units are exposed. A generalized section is as follows:

Unit	Lithology	Minimum thickness (feet)
	Map-unit 13	
4	Volcanic rocks mainly, greenish tuff and breccia, dark grey to grey tuff and breccia; reddish brown to maroon breccia-conglomerate and purplish breccia occur high in the unit; thin beds of brittle shale or siltstone are interbedded in places	5000+

Unit	Lithology	Minimum thickness (feet)
	Map-unit 12	
3	Unit of interbedded massive grey siltstone and greenish greywacke on Perkins Peak that becomes entirely siltstone to east along Klinaklini River, abundant fragments of Inoceramus sp., unidentified pelecypods and poorly preserved ammonites Simbirskites (Simbirskites) sp. of middle or late Hauterivian age have been identified and dated by J.A. Jeletzky; carbonaceous shales in upper part	2500+
2	Interbedded poorly sorted greywacke and moderately well sorted greywacke in massive beds that rarely show well defined bedding planes. Rocks have irregular fragments of fine-grained volcanics and feldspar and chert; commonly a greenish to grey colour weathering yellowish brown or sandy; a few pods or lenses of calcareous greywacke; a few thin, laminated, rusty weathering or grey weathering dark grey or black siltstone; thin beds and lenses of pebble conglomerate	6500+
1	Pebble conglomerate and cobble conglomerate in massive beds, closely packed with pebbles and cobbles up to 4 inches in diameter; thin interbeds of greywacke; pebbles are mainly volcanic porphyritic or aphanitic rocks, a few argillite pebbles, and few to many pebbles and cobbles of coarse-grained plutonic rocks	1500+

Base not exposed.

Around Kleena Kleene post office and from south of One Eye Lake to Miner Lake typical breccia of map-unit 13 is exposed but faults are closely spaced. A meaningful estimate of the thickness is not possible. At Kleena Kleene post office, a thin laminated black shale unit about 50 feet thick lies below the volcanic rocks and may be the uppermost part of map-unit 12. These beds contain abundant plant fragments including a few poorly preserved leaf imprints.

The creek flowing into the north end of Sapeye Lake cuts a canyon through rocks of map-unit 12. This section is intensely faulted and is a pendant in granitic rocks outcropping to the north and south. The section was studied by Jeletzky (1968) who found several hundred feet of siltstone, shale and greywacke in several fault slices. Lack of sufficient fossil evidence precludes a satisfactory reconstruction of the stratigraphic succession. One important unit is 250 to 300 feet of black arenaceous and tuffaceous(?) siltstone or shale and black fine-grained, crossbedded greywacke that contain abundant Inoceramus n. sp. This Inoceramus is the same as that recorded from the middle Hauterivian rocks of the Tchaikazan River area to the southeast (Jeletzky, 1967, p. 65). It is Type B in Table II. Overlying this unit are interbedded fine-grained, massive greywacke, and dark grey shale with the middle Hauterivian ammonites Simbirskites (Hollisites) and Speetoniceras spp. also identified by J.A. Jeletzky. One fault slice of a non-marine section of interbedded siltstone, arkose, shale and greywacke includes abundant fragments and beds of carbonaceous to coaly shale. Whether this overlies or underlies the Simbirskites (Hollisites)-Speetoniceras fauna is not known but as all these rocks resemble the upper units of map-unit 12 on Perkins Peak, the former is believed to be the case.

The rocks of Niut Mountain area are similar to those of the Perkins Peak area. Map-unit 13 forms a thick upper unit of unknown thickness, probably several thousand feet but intrusions and faulting have complicated the section. Reddish breccia-conglomerate is present in this section. Below the volcanics a thick unit of grey to dark grey shale and siltstone with interbedded greywacke contains the middle Hauterivian ammonite Speetoniceras agnessense Imlay identified by J.A. Jeletzky. Greywacke and conglomerate in fault slices presumably are older than the fossiliferous beds. It is difficult or impossible to reconstruct the section in the Niut Mountain area but it is thought to be thinner than that in the Perkins Peak or Razorback Mountain areas.

From Razorback Mountain southeast to Homathko River map-unit 12 is complexly folded, faulted, and intruded. Although fossils are abundant, they seldom indicate anything other than a general Hauterivian-Barremian age according to J.A. Jeletzky. Because of the lack of distinctive lithologic markers as well as the lack of paleontologic control, no satisfactory stratigraphic section has been worked out. A generalized sequence follows:

Unit	Lithology	Minimum thickness (feet)
3	Interbedded black carbonaceous shale, light grey to cream coloured arkose, fine pebble conglomerate and grit, unsorted greywacke with wood fragments. This is generally a non-marine section but with a few	

Unit	Lithology	Minimum thickness (feet)
	marine interbeds. Shale contains abundant plant imprints and greywacke yielded one or two non-diagnostic pelecypods	500-600
2	Massive beds of black, Inoceramus-bearing siltstone and shale with thin interbeds of greenish greywacke weathering grey or buff. Limy concretions occur in the siltstone. Acroteuthis impressa Gabb is a common fossil and one locality contains Speetoniceras sp. indet. Crioceratid-like ammonites were also found as well as numerous indeterminate pelecypods. All fossils have been identified and dated by J.A. Jeletzky	1500-2000
1	Coarse greywacke, pebbly greywacke and siltstone interbedded in massive beds with coarse to fine pebble conglomerate. Conglomerate is poorly sorted but closely packed. Pebbles vary in diameter to 4 inches, usually 1 inch to 2 inches. Pebbles of volcanic rocks, limestone, chert, and granitic rocks. Indeterminate pelecypods are common in the unit. One ammonite, resembling the early Hauterivian Homolsomites packardi (Anderson) was found and identified by J.A. Jeletzky. The thickness is estimated at several hundred feet, possibly as much as 2,000 feet. Southwesterly the conglomerates give way to a greywacke-siltstone sequence	2000+(?)

North of Tredcroft Glacier 2 1/2 miles northeast of Mount Dartmouth a section of rocks of map-unit 12 was studied and measured by Jeletzky as Section JA-F67-10.

Unit	Lithology	Thickness (feet) Unit	Total from base
	Middle (?)Hauterivian		
18	Greywacke, light brown-grey; massive.....	48	1749

Unit	Lithology	Thickness (feet) Unit	Total from base
17	Shale, black, friable, thin laminations 1/4 to 1 inch thick, poor fragments of Inoceramus sp.	28	1701
16	Greywacke, light brown	61	1673
	Middle Hauterivian		
15	Interbedded laminated shale and siltstone contains Inoceramus n. sp. Type B	42	1612
	Middle and early Hauterivian		
14	Greywacke, massive with interbeds of shale and siltstone; contains Inoceramus fragments	193	1570
13	Covered interval, probably black shale	47	1377
12	Greywacke, massive, dense, few interbeds of tuffaceous greywacke; poor Inoceramus and ammonite fragments	53	1330
11	Interbedded dark grey to black shale and siltstone with fine carbonaceous greywacke; contains Inoceramus and other pelecypods	25	1277
10	Greywacke, dark, grey and rust-coloured interfingered with dark siltstone	25	1252
9	Shale, hard, dark grey with grey limestone concretions; contains Acroteuthis impressa Gabb	67	1227
8	Greywacke, medium grey, limy, massive, hard; Inoceramus sp.	35	1160
	Early Hauterivian		
7	Shale, with limy concretions 6 to 18 inches in diameter; Inoceramus fragments are		

Unit	Lithology	Thickness (feet) Unit	Total from base
	common as well as Acroteuthis impressa Gabb. Near base of unit Homolsomites oregonensis (Anderson) was found in concretions	125	1125
6	Arkose, light brown-grey	30	1000
5	Shale, dark grey to black without coarser interbeds; a few Acroteuthis cf. impressa Gabb	125	970
4	Snow covered interval	220	845
3	Greywacke, dull grey, mottled. Interbeds of grit, pebbly grit, and pebble conglomerate; contains Inoceramus ex. gr. colonicus (Anderson)	330	625
2	Interbedded coarse-grained greywacke and fine to coarse grit; tuffaceous interbeds; greenish grey	175	295
1	Siltstone, dull-grey weathering brown to chocolate brown	20	120
	Snow covered interval	100	100

The writer examined the section when the snow cover below unit 1 had melted. This 100-foot interval is mainly greywacke, siltstone and fine pebble conglomerate forming an uneven contact with the Triassic sediments below. Some pebbles of the conglomerate are limestone but most are volcanic. Although the contact is somewhat sheared, the Hauterivian strata appear to rest unconformably on Triassic rocks with only a slight angular discordance.

The volcanic rocks near Mount Good Hope and Nine Mile Creek are included with map-unit 13 for two reasons, (a) a general lithologic similarity, and (b) a few fragments of Inoceramus shells were noted in shaly tuffs. Around Mount Good Hope the rocks are thoroughly altered, chloritized, epidotized and dioritized and most original structures have been destroyed. North and south of Nine Mile Creek the volcanic rocks are clearly pyroclastic, mainly well-bedded tuff, fine breccia, and tuffaceous siltstone and greywacke. North of Nine Mile Creek over 4,000 feet of coarse, bedded, greenish and purplish breccia are exposed near the base above hard massive argillite. On

the ridge south of Nine Mile Creek mainly pyroclastic rocks (fine breccia and tuff) and interlayered tuffaceous greywacke and siltstone are thoroughly baked by the granitic rocks to the southwest. A thickness of 10,000 feet or more is suggested but the section is probably repeated. Unquestionably the volcanic rocks of map-unit 13 are several thousand feet thick and may locally exceed 5,000 feet.

The structural relations of these two map-units are poorly known. Internally they form an apparently conformable succession; no disconformities were recognized and no major time gaps appear to exist. North of Tredcroft Glacier map-unit 12 unconformably overlies Upper Triassic rocks and a similar relationship is believed to apply generally to these strata suggesting transgressive deposition on the southwest side of Tyaughton Trough. The reasons for this supposition are (a) coarse conglomerate near the base of map-unit 12; (b) almost complete absence of Jurassic or early Early Cretaceous rocks where the Upper Triassic and map-units 12 and 13 outcrop together; (c) presence of detritus in Hauterivian sediments apparently derived from Triassic rocks; and (d) the observed unconformity north of Tredcroft Glacier.

Map-units 12 and 13 are evidently Hauterivian and ?younger. The upper part of map-unit 12 yielded plant remains as yet unidentified. Table II shows that middle Hauterivian fauna was found in all sections of these rocks whereas early Hauterivian fauna is locally missing because of incomplete sections. The age of map-unit 13 is believed to be late Hauterivian because (a) it conformably overlies middle Hauterivian rocks; and (b) in the Relay Mountain area to the east late Hauterivian strata include volcanic tuff. The possibility exists, however, that the volcanic rocks may in part be Barremian or Aptian, but this is not considered probable.

Map-units 14 and 15

The main outcrop area of map-units 14 and 15 is west of Chilko Lake and north of Franklyn Arm where they are exposed in a curved syncline. Elsewhere they occur as thin fault slices mainly along and near Stikelan Creek valley. These rocks are volcanic (map-unit 15) and sedimentary (map-unit 14) but little is known of their age or stratigraphic position. The only fossils present are fragments of Inoceramus and some extremely large Inoceramus shells but the stratigraphic value of these is in doubt. The rocks of both map-units stand out as bright red, maroon, reddish brown, and purplish red rocks that are not easily mistaken for other rock groups.

Map-unit 14 is a group of sedimentary rocks characterized by their red colour. Interbedded red, reddish brown, and maroon siltstone, greywacke and conglomerate form beds 1 foot to 2 feet to as much as 5 feet thick. Conglomerate is composed of chert, jasper, quartz, and red and green volcanic pebbles set in a reddish silty matrix. The siltstone is a dark maroon in

Table II. Hauterivian Faunal zones represented in Mount Waddington and Taseko Lakes map-areas.

	Faunal Zones	Potato Range	Perkins Peak	Sapeye Creek	Niut Mountain	Razorback Mountain to Homathko River	Tredcroft Glacier area	Tchaikazan River (Taseko Lakes area)	Stikelan Creek	Relay Mountain (Taseko Lakes area)
Late Hauterivian	Craspedodiscus cf. discofalcatus and Simbirskites (Simbirskites) cf. broadi	Simbirskites (Simbirskites) cf. kleini (Neumayr and Uhlig	(volcanic rocks, no fossils non-marine sediments	(volcanic rocks, no fossils) non-marine sediments	(volcanic rocks, no fossils) ?	(volcanic rocks, no fossils) marine and non-marine sediments	(volcanic rocks, no fossils) ?	(volcanic rocks, no fossils) non-marine sediments	(volcanic rocks)	Craspedodiscus cf. discofalcatus (Lahusen) and Simbirskites (Simbirskites) cf. broadi Anderson
Middle Hauterivian				Inoceramus n. sp. Type B			Inoceramus n. sp. Type B	Inoceramus n. sp. Type B	Inoceramus n. sp. Type A (position in doubt)	Inoceramus n. sp. Type A (position in doubt)
	Simbirskites (Hollisites) lucasi, Speetoniceras agnessense, and Simbirskites (Simbirskites) spp. indet.	unknown, probably absent	Simbirskites (Simbirskites) sp. indet.	Simbirskites (Hollisites) sp. and Speetoniceras spp.	Speetoniceras agnessense Imlay	Speetoniceras sp. indet.		Simbirskites (Hollisites) sp. indet.		Simbirskites (Hollisites) lucasi Imlay Speetoniceras agnessense Imlay
Early Hauterivian	Homolsomites packardi	unknown, probably absent	probably present	?	?	Homolsomites packardi (Anderson)	probably present no diagnostic fossils	Homolsomites packardi (Anderson)		unknown (assumed to be present)
	Homolsomites oregonensis and Inoceramus nov. sp. aff. quatsinoensis	unknown, probably absent	probably present	?	?	probably present	Homolsomites oregonensis (Anderson)	Homolsomites oregonensis (Anderson)		unknown (assumed to be present)

massive or occasionally laminated beds. Greywacke contains mainly greenish or grey fragments in a reddish silty matrix. Conglomerate pebbles are usually well rounded but near the top of the unit pebbles are subangular to angular and the rock is sedimentary breccia or breccia-conglomerate. Similar rocks occur with the volcanics of map-unit 13.

Interbedded with the reddish sediments are subordinate greenish shale and greywacke, grey to dark grey siltstone, greenish conglomerate and poorly sorted greenish breccia. Rare pale greenish white quartz sandstone forms massive, unstratified beds to 10 or 15 feet thick. Quartz grains are well-rounded.

Here and there minor light grey, very fine grained, buff weathering limestone beds vary from 2 to 50 feet in thickness. Some of the limestone is nodular. In places limy dark grey shale carries multitudes of closely packed Inoceramus fragments. In two or three localities layers of gigantic prismatic shell fragments suggest the presence of Inoceramus with shells up to 2 inches thick and in one case more than 8 feet long. In the Taseko Lakes area Inoceramus-like pelecypods over 4 feet long were found (Jeletzky, pers. comm.) so that the size indicated here is not unreasonable. Locally 1- to 2-foot beds of grey limestone are interlayered with massive beds of tuff and fine volcanic breccia.

The section as a whole is dominantly a red bed sequence of conglomerate, siltstone and greywacke with minor greenish, grey, and black sediments and some minor pyroclastic rocks. Although no section was measured, it was apparent that the non-red rocks increase downward in the section. Exposed sections may be as much as 4,000 feet thick as on the north side of Tredcroft Creek, but repetitions are suspected because elsewhere sections are seldom more than 400 feet thick though the base is invariably faulted or covered.

Massive purplish volcanic breccia and tuff (map-unit 15) apparently overlie map-unit 14 conformably. The contact is gradational from subangular sedimentary breccia to angular volcanic breccia. The volcanic breccia is dominantly coarse; fragments average about 1 inch and the largest are up to 8 inches across. The colour is predominantly purple, with maroon, light green and grey less common. The fragments are purplish andesitic porphyry with small phenocrysts of plagioclase feldspar. The breccia occurs in massive beds 10 to 100 feet thick. In places the breccia resembles volcanic conglomerate but the fragments are very coarse and poorly rounded, showing little evidence of transportation and sorting. No flows were noted with the breccias but dykes and sills of material similar to the fragments of the breccias are common. Rare bright red to purple tuff is interbedded with the breccia. This forms poorly stratified beds 1 foot to 2 feet thick. The thickness of the unit is estimated at 3,000+ feet.

As no complete sections of map-units 14 and 15 were measured or studied in detail and as diagnostic fossils, are lacking the structural relations of these rocks are not clear. Internally the strata appear to be structurally conformable. The total time-span represented by the deposits is unknown. In the area mapped unit 15 is not in contact with an overlying unit, but in Taseko Lakes area to the east similar rocks are overlain unconformably by conglomeratic and shaly rocks of presumed Albian age. The relation of map-unit 14 to older rocks is unknown as the base of that unit is faulted or concealed.

The age of map-units 14 and 15 is thought to be late and middle Hauterivian but the evidence for this is weak and inconclusive. No fossils other than large Inocerami are known and these are of dubious value. The arguments for Hauterivian age are as follows:

(a) The pelecypod Inoceramus, although not restricted to the Hauterivian stage, is nevertheless abundant in that stage throughout Mount Waddington and Taseko Lakes map-areas.

(b) In Taseko Lakes map-area large Inoceramus-like pelecypods were found in the Relay Mountain Group stratigraphically below a late Hauterivian ammonite fauna. Whether these Inoceramus-like pelecypods are related to those of the Mount Waddington area is, of course, unknown and their range is in no way restricted, however the comparison is suggestive at least.

(c) Reddish breccia-conglomerates and some purplish volcanic breccia in map-unit 13 are similar to rocks of map-units 14 and 15. As map-unit 13 is believed to be of late Hauterivian age, then units 14 and 15 must also be in part of this age if the comparison is valid.

(d) If the equivalent of map-unit 15 in Taseko Lakes area lies unconformably below rocks of probable Albian age then presumably it is pre-Albian and may in part be Barremian or Aptian. However map-units 14 and 15 bear no similarity to Barremian or Aptian rocks in this or adjoining map-areas.

Table II illustrates the correlation of the Hauterivian rocks of Mount Waddington and Taseko Lakes map-areas and indicates the faunal zones present. Of particular importance in later discussion is the dissimilarity of the upper Hauterivian rocks of the Relay Mountain Group and those of map-units 13 and 15, the former being almost entirely sedimentary and the latter being almost entirely volcanic.

LATE LOWER CRETACEOUS (ALBIAN) AND EARLY UPPER CRETACEOUS (CENOMANIAN) ROCKS

The end of Hauterivian time marked a change in the history of Tyaughton Trough. The trough was narrowed and bordering source areas were uplifted. Erosion and reworking of the earlier deposits contributed to the destruction of any record of Barremian or Aptian rocks with the exception of the Barremian of the Relay Mountain Group and the Aptian of Taylor Creek Group (see below). Subsequent to this period both marine and non-marine Albian deposits blanketed the area, followed by widespread deposition of non-marine Cenomanian sediments and volcanics. Although Albian and Cenomanian sediments were deposited over wide areas seemingly unrelated to Tyaughton Trough, there is evidence to suggest the persistence of the trough throughout this time. The greatest accumulation of sediment apparently coincided with the axis of the trough.

The map-units described below were deposited in Albian and Cenomanian time. Map-unit 16 (Taylor Creek Group) comprises marine sedimentary rocks deposited in the centre or southwest side of Tyaughton Trough. Map-unit 17 (Jackass Mountain Group) is a predominantly non-marine assemblage of sedimentary rocks of Albian age restricted mainly to the northeast side of the trough. Some marine beds are included with this unit. Non-marine sediments (map-unit 18) and pyroclastic volcanic rocks (map-unit 19) of Cenomanian age mainly, make up the Kingsvale Group.

Taylor Creek Group (map-unit 16)

The Taylor Creek Group in Taseko Lakes map-area has several distinct facies; the upper part is mainly chert pebble conglomerate and black marine shale, the middle and lower parts are mainly shale or siltstone in the east but westward become volcanic, whereas the lower part is entirely sedimentary and includes coarser material. Chert-pebble conglomerate is characteristic, shale is black to dark grey, and arenaceous rocks are greywacke, subgreywacke and quartzose sandstones.

In Mount Waddington area the lower part of the group is believed to be present on Mount Dartmouth and its eastern ridges. There the rocks are typically dark blue-black argillite in massive, hard beds up to 6 feet thick. Dark grey to grey siliceous siltstone forms beds 3 to 4 feet thick. A few bands of pure quartzose sandstone and minor lenses and beds of fine chert-pebble conglomerate with fine grit are interbedded. Some limy shales also are present. The rocks are massive, rarely laminated, concretionary, and contain wood fragments. Crossbedding in the arenaceous beds suggests transport from the southeast.

Near the base of the unit beds are thickest. Massive argillite forms beds to 20 feet and clean quartz sandstones are as much as 30 feet

thick. Near the top of the unit more thinly bedded shales predominate. The contact effect of the plutonic rocks to the southwest has baked and apparently silicified the rocks, an effect that decreases to the northeast. Pure quartz sandstone, a characteristic of the map-unit, indicates that the sediments are much more mature than any earlier sedimentary rocks in Tyaughton Trough. The section on Mount Dartmouth is about 1,000 feet thick.

On the north side of Mount Nemaia a second occurrence of the Taylor Creek Group lies conformably below the Jackass Mountain Group. These rocks are dark grey to black siltstone, shale and light greenish grey to bluish grey greywacke with a few thin interbeds or lenses of grit or fine pebble conglomerate that form non-laminated even beds 6 inches to 3 feet thick. The strata weather rubbly or platy if baked by nearby intrusions. The thickness of this unit is apparently over 3,000 feet but some repetition is probable.

The Taylor Creek Group also outcrops in a fault slice about 4 miles west of Bluff Lake. Here the poorly exposed rocks of unknown thickness are massive, fine grained, greenish grey greywacke, dark grey, massive siltstone, and black shale. They are not well indurated but are generally soft and weather recessively.

The rocks north of Mount Nemaia underlie the Jackass Mountain Group conformably but otherwise all known contacts of the group are faulted. In Taseko Lakes area a basal pebble conglomerate of the group overlies the equivalent of map-unit 15 with angular unconformity. The rocks on Mount Dartmouth similarly have coarser rocks near the base but no extensive conglomerate. The upper contacts of the group will be discussed with the Jackass Mountain Group, with which it interfingers, and with the Kingsvale Group which overlies it conformably in the Taseko Lakes map-area.

The age of the group is mainly Albian but probably includes upper Aptian rocks in its basal beds. The rocks on Mount Dartmouth yielded no fossils but the section is similar lithologically to rocks occurring in Taseko Lakes area, a short distance east of Chilko Lake, and these yielded an ammonite tentatively identified by J.A. Jeletzky as Hamites (s. stricto) sp. indet. of presumably Albian or ?upper Aptian age. The rocks are also lithologically similar to rocks in the Rivers Inlet area to the west which yielded an ammonite fauna tentatively referred to the middle Albian or ?late lower Albian.

The age of the part of the group north of Mount Nemaia is suggested by two ammonite faunas, one of which indicates early lower Albian age and the other indicates middle Albian age (Jeletzky, 1968, p. 104). These rocks are thought to be older than those on Mount Dartmouth. In the Taseko Lakes area, a few miles to the east in the same group of rocks, an upper Aptian ammonite was identified by J.A. Jeletzky as Acanthohoplites cf. reesidei (Anderson). An upper Aptian age must therefore be considered as possible for the lower parts of Taylor Creek Group but so far is only known in Taseko Lakes map-area.

The beds west of Buff Lake yielded one fossil collection identified by J.A. Jeletzky.

Field No. F3-11M-TD GSC loc. 79016

Locality: West of south end of Bluff Lake 124°46'00"W, 51°45'10"N.

uncoiled ammonite resembling Idiohamites sp. indet.
phylloceratid ammonite
Pleuromya sp.

Age and correlation: Possibly upper Albian to Cenomanian but cannot be dated confidently.

Jackass Mountain Group (map-unit 17)

The Jackass Mountain Group is exposed south of Lytton along Fraser River and outcrops over wide areas northwestward across Taseko Lakes map-area where it has been described (Jeletzky and Tipper, in press) as a non-marine sequence of greywacke, siltstone, and conglomerate that was deposited along the northeastern part of Tyaughton Trough in Aptian and Albian time. It is believed to be correlative as a whole or in part with the Taylor Creek Group with which it interfingers.

In Mount Waddington map-area, two regions are underlain by rocks that are lithologically similar to the Jackass Mountain rocks. They agree reasonably well in age and structural relations but differ in that there are apparently marine beds within the section. However the bulk of the beds are believed to be non-marine.

Jackass Mountain Group rocks outcrop in the centre of a doubly plunging syncline that is along and subparallel to Tsuniah Lake valley. The following section was measured by J.A. Jeletzky across the south limb in a north-south direction. It is presented here in an abbreviated form.

Unit	Lithology	Thickness (feet) Unit	Total from base
	Top 200 to 300 feet of section is inaccessible		
19	Interbedded coarse to medium grained gritty greywacke with fine to medium grained grit; dull brown to greenish grey, hard, massive, resistant	95+	6694

Unit	Lithology	Thickness (feet) Unit	Total from base
18	Boulder conglomerate, light grey; weathering spotted rust to brown; boulders of granitic material, well-rounded, 1 foot to 3 feet in diameter	21	6599
17	Greywacke, light bluish to greenish grey, weathering light brown; fine to medium grained, massive	52	6578
16	Interbedded coarse to very coarse gritty and fine to coarse pebbly arkose with pebbly arkosic grit; lenses and thin beds of granitic pebbles 1 inch to 8 inches in diameter; uneven contact below	8	6526
15	Interbedded dark grey, black, or dark greenish grey sandy siltstone with similar silty greywacke; lenticular beds 1 inch to 10 inches thick; slump structures noted; fragment of an ammonite and fragments of wood; in the upper part the siltstone is thin bedded and laminated and the dominant rock type	765	6518
14	Greywacke, light bluish grey to light greenish grey or dull brown-grey; 6- to 10-inch thick interbeds of dark grey siltstone; greywacke in massive beds 5 to 50 feet thick; slump structure noted; greywacke is resistant, siltstone recessive	2050	5753
13	Interbedded sandy siltstone, dark grey, and greywacke, dull grey to light green; friable, weathers spheroidally; abundant plant fragments and pieces of wood	160	3703
12	Greywacke, light bluish grey to light greenish grey with 3- to 6-inch thick bands of grit and pebbly greywacke. Poorly sorted; a few 3- to 18-inch beds of sandy siltstone; gradational with overlying unit	105	3543
11	Greywacke, as above but commonly very fine and dark grey coloured; several beds 4 to 8 inches thick with worm burrows	185	3438

Unit	Lithology	Thickness (feet) Unit	Total from base
10	Greywacke, light bluish grey to light greenish grey with interbeds of siltstone	148	3253
9	Irregularly interbedded dark to green-grey siltstone and fine greywacke; thinly bedded or laminated	76	3105
8	Greywacke, bluish grey to greenish grey; sheared; finely bedded or laminated	81	3029
7	Covered interval	50	2948
6	Greywacke, light bluish grey to light greenish grey, weathering light brown to buff; mostly fine grained; generally massive but pods of gritty and pebbly greywacke occur; interbeds up to 20 feet thick of dark grey to black sandy shale or siltstone; slump structures present	1915	2898
5	Black to dark grey or olive green shale and siltstone	26	983
4	Covered interval, probably shale and siltstone	25	957
3	Shale and siltstone with pods and lenses of greywacke; locally abundant wood fragments; slump structures	245	932
2	Covered interval, probably shale and siltstone	200	687
1	Black to dark grey or olive green shale and siltstone; more or less sandy in most beds grading to fine silty greywacke; pods and lenses of gritty and pebbly greywacke; slumping and channelling evident; wood fragments	240	487
	Covered interval	247	247

The Jackass Mountain Group is distinguished from the Relay Mountain Group within the map-area by its almost complete lack of arkose and by its massive, resistant greywacke beds that stand out as ridges and cliffs. The Relay Mountain Group is for the most part marine whereas the Jackass Mountain is typically non-marine with only rare marine interbeds.

About 7 miles north of Tatlayoko Lake is an area of Jackass Mountain Group rocks that are mainly massive greywacke with a few interbeds of pebbly greywacke and of siltstone. In one bed of coarse conglomerate the boulders are mainly granitic in composition.

The Jackass Mountain Group is essentially a conformable succession and is conformable with the underlying Taylor Creek Group but is not in contact with younger rocks. The age of the group is probably late(?) middle to late Albian as it conformably overlies the Taylor Creek Group containing a middle Albian fauna. Presumably it is older than the Cenomanian Kingsvale Group. In Taseko Lakes map-area the Jackass Mountain Group is believed to be a non-marine facies of the Taylor Creek Group and the two groups should interfinger. The observed fact that the Jackass Mountain Group overlies middle Albian Taylor Creek Group rocks in Mount Waddington map-area suggests that the Jackass Mountain Group is essentially younger. On the other hand, the probable marine interbeds in the Jackass Mountain Group may corroborate the suggestion that the two groups are partly contemporaneous and interfinger. The true relation between these groups is not satisfactorily established.

Kingsvale Group (map-units 18 and 19)

The Kingsvale Group is prominent in Princeton map-area, the type area (Rice, 1947, pp. 25-27), in Ashcroft map-area where it is divisible into a sedimentary member and overlying volcanic rocks (Duffell and McTaggart, 1952, pp. 55-58), and in Taseko Lakes area where two sedimentary and two volcanic divisions were recognized (Jeletzky and Tipper, in press). In the Mount Waddington map-area only two units are recognizable, a sedimentary section, Division A (map-unit 18) and an overlying volcanic succession, Division B (map-unit 19).

The sedimentary rocks of Division A are mainly interbedded soft, brown to dark grey shales and siltstones, friable sandy greenish to grey greywacke, and poorly to well consolidated pebble conglomerate. Shale and siltstone are more prominent low in the section and coarser clastics near the top. However, both fine and coarse well and evenly bedded clastic sediments are present throughout the section. Beds vary from 1 foot or 2 feet up to massive layers 40 or 50 feet thick. The conglomerate is not well sorted but the pebbles are well rounded and are composed of a great variety of rock types, volcanic rocks, argillite, chert, conglomerate, greywacke and a variety of intrusive rocks. Wood fragments are abundant throughout the unit and plant imprints were collected in places.

Figure 6. Cenomanian Kingsvale sedimentary and volcanic rocks east of Stikelan Creek. Stikelan Fault follows base of the slope across centre of photograph. View easterly from mountain north of Tredcroft glacier. (H.W.T. 2-10-67)

On the east side of Chilko Lake, south of Mount Nemaia a sedimentary section underlies the volcanic rocks of the Kingsvale Group but the base is cut out by a fault. As much as 2,000 feet of siltstone, shale, greywacke, and conglomerate are exposed in canyons near the base of the mountain. Soft shale is prominent in this section with considerable conglomerate at the top.

East of Stikelan Creek valley (Fig. 6), the Kingsvale Group sedimentary rocks occur as fault slices and no good section is known. The rocks are mainly interbedded shale, siltstone, and greywacke with pebble conglomerate. Some shales are calcareous and some have limy concretions. Typically the shale is grey to dark grey and the greywacke is light green to greenish grey. Commonly the shales are in beds 2 to 5 feet thick and the greywackes are 10 to 15 feet thick or more. Some 8- to 10-inch beds of marl are present.

Northeast of Mount Good Hope and south of Franklyn Arm the sedimentary rocks are exposed as a sequence as much as 3,000 feet thick. These rocks are generally coarse, pebble conglomerate and pebbles are mainly chert. Near the base coarse quartz sandstone is present but this may be part of the older Taylor Creek Group.

The volcanic rocks of Division B form very rugged mountains on the west side of Tatlayoko Lake, south of Tatlayoko Lake, south of Mount Nemaia, and around Franklyn Arm. These rocks are entirely pyroclastic with a few sills and dykes. Typically the rocks are green, grey, reddish and purplish andesitic breccia with angular fragments in massive beds 10 to 200 feet thick. Some beds are well sorted with fragments that suggest rounding but none of the rocks appear to be waterlain. Fragment size is 1 inch up to 2 or 3 feet but 6- to 10-inch size is common. The fragments were derived from a porphyritic to aphanitic rock but seldom are the rocks coarsely crystalline.

Interbedded with the breccia are thinner beds of tuffaceous rocks. These are usually but not always well sorted. They vary in colour from pale greenish white, deep maroon, grey, and green. Beds range from 2 to 10 feet in thickness. The beds of tuff stand out and give the volcanic unit a well bedded appearance, particularly evident east of Chilko Lake and west of Tatlayoko Lake. East of Chilko Lake, poorly bedded tuffaceous sedimentary rocks about 150 feet thick are interbedded with the volcanic rocks. Included with this unit is a conspicuous white, brecciated marl about 30 feet thick.

Along Chilko River, two areas of rocks similar to the Kingsvale Group have been mapped and because there are Kingsvale rocks to the east in Taseko Lakes map-area, they are included here. They could be older.

Division A and Division B are apparently conformable and the contact in places appears to be gradational from shale and siltstone into shaly tuff. In Taseko Lakes map-area the sedimentary rocks of Division A are conformable with the underlying Taylor Creek Group and this probably applies to Mount Waddington area although the contact was not recognized. No younger rocks are in contact with the group.

The age of the group is believed to be Cenomanian. Only plant remains and freshwater gastropods have been found in this map-area and these have not yet been identified. The gastropods from several widely separated localities near the top of the sedimentary section appear to be always the same species. In Taseko Lakes map-area plants near the top of the sedimentary section are Albian, Albian or Cenomanian, or Cenomanian in age. The group overlies the Taylor Creek Group conformably and in the latter marine upper Albian fossils were the youngest found. It is probable that the group is mainly or entirely Cenomanian in Taseko Lakes map-area and this should hold true for the Mount Waddington map-area.

In 1955 Fry (1959) collected petrified logs of Cupressinoxylon from the west shore of Chilko Lake south of Franklyn Arm. The writer did

not return to the locality but it appears that these logs were collected from the sedimentary rocks of the Kingsvale Group and would be of late Albian or Cenomanian age. Similar petrified wood occurs in the Kingsvale Group in Taseko Lakes map-area.

COAST PLUTONIC ROCKS

The main mass of the Coast Mountains is underlain by granitic and metamorphic rocks that have been referred to under many names such as Coast Range batholith, Coast intrusions, Coast Metamorphic Complex, and Coast Plutonic rocks. The map-units that have been described thus far, are mainly older than the granitic rocks along the eastern contact of the Coast Plutonic rocks and the investigation and description of those older rocks was the main purpose of this report. The Coast Plutonic rocks, a study in themselves, are being investigated by J.A. Roddick and W.W. Hutchison (1968, pp. 37-41). In this report only the stratigraphic relations of the various bodies and their age will be indicated. Reports on the Coast Plutonic rocks are already in print (Baer, 1967; Hutchison, 1965; Roddick, 1965) and others will follow in the near future.

The age of these rocks is varied. Map-unit B is believed to be younger than Early Cretaceous (in part younger than early Upper Cretaceous) and potassium-argon age determinations in Taseko Lakes area (Wanless et al., 1965, pp. 16-17) and in other parts of the Coast Mountains indicate that ages as young as Paleocene or Eocene are to be expected. However, granitic detritus believed to be derived from the Coast Mountains occurs in Upper Jurassic rocks (map-unit 11) and in Hauterivian rocks (map-unit 12). For these reasons, an older age of some granitic bodies in the Coast Mountains must be considered. Map-unit B_1 is one such possibility and could be the source of the detritus in map-units 11 and 12.

Map-unit B

The two small plugs on Mount Nemaia and the stock 10 miles to the west on the west side of Chilko Lake, display well defined contact relations. The rocks are equigranular, non-foliated granodiorite and have sharp contacts with Middle Jurassic strata (map-unit 8). The intrusions have baked and indurated the Jurassic rocks creating aureoles that, in the case of the plugs on Mount Nemaia, have radii of 3 to 4 miles. The rocks within the aureole are baked and pyritized so that they are hard and brittle and weather rusty. On the north side of Mount Nemaia early Albian Taylor Creek Group rocks are also affected by the contact metamorphism hence the plugs are probably post-Albian in age.

In the area of Mount Skinner dioritic and granodioritic rocks have an irregular and gradational contact with rocks of middle Jurassic age (map-unit 8) and presumed Triassic age (map-unit 6b). The outline of the mass is

difficult to define on this scale of mapping but the body is similar to those in the vicinity of Niut Mountain. The small bodies of granitic rock north of Choelquoit Lake are included in this map-unit but could be related to map-unit A.

A large sill-like body along Lingfield Creek, east of Tatlayoko Lake, is composed of buff to light grey feldspar porphyry and intrudes the Relay Mountain Group. Similar dykes and sills are common throughout the Relay Mountain Group in this area and are widespread in the Taseko Lakes map-area to the east where they are known to be post-Albian and are thought to be related to Eocene volcanism.

The dioritic to granodioritic generally non-foliated rocks south-east of Bluff Lake and around Niut Mountain and those northwest of Bluff and Sapeye Lake are varied in composition and texture. Contacts are generally gradational although in places they are sharp. These rocks are younger than Hauterivian and probably younger than Albian.

Southeast of Perkins Peak and on Whitesaddle Mountain irregular masses of granodiorite to diorite are emplaced in Hauterivian volcanic and sedimentary rocks. These appear to be closely related to the main mass of the Coast Plutonic rocks to the west which in this area has a very irregular, gradational contact. As mentioned previously this is an area of a multitude of dykes and sills of volcanic and granitic material and the older rocks are chloritized and epidotized.

The elongate granitic body along Homathko River has sharp contacts with the Triassic rocks (map-unit 1) and the Cretaceous rocks (map-unit 12) into which it has been emplaced. The surrounding rocks have been baked, particularly the Cretaceous sediments, and pyritized. The granitic rocks are apparently younger than the fault that separates the Triassic from the Cretaceous strata as the intrusive contacts have not been offset. However evidence of fracturing extends across the granitic mass hence slight, later movement may have occurred on the fault.

About 4 miles east of Mount Dartmouth a stock of granodiorite to quartz diorite is emplaced between a northwest trending transcurrent fault on the northeast and a thrust fault on the southwest. Neither cuts the granitic rocks hence the intrusion is believed to post-date the faults. The stock cuts Karnian, Hauterivian and Albian rocks and so is late Cretaceous or younger. The stock apparently domed the enclosing rocks which generally dip away from the contacts. The doming of the enclosing strata is evidently responsible for bringing Triassic rocks to the level at which they are now exposed.

The contact of the granitic rocks with the Triassic rocks south of Blackhorn Mountain is generally sharp and clear cut. The metamorphism that has affected the Triassic rocks is thought to pre-date the emplacement of these granitic rocks.

Map-unit B_1

There were some granitic rocks in the Coast Mountains by Late Jurassic time. One such body is tentatively thought to be the hornblende granodiorite on Homathko Peak. This has not been carefully studied and the contacts and extent shown on the map are subject to revision. The writer is of the opinion that these rocks are metamorphic and were formed by the same metamorphism that affected the Triassic rocks south of Blackhorn Peak and produced gneiss and schist north of the junction of Homathko River and Moseley Creek and on Reliance Mountain. As will be discussed later, this metamorphism is certainly pre-Hauterivian and possibly pre-Late Jurassic. If the granodiorite on Homathko Peak is a product of this metamorphism, it then follows that it must be pre-Hauterivian or older.

TERTIARY ROCKS

In the low, hilly country, in the northeast part of the area Tertiary rocks underlie several small areas. These represent the southwest extremities of more extensive areas of Tertiary rocks to the north, northeast and east (Tipper, 1957, 1959, 1963).

Map-unit 20

Dacitic volcanic rocks are exposed about 4 miles northeast of Martin Lake. They apparently rest upon an erosional surface above rocks of map-unit A. From evidence in adjoining areas, this surface is believed to be of early Tertiary age, possibly Eocene. Other such areas may be present in the drift-covered parts of the area as related dykes in rocks of map-unit A are fairly numerous.

Map-unit 21

Essentially flat-lying or gently northeast dipping basaltic plateau lavas outcrop in Choelquoit Lake valley and east of the north end of Chilko Lake. These are part of the extensive Miocene and Pliocene lavas that underlie wide areas of the Chilcotin Plateau to the east.

The lavas, mainly basalt and andesite, are dense grey to dark grey or black and weather grey to buff. They are coarsely to finely vesicular, fine grained and dense, or finely porphyritic with plagioclase phenocrysts. Olivine basalt is common. Characteristic columnar jointing is well displayed along the margins of the large mass east of Chilko Lake.

Along Lingfield Creek a small outcrop of mainly dense black basalt is underlain by buff-coloured river gravel. These flows may be part of a larger mass concealed by drift along the northern margin of Potato Range.

In adjoining areas the lavas overlie sediments bearing late Miocene plant remains (Tipper, 1963) hence they are Miocene and ?younger. No new evidence respecting their age was found in Mount Waddington map-area.

STRUCTURAL GEOLOGY

An outstanding and significant structural feature of the map-area is the multitude of closely spaced faults. The several long, straight to gently curving faults trending northwesterly, are transcurrent right lateral breaks. The Blackhorn Fault is a southwest dipping thrust fault in which Upper Triassic rocks are thrust northeast over Lower Cretaceous strata. Several other small zones of thrust faulting were found in Potato Range. Several northeast trending normal faults presumably result from late relaxation of stresses. Small folds mainly synclines, occur in the Potato Range, in Tsuniah Lake valley, and elsewhere. These folds are directly related to fault movement and do not represent a regional fold pattern.

TRANSCURRENT FAULTS

Yalakom Fault

The major fault along Yalakom River northwest of Lillooet was mapped and named by G. B. Leech as the Yalakom Fault (Leech, 1953, pp. 10-11). The sense of movement was not indicated by Leech but he pointed out that the fault strikes into the Fraser River fault system. The writer subsequently traced the Yalakom Fault across Taseko Lakes map-area to the Mount Waddington map-area where it extends from the north end of Tsuniah Lake to Kleena Kleene post office. From a personal familiarity with the geology, the writer believes that the fault may extend northwesterly another 100 miles across the Anahim Lake map-area (93C) into the Whitesail Lake map-area (93E). The fault has a known length of more than 140 miles and a suggested length of more than 250 miles.

In Taseko Lakes area evidence suggests that the Yalakom Fault is transcurrent but the fault is not well exposed and the evidence is not completely conclusive. In Mount Waddington map-area evidence supports the contention that the fault is transcurrent.

The fault is recognized and located by the following criteria; (a) a lineament forming the abrupt northeastern edge of Coast Mountains; (b) completely different rock types on either side of the lineament; (c) intense shearing and brecciation in rocks close to the lineament, such as the granitic rocks west of Cochin Lake; (d) occurrence of many small northwesterly striking faults in the rocks on the southwest side of the lineament and their parallelism with it; and (e) rare horizontal striations on vertical slickensided surfaces striking parallel with the lineament.

Although not well exposed, the fault is presumed to dip steeply southwest; at least the observed subsidiary faults indicate that is probably the case. The width of the main fault zone is not great, possibly as little as

a few hundred feet, but subsidiary faults are known several miles to the southwest and may indicate a much wider zone of movement.

The rocks north of Choelquoit Lake, and thus on the northeast side of the fault, are entirely volcanic (map-unit 7) and are Middle Jurassic (Bajocian and (?)Callovian). Southwest of the fault along Tatlayoko Lake, at the north end of Potato Range, and near the north end of Chilko Lake are Middle Jurassic, mainly Bajocian, sedimentary rocks (map-unit 8). The sedimentary sections have no interbedded volcanic rock although detrital material is in part of volcanic origin. If these two groups of rocks are in their original relative positions some interfingering and interbedding would be expected because of their proximity to one another. None was found.

The writer believes that these rocks, partly or entirely of the same age, were brought into juxtaposition by right lateral transcurrent movement on the Yalakom Fault. A sedimentary facies of Middle Jurassic age without interlayered volcanic rocks is unusual in British Columbia west of the Rocky Mountains and is known to the writer only in Mount Waddington and Taseko Lakes map-areas and near Ashcroft (Duffell and McTaggart, 1952, pp. 31-33). The latter are northeast of the Yalakom Fault and are lithologically similar to the former. Thus the speculation seems warranted that the section at Ashcroft is separated from those in Taseko Lakes and Mount Waddington map-areas by the transcurrent movement. This involves a possible displacement of 50 to 120 miles. Similarly the nearest volcanic rocks believed to be southwest of the fault and northwest of the Mount Waddington map-area are in the Anahim Lake map-area north of Hotnarko Lake and in Bella Coola map-area at Sigutlat Lake. This suggests a separation of 80 to 120 miles. Although continuous outcrop of these groups along the fault is lacking and thus it is not known how much the apparent separation is exaggerated by erosion or cover of intervening parts of the sections, appreciable separation is indicated.

Southwest of the fault in Mount Waddington map-area a few features indicate northwesterly directed stress acting parallel with the fault trend. These are an asymmetrical syncline in Potato Range and southeast dipping low angle thrust faults all of which are oriented nearly perpendicular to and are consistent with the right lateral sense of movement of the Yalakom Fault.

The time of movement is not known precisely. The fault disrupts Hauterivian volcanic rocks and presumably Tertiary or Late Cretaceous granitic rocks that intrude them. Leech related the movement to that of the Fraser River fault system that involves Eocene strata (Leech, 1953, p. 11). In Taseko Lakes map-area Miocene-Pliocene plateau lavas outcrop astride the fault zone and are undisturbed. Movement thus persisted to mid-Tertiary time but when it was initiated is unknown.

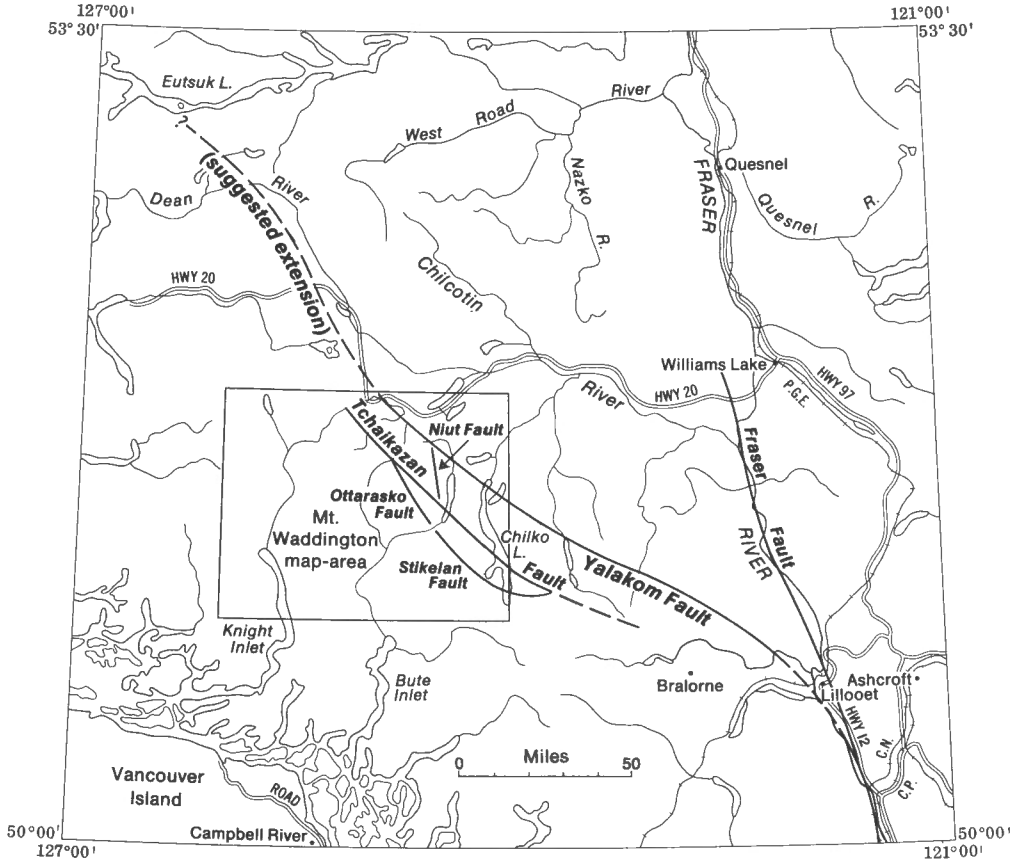

Figure 7. The major transcurrent faults of Mount Waddington map-area and their relation to the Fraser Fault

Niut Fault zone

On the west side of Tatlayoko Lake several parallel to subparallel faults trend northwesterly. These converge into a single fault southeasterly and diverge northwesterly. On Niut Mountain they bring together slices of Hauterivian and Upper Jurassic sedimentary and volcanic rocks, and granitic rocks. The slices are bounded on the east by the main Niut Fault which separates them from the Lower Jurassic to Lower Cretaceous sequences of Potato Range. To the southeast the Niut Fault merges with or is cut off by the Tchaikazan Fault. All faults of the Niut system are believed to be transcurrent breaks with penecontemporaneous movement. All are discussed below together with the main Niut Fault.

The Niut Fault brings rocks of the same age but different lithology into adjacent positions. To the northeast are rocks of the Relay Mountain Group and of map-unit 8; particular interest are the Kimmeridgian greywacke and siltstone and the late Hauterivian siltstone and greywacke. On the opposite side of the fault are coarse Kimmeridgian conglomerate and tuff and late Hauterivian volcanic rocks. Thus the fault separates rocks of the same age but of completely different facies. It is most unlikely that the two facies could be deposited 6 or 7 miles apart and not reflect some of the principal environmental factors of the other. In particular, the volcanic rocks on the southwest side of the fault should be reflected in the sequence on Potato Range. In previous sections dealing with these rocks the theory was advanced that the different facies represent sequences deposited on opposite sides of the Tyaughton Trough. This explains the difference in lithology and also can account for the incomplete section on the southwest side of the fault. It is believed that the fault cuts diagonally across the trough in a northwesterly direction and right lateral displacement moved the rocks of the southwest side into juxtaposition with those of the northeast side.

The fault is nearly vertical or dips very steeply west. The faults are reasonably well exposed as the rocks involved are resistant. Slickensided surfaces, commonly with horizontal or gently southeasterly plunging striations are particularly common in volcanic rocks. The sedimentary rocks in a few places near Niut Mountain display tight folds overturned to the northwest indicating northwesterly directed stress acting parallel with the fault.

Movement on the Niut Fault system pre-dates the granitic rocks northwest of Niut Mountain. Apparently movement was post-Hauterivian but was effectively blocked by the emplacement of the granitic rocks. The faults can be traced across pendants in the granitic mass but generally not in the granitic rock itself and intrusive contacts are not offset.

Tchaikazan Fault

The Tchaikazan Fault trends northwesterly across Chilko Lake to Tatlayoko Lake, along two aligned creek valleys southwest of Niut Mountain

to Bluff Lake and thence northwesterly to Miner Lake. It is easily traced as it commonly occupies topographic depressions. Exposure along it is good hence much is known of its nature.

Several groups of rocks lie on either side. On the northeast are the Kingsvale Group, Relay Mountain Group, map-units 12 and 13, and granitic rocks. On the southwest are map-units 12 and 13, map-unit 14, Upper Triassic rocks and the Kingsvale Group. The distribution of the rock groups reflects a complicated movement history and evidence for transcurrent movement is not as obvious as with the previously described faults. In Kingsvale Group rocks west of Niut Mountain the fault is fairly well exposed and slickensided surfaces with nearly horizontal striations indicate horizontal movement. The fault at this point dips about 80 degrees southwest or nearly vertical.

The time of movement on the Tchaikazan Fault can be determined more precisely than that of the Niut Fault. Cenomanian Kingsvale Group rocks are cut by the fault as are the granitic rocks that blocked the Niut Fault. Presumably the granitic rocks are the youngest involved and so the movement is no older than Upper Cretaceous and probably no older than early Tertiary.

As the granitic rocks blocked the Niut Fault but were themselves cut by the Tchaikazan Fault, it follows that the Tchaikazan Fault is younger than the Niut Fault. It is suggested that after the emplacement of the granitic rocks and cessation of movement on the Niut Fault, the Tchaikazan Fault developed at an angle to the older break and took a more westerly direction southwest of the granitic plutons northwest of Niut Mountain. If this be a transcurrent fault then the extension of the Niut Fault south of Tchaikazan Fault should be found displaced northwesterly along Tchaikazan Fault. Such an extension may be the Ottarasko Fault described below. If this be the case then there has been right lateral movement on the Tchaikazan Fault and a displacement along the fault of about 20 miles.

Ottarasko Fault

This is a northwest trending fault subparallel to Ottarasko Creek and extending along the lower northeast slopes of Razorback Mountain to near Bluff Lake. It is not well defined in that it does not have a distinct topographic expression nor is it well exposed. It separates rocks of map-unit 12, on the southwest from generally younger rocks of the Kingsvale Group and map-unit 14 on the northeast. Its extension southeasterly is obscured by normal faulting along Homathko River but it probably continues as the Stikelan Fault. Northwesterly it is cut off by Tchaikazan Fault.

The Ottarasko Fault is vertical or dips about 85 degrees to the southwest. It is marked in places by a single narrow sheared and brecciated

zone 25 to 50 feet wide; commonly dykes of intermediate composition are present along it. In places the zone is probably up to a mile wide with a multitude of parallel to subparallel thin slices within it. On some of the slickensided surfaces striations are nearly horizontal or plunge as much as 20 degrees southeasterly. Locally small isoclinal folds plunge down the dip of the fault and the axial planes are parallel with the fault surface. The folds are overturned to the northwest reflecting northwesterly directed horizontal stress parallel to the fault plane thus indicating right lateral movement.

Further evidence of right lateral movement is seen in faults to the southwest. Although these are low to moderate dipping thrusts they have subsequent transcurrent movement as indicated by folds developed on the fault plane as described in the previous paragraph. This will be discussed further in regard to thrust faulting.

The amount of dislocation along Ottarasko Fault is not known. As previously mentioned the Ottarasko Fault could be considered the southern extension of the Niut Fault offset by the Tchaikazan Fault. If the Ottarasko Fault were restored to its pre-Tchaikazan Fault position as an extension of Niut Fault, then this restored Ottarasko-Niut Fault restricts nearly all of map-unit 12 and the underlying Upper Triassic rocks to the southwest side of the fault. These rocks are a unit in that they represent the rocks deposited on the southwest side of Tyaughton Trough.

The time of movement on the Ottarasko Fault should be the same as Niut Fault. As Kingsvale Group rocks are involved, time of faulting is post-Cenomanian and this is probably true of the Niut Fault as well. Presumably then the Ottarasko Fault pre-dates the granitic rocks as does the Niut Fault.

Stikelan Fault

The Ottarasko Fault is disrupted at Homathko River by normal faulting. South of the river it apparently continues in the lower plate of a thrust fault and is covered by Triassic rocks that were carried over Cretaceous strata. South of the Triassic rocks and presumably again in the lower plate the Stikelan Fault trends southeasterly and resembles the Ottarasko Fault in many ways. Apparently it brings Triassic and Hauterivian (map-unit 12) rocks on the southwest against Kingsvale Group and Hauterivian (map-units 14 and 15) rocks on the northeast side.

The Stikelan Fault is poorly exposed and the information obtained is not entirely satisfactory. At its northern end it dips vertically or steeply southwesterly much like the Ottarasko Fault. However it is vertical northeast of Mount Dartmouth and dips steeply northeast near Franklyn Arm. It is offset by a normal fault at Franklyn Arm but continues southeast and dips northeast. In the Taseko Lakes map-area the extension of the Stikelan Fault

dips steeply to the northeast. The width of the fault zone is not great, probably in the order of 300 feet or less. In places several closely spaced parallel faults occur within the fault zone and here and there are small dykes.

That movement on this fault is transcurrent is more difficult to substantiate than with the other faults. A few near horizontal striations on slickensided surfaces were noted. One small drag fold in Hauterivian shales near the head of Stikelan Creek suggests right lateral movement.

The amount of displacement on this fault is difficult to estimate. On either side of the fault but not in contact with it are map-units 13 and 15, both thought to be of late Hauterivian age. They appear to be completely different volcanic facies that have been brought together by transcurrent movement but how much movement is unknown. It could be appreciable.

Faulting north of Franklyn Arm

East of Stikelan Creek and north of Franklyn Arm is an area of closely spaced faults that cut the Kingsvale Group (map-units 18 and 19) and map-units 14 and 15. In general the faults strike northwesterly and dip vertically to very steeply (80 degrees or more) to the southwest. The faults are marked by narrow zones of shearing, slickensides, and brecciation but the rocks in contact with them, particularly the shale and siltstone, are folded and contorted in the plane of the fault. Folds with axes oriented down-dip and axial planes parallel to the fault are common. Bedding planes adjacent to the faults are generally parallel to the fault planes or at least have coincident strikes. These are commonly warped into broad open folds and flexures about axes oriented at right angles to the strike of the fault plane. This corrugated effect is believed to be the result of horizontal stress acting in the plane of the fault.

The amount of movement on these closely spaced faults is not considered great. Movement on the southwest bounding Stikelan Fault, as previously mentioned, may be appreciable. The northeast bounding Tchaikazan Fault may have had displacement of no more than 20 miles. Further evidence provided by a freshwater gastropod fauna in Division A of the Kingsvale Group suggests that movement on these faults north of Franklyn Arm, like that on Tchaikazan Fault, is not great. The gastropod fauna was found in a marl or limy shale at about six localities, each in separate fault slices, but, as far as can be determined, occupying the same stratigraphic position. This unusual fauna is not diagnostic but is probably the same species. Nowhere have these gastropods been encountered in this group by the writer in this or adjoining areas and it would seem reasonable to suggest that these represent a restricted basin of deposition. The fact that the fossil localities are in different fault slices but still in a relatively small area indicates that displacement on the faults is not great.

Movement on the transcurrent faults

In summary, the writer believes that displacement was right lateral on the faults described above. The amount of movement differs greatly on the different faults, as much as 120 miles is suggested for the Yalakom Fault and 20 miles (or less) for the Tchaikazan Fault.

The time of faulting apparently was Late Cretaceous or Tertiary but probably earlier movements are masked. In the discussion of the Niut and Tchaikazan Faults it was mentioned that the former predates a granitic mass whereas the latter is clearly later. Unquestionably two different times of movement are involved. Similarly the Yalakom Fault postdates the same granitic rocks but the amount of movement suggested is sufficiently large that probably pregranite as well as postgranite movement took place.

Although most of the transcurrent faults have dislocated Hauterivian rocks, it should not be assumed that all faulting was post-Hauterivian, only that there was activity on the faults in post-Hauterivian time. With decreasing age, the rock units apparently suffered less lateral dislocation. Thus Cenomanian Kingsvale Group rocks appear to have been transported less than 20 miles. Hauterivian volcanic rocks appear to have been transported farther to bring unlike facies together. Middle Jurassic rocks appear to have the greatest separation along the Yalakom Fault whereby totally dissimilar facies are brought into juxtaposition. As yet the evidence supporting this impression is tenuous but the suggestion is not unreasonable. In the writer's opinion movement on the Yalakom Fault may have begun in Oxfordian or Callovian, that is after the formation of the gneisses of map-unit A. From evidence in Taseko Lakes map-area, movement on these faults ceased before late Miocene time.

THRUST FAULTS

Although transcurrent faults are the most important structural feature of the map-area there are many thrust faults. On Potato Range and the range to the east several small thrusts are related to the movement on transcurrent faults. The Blackhorn and several associated thrusts form interrelated northwesterly trending structures that extend nearly across the map-area. These are apparently independent of the transcurrent faults.

Thrust faults of Potato Range

The Relay Mountain Group and Middle Jurassic strata (map-unit 8) underlie most of Potato Range and the range to the east. Several thrusts have been recognized mainly because abundant fossils provide good stratigraphic control. These ranges lie between the right-lateral transcurrent Yalakom and Tchaikazan Faults to the northeast and southwest respectively.

In this environment rocks within the ranges must have periodically been subjected to northwesterly directed stresses acting parallel or subparallel to the strike of Yalakom Fault. This has produced several southeasterly dipping bedding plane thrust faults. One, in which Upper Jurassic rocks are thrust over Lower Cretaceous strata, is believed to lie along Lingfield Creek. The fault plane subsequently localized an intrusive body. At the southerly end of the range east of Potato Range, Callovian and Oxfordian rocks are thrust northwesterly over the aforementioned Upper Jurassic sediments and at the south end of Potato Range, Oxfordian rocks are thrust onto Kimmeridgian strata in a small bedding plane thrust.

Along Tatlayoko Lake several small thrusts can be recognized but these are oriented more nearly at right angles to the Niut Fault than to the Yalakom Fault. The faults are steep at the surface, dipping as much as 60 degrees, and displacement has been slight, in one instance probably no more than 300 feet, but the fault can be traced for several miles.

The Blackhorn Thrust and related faults

Southwest of Tchaikazan, Stikelan, and Ottarasko Faults, the structural pattern is dominated by southwest dipping thrust faults that extend from north of Franklyn Arm northwesterly to near Miner Lake. The dip on these faults is generally low, from 5 to 10 degrees to a maximum of about 40 degrees.

From Blackhorn Mountain northeasterly to the Ottarasko Fault, several southwest dipping thrust sheets are recognized. The rocks of Blackhorn Mountain are Karnian or early Norian and have been transported northeasterly over Karnian or early Norian and then onto late Norian rocks. The faults dip as much as 30 degrees at their northeast margin but flatten southwestward to about 10 degrees, closely paralleling the bedding surfaces. The Norian rocks are thrust northeastward onto presumably mid-Hauterivian shale and siltstone and these in turn are thrust onto slightly younger Hauterivian sedimentary rocks. Northeast from Blackhorn Mountain each succeeding thrust fault is slightly steeper at the surface so that the last one next to the Ottarasko transcurrent fault is nearly vertical. The fault that brought Triassic over Cretaceous rocks is the Blackhorn thrust fault.

Between Ottarasko Mountain and Homathko River a mass of middle to early Hauterivian sediments have been transported northeast onto slightly younger Hauterivian rocks by a low-angle thrust that is subparallel to and merges southeastward with the Ottarasko transcurrent fault. The rocks in the hanging wall of the thrust form a large overturned southeast plunging syncline that is exposed for 3 miles on the south side of the valley of the creek about 8 miles northwest of Homathko River. The fold is cut off on the west by a northwest trending normal fault.

The Blackhorn Fault, forming the contact of Upper Triassic with Lower Cretaceous rocks south and southeast of Ottarasko Mountain, is complicated. In several places, west of Stikelan Creek and east of Nude Creek, there is no question that Upper Triassic rocks are thrust from the southwest over Hauterivian rocks. South of Homathko River Triassic rocks are repeatedly thrust on themselves along southerly dipping low angle thrust planes. However, along Homathko River late tectonic normal faults add complications so that the nature of the faults in this rather poorly exposed section is obscure. West of Stikelan Creek the thrust sheet has similarly been disrupted by late normal faults and also by transcurrent movement on the Stikelan Fault with which the thrust merges or with which the trace of the thrust fault is parallel to subparallel.

Wherever the Blackhorn thrust fault is intersected by or is close to the major Ottarasko or Stikelan transcurrent faults there is major disruption of the thrust plate or late transcurrent movement on the thrust faults. Thus at the intersections in the areas west of Bluff Lake and west of Stikelan Creek the Triassic rocks are shattered into many disoriented fault blocks and slices. Around Razorback Mountain and along Ottarasko Creek, where the traces of the thrust faults are parallel or subparallel to the Ottarasko Fault, several examples were found of small isoclinal folds; the axes plunge down the dip of the fault plane and the axial planes are parallel to the fault plane. The sense of movement agrees with the right lateral movement on the Ottarasko Fault. Late transcurrent movement on thrust faults is most pronounced on the fault closest to the Ottarasko transcurrent fault and not evident on the fault on Blackhorn Mountain.

The time of thrust faulting is post-Hauterivian as Hauterivian rocks are involved. It took place before most of the transcurrent faulting and before the emplacement of the Coast Plutonic rocks just south of Ottarasko Mountain which here intersect the thrusts.

NORMAL FAULTS

Normal faults, recognized in several parts of the area, are late structural features. They are generally distinguished by their northeasterly to easterly trends. Rarely are they parallel with the transcurrent faults.

Between Yalakom and Tchaikazan Faults near the north end of Chilko Lake several normal faults bring younger blocks of strata against older rocks. Thus the Tsuniah Lake syncline has a central block of Albian rocks opposite mainly Bajocian beds. The Cretaceous rocks west of Tullin Mountain are dropped against Upper Jurassic strata. These and many other faults of varying magnitude presumably result from adjustments during the relaxation of the major stress environment. All these faults terminate between Yalakom and Tchaikazan Faults and none truncate the transcurrent faults. They apparently do truncate and offset small thrust faults and folds

believed to be contemporaneous with and related to the transcurrent faults and would, therefore, be younger.

Southwest of Stikelan-Ottarasko-Tchaikazan Faults four zones of normal faulting are prominent. From southeast to northwest they are along and southwest of Franklyn Arm, along Homathko River valley, along Moseley Creek valley near Bluff Lake, and along Klinaklini River valley northwest of Perkins Peak. Most of these faults trend northeasterly though some strike easterly. The faulting near Moseley Creek formed a graben in which a segment of the Triassic over-thrust sheet of the Blackhorn Thrust was dropped against Cretaceous rocks below the thrust.

These zones of normal faults truncate and offset some of the transcurrent faults and are themselves truncated by other transcurrent faults. The normal faulting along Klinaklini River apparently offsets the Tchaikazan Fault but elsewhere normal faults terminate against it. In Homathko River valley and along Franklyn Arm normal faults offset the transcurrent faults. The normal faults along Klinaklini River, Homathko River, and Franklyn Arm that offset transcurrent faults, trend, northeasterly. The offset is such that the northwest side of the faults has apparently moved northeastward relative to the southeast side, thus movement is not entirely dip-slip.

The Lower Cretaceous rocks around Perkins Peak lie west of the major transcurrent and thrust faults of the area and the faulted contact between these and the Triassic rocks to the east is poorly exposed and poorly understood. The normal relationship expected here is a major unconformity with Cretaceous strata resting on Upper Triassic rocks. However, the Cretaceous rocks are lowered relative to the Triassic rocks and the contact is thought to be a normal fault. The fault zone, where seen, is nearly vertical, narrow, and is marked by several small andesitic or basaltic dykes, some brecciation, and slickensiding. The sense of movement is unknown.

The normal faults are manifestly late features. They are younger than most transcurrent and thrust faults and probably all of the granitic rocks, but it is unknown whether all normal faults are contemporaneous or whether they represent late features of several distinct tectonic episodes.

FOLDS

No regional fold pattern has been recognized in the map-area and if one existed, it must have featured broad open folds that subsequently have been completely masked by later faulting. The oldest sequence in the map-area, the Triassic rocks, show no indication of intense regional folding. The Triassic rocks of the thrust plates on Blackhorn Mountain and southward, although metamorphosed to varying degrees, do not appear to be intensely deformed and dip as little as 5 to 15 degrees over broad areas. The

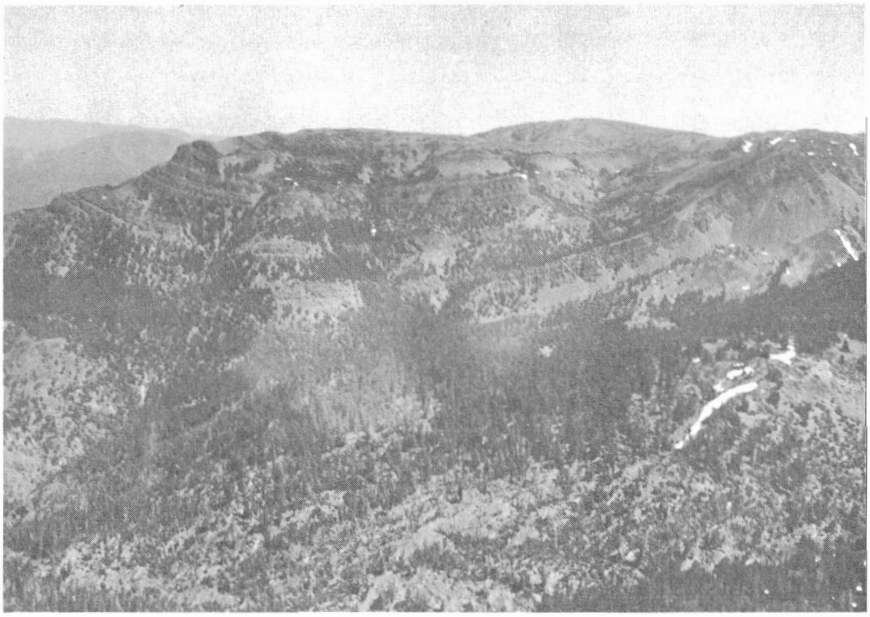

Figure 8. Potato Range syncline north of Fossil Creek. View to north of Barremian rocks of the Relay Mountain Group. (Photo by J.A. Jeletzky)

unconformity between the Hauterivian and underlying Triassic rocks is not marked by a sharp angular discordance. The lack of regional folding is also apparent throughout the Taseko Lakes map-area to the east.

All folds, of which synclines are most common appear to be related to movements on transcurrent faults. Between Yalakom and Tchaikazan Faults the Tsuniah Lake syncline and the Potato Range syncline (Fig. 8) are the two most prominent folds. Both are doubly plunging and both are northeasterly oriented, but the latter has been secondarily deformed so that its fold axis forms a reverse s-shape. Southwest of Tchaikazan Fault several distorted and truncated synclines oriented subparallel with transcurrent faults.

METAMORPHISM OF UPPER TRIASSIC ROCKS

The Upper Triassic rocks display various grades of metamorphism but all younger rocks, except for local contact effects, are unmetamorphosed. Triassic rocks between Blackhorn Mountain and Homathko Peak along the west side of the Blackhorn Thrust are phyllite and schist but to the northwest and southeast the metamorphic effects decrease. To the southwest towards the central part of the Coast Mountains the grade of metamorphism increases and the rocks are garnetiferous schist and gneiss.

The significance of this metamorphism in the structural evolution of the area is important. The metamorphosed rocks are unconformably overlain by and locally thrust over unmetamorphosed Hauterivian strata. Granitic rocks south of Ottarasko Mountain intrude both Triassic and Hauterivian rocks and produce but a narrow zone of hornfels near the contact with the latter. For these reasons the metamorphism of Upper Triassic rocks is believed to be pre-Hauterivian and unrelated to the post-Hauterivian Coast Plutonic rocks. As previously mentioned some bodies of Coast Plutonic rocks may be products of or related to this metamorphism and may thus be pre-Hauterivian.

The age of the metamorphism is not known precisely. Certainly it is pre-Hauterivian and post-Norian. If the granitic rocks that supplied detritus to map-units 11 and 12 are related to it, then the metamorphism is pre-Kimmeridgian. It is known from map-unit A that Middle Jurassic orogenic activity was localized somewhat to the east of the Coast Mountains. It is not unreasonable to suggest that this coincided with the metamorphic episode in the Coast Mountains.

HISTORICAL GEOLOGY

Within the Mount Waddington map-area it has been possible to establish relative ages for some features and events and to indicate approximate spans of time within which the events occurred. Evidence for this comes from work within the map-area and earlier work by the writer in adjoining areas. The following is a chronological listing of the tectonic events and structural features in the order that the writer believes most closely fits the available evidence. Many of the following statements suggest a greater certainty than is justified by the evidence but are offered as the most reasonable explanation of the facts now available.

1. Karnian, Norian, and Rhaetian: Volcanic and sedimentary rocks accumulated, presumably on and near volcanic islands.

2. Hettangian to Middle Bajocian: Widespread sedimentation in a broad basin produced a thick section of interbedded greywacke, siltstone, and shale. Bajocian(?) volcanic rocks accumulated in the area northeast of Yalakom Fault. The volcanic and sedimentary rocks accumulated separately in basins that were many miles apart.

3. Late Bajocian and Bathonian: This was an orogenic period in which Bajocian(?) volcanic rocks were intruded, metamorphosed and deformed. At about the same time Upper Triassic rocks and possibly some Jurassic sediments within the present Coast Mountains were metamorphosed and some granitic rocks were emplaced.

4. Early and Middle Callovian: Sedimentation resumed in the area of Bajocian sedimentation.

5. Late Callovian and earliest Oxfordian: No record of this time exists and presumably the area was emergent. This period immediately precedes the development of the Tyaughton Trough, a northwesterly trending sedimentary trough flanked on the northeast by Middle Jurassic volcanic, metamorphic and granitic rocks and on the southwest by Upper Triassic volcanic and sedimentary rocks and by metamorphic and granitic rocks of possibly Middle Jurassic age. With the development of the Tyaughton Trough as a distinct structural element, initial development of Yalakom Fault could also have begun.

6. Oxfordian to Barremian: An almost uninterrupted sequence of sedimentary rocks accumulated in the Tyaughton Trough in the central and northeastern parts. The shape and size of the marine area fluctuated from time to time. The southwestern side of the trough left a poor record and except for Kimmeridgian sedimentation, nothing is known between Triassic and Hauterivian. The Hauterivian record indicates widespread volcanism on the southwest side.

7. Barremian and Aptian: This was a period of instability with erosion and uplift, particularly on the northeast side of Tyaughton Trough. The record is fragmentary.

8. Aptian and Albian: This is the last major marine inundation of central British Columbia. Seas spread far beyond the Tyaughton Trough.

9. Cenomanian: Non-marine sedimentation followed by widespread volcanism mark the end of Tyaughton Trough as a basin of deposition. No longer were volcanic rocks restricted to the southwest side of the trough. Presumably the Yalakom Fault was active.

10. Late Cretaceous and early Tertiary: This span of time witnessed several important tectonic events. These are briefly listed from oldest to youngest.

    a) Transcurrent Yalakom Fault may have been active.
    b) Thrusting on Blackhorn and related thrusts.
    c) Transcurrent movement on Niut, Ottarasko, and Stikelan Faults which brought rocks characteristic of the southwest side of Tyaughton Trough into contact with those of the northerly and northeasterly sides.
    d) Emplacement of some of the Coast Plutonic rocks.
    e) Transcurrent movement on Tchaikazan Fault and renewed movement on Yalakom Fault. Development of related thrusts and folds in Potato Range. Transcurrent movement on the faults east of Stikelan Creek.
    f) Normal faulting.

11. Miocene and later: The outpouring of plateau lavas in central British Columbia marked the end of the episode of faulting that destroyed the Tyaughton Trough as a basin of sedimentation.

ECONOMIC GEOLOGY

The northeast part of Mount Waddington map-area has never had a productive mine and few mineral occurrences have been located and staked. Description of the mineral potential and outlook for the area, was described by V. Dolmage in 1924 and 1925 (Dolmage, 1925, 1926), and since then little has been learned to improve a rather bleak picture. Descriptions of the properties can be found in the British Columbia Minister of Mines Reports over the last sixty years.

The principal mineral occurrences lie south and southwest of the Niut and Tchaikazan Faults. Near Perkins Peak gold in arsenopyrite occurs in Hauterivian sediments and a deposit of hematite occurs in Hauterivian volcanic rocks. Around Blackhorn Mountain several gold-silver properties in Karnian rocks have been staked. About 12 miles up Ottarasko Creek several gold-silver veins in Hauterivian sediments and in small intrusive offshoots of the Coast Plutonic rocks are known. The Morris Mine, in Upper Triassic rocks about 3 miles south of Tatlayoko Lake, is also a gold-silver deposit that was investigated over several years. In the Franklyn Arm area gold-silver and copper-zinc occurrences have been known for many years. These are presumably in Triassic and Cretaceous rocks. In many of the gold-silver prospects small amounts of chalcopyrite, sphalerite, and tetrahedrite are reported.

During the course of field work few mineral occurrences were noted and none are apparently of any size or importance. West of Tatlayoko Lake on Niut Mountain there is a conspicuous large rusty zone that is reported to contain a trace of gold and small amount of chalcopyrite and malachite was noted in one or two places. About five miles east of Bluff Lake, near a volcanic-granitic contact, a small amount of bornite was noted in a narrow quartz vein. Near the head of Nude Creek in the Triassic rocks near the granitic contact, several small quartz stringers contain chalcopyrite and malachite. West of Stikelan Creek a small quartz veinlet in Triassic rocks contains a very small amount of molybdenite. The above are mentioned here merely to record the presence of certain minerals and not to imply that individual deposits of consequence were noted.

All mineralized zones appear to be related to one of two sets of conditions. A few occurrences of copper minerals in quartz stringers apparently are restricted to or near the contact zone of the Coast Plutonic rocks. All other deposits apparently are associated with normal faulting along the four northeasterly trending normal fault zones, namely along Klinaklini River, Moseley Creek, Homathko River, and along and southwest of Franklyn Arm. For the most part mineral occurrences are not located on or in the main zones of faulting but are on or near subsidiary normal faults. The mineralization appears in the main to be a late event, probably early Tertiary.

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APPENDIX

APPENDIX

A report by W. A. Bell on the fossil flora collected in the Mount Waddington map-area was received after the main part of the paper was written. This report offers some interesting new paleobotanical information when compared with the fossil fauna of the same map-units; a wider stratigraphic range is suggested for some floras. Bell's report on the collections is given here with a discussion by the writer on the apparent significance of the flora in this map-area. The plant collections were made by J. A. Jeletzky, D. C. McGregor, and the writer in 1967.

Late Cretaceous Flora

Cat. No. 7906

Location: three miles NE of Mt. Dartmouth about 20 feet stratigraphically below Cat. No. 7908.

Florule: ?*Psuedocycas dunkeriana* (Göppert) Florin
Menispermites reniformis Dawson
Platanus latiloba? Newberry
an unidentified dicotyledonous leaf

Remarks: The above meagre assemblage precludes any satisfactory interpretation of age other than some interval in Albian-Cenomanian. The unidentifiable dicotyledonous leaf is elliptical, about 4 cm long by 1 cm greatest width, the midrib is straight, rather narrow, strong, and the base and apex of leaf are acute. Although lack of preserved secondary veins affords no clues as to identification, *Sapindopsis* sp. cf. *angusta* is a possibility, and if so late Albian age would be favoured.

Cat. No. 7907

Location: lat. 51°11'N, long. 124°16'W., about 60 feet stratigraphically below Cat. No. 7908.

Florule: *Zizyphus mcgregori* Bell
Carpites sp. Dawson
small unidentifiable fragments of dicotyledons

Remarks: *Z. mcgregori* occurs in the Bad Heart Formation of early Santonian age, and *Carpites* sp. in Comox Formation of Nanaimo Group, of Santonian-Campanian age, so, while the florule is too small to be positively indicative of age, in the writer's opinion a Santonian-Campanian age rather than a Cenomanian one is favoured.

Cat. No. 7908

Location: 3 miles northeast of Mt. Dartmouth.

Florule:
Czekanowskia cf. rigida Heer
Trochodendroides (Cercidiphyllum?) potomacensis Berry
Jenkensella arctica (Heer) Bell forma minor
Myrtophyllum boreale Seward and Conway
Sapindopsis pacificus? (Dawson) Bell
Platanus affinis Lesquereux
Laurophyllum insigna Dawson
Araliaephyllum westoni Dawson

Remarks: A. westoni is a common element in the Upper Blairmore flora, particularly in Dawson's Mill Creek series. Trochodendroides potomacensis was considered by the writer to be only a form of T. arctica, and the discovery of Jenkinsella arctica in beds of locality 7908 supports such an attribution; forma minor is associated with larger fruits in Upper Cretaceous beds and occurs as well in early Tertiary beds e.g. in the Wilcox Formation.

Czekanowskia cf. rigida is a common constituent in strata of Neocomian age in western Canada, and its occurrence at locality 7908 presumably extends its hitherto known stratigraphic range from Upper Jurassic and early Cretaceous beds.

Myrtophyllum boreale and Araliaephyllum westoni in the above florule rather strongly suggest an Albian age, whereas, Platanus affinis and Laurophyllum insigne were recorded earlier only from the Dunvegan Formation.

On the whole the above florule cannot reasonably be assigned any more refined age than some time interval within late Albian-Cenomanian.

Discussion (H. W. T.)

These three collections were obtained from map-unit 18, part of the Kingsvale Group. The writer has presented his reasons for believing the group to be mainly of Cenomanian age (p. 67) although a very late Albian age may apply to the lowest part of the group. The information offered here indicates that Cat. No. 7908, the youngest stratigraphically, is of Albian-Cenomanian age and the oldest stratigraphically, Cat. No. 7907, is Late Cretaceous with a Santonian-Campanian age favoured over Cenomanian. All three collections are from the same section and, in the writer's opinion should be essentially the same age. With one collection compared with Late Cretaceous flora and the other two with Albian-Cenomanian flora, the obvious preference for all three would be a Cenomanian age.

Early Cretaceous Flora

Cat. No. 7909

Location: 100 yards north of Kleena Kleene Motel, lat. 51°58'30"N., long. 124°59'W.

Faunule: *Brachyphyllum* sp.
Protodammara sp. cf. *speciosa* Hollick and Jeffrey

Remarks: The above assemblage occurs among small carbonized fragments that are of no use for refined age interpretation. *P. speciosa* occurs in the Tuscaloosa Formation, Alabama, of Cenomanian age, so that the latter for beds of 7909 is quite possible. In addition to the above genera some of the rock fragments have a number of isolated, unidentified, paired spore-like (megaspores) bodies, which in cross-section are more or less circular, about 1 mm diameter and characterized by long surface filiform appendages.

Cat. No. 7865

Location: northwesterly ridge of Razorback Mt., lat. 51°41'N., long. 124°43'30"W.

Florule: *Nilssonia canadensis* Bell

Remarks: The veins are poorly preserved, but are clearly attached to upper part of rachis at nearly right angle and run apparently straight to the border. Previously recorded from the Bullhead Group (Gething Member), upper part of Hazelton Group in Skeena River valley, Luscar Formation, Lower Blairmore and Kingsvale Group, from beds all considered to fall in an age within time interval Aptian and/or early Albian to late Albian.

Cat. No. 7871

Location: lat. 51°29'N., long. 124°38'W.

Florule: *Pseudocycas* sp. A Bell cf. *unjiga* (Dawson)

Remarks: This species occurs in Upper Blairmore Formation and in Spence Bridge Group. Although it is not reasonable to imply that it is restricted to beds of Albian age, the narrow pinnae as compared with those of the types of *P. unjiga* does favour an Aptian or early Albian age rather than a Cenomanian one for the beds of above locality.

Cat. No. 7869

Location: southwest of Ottarasko River, west of south end of Tatlayoko Lake, lat. 51°27'N., long. 124°33'20"W.

Florule: Cladophlebis virginensis (Fontaine) Berry
Coniopteris brevifolia (Fontaine) Bell
Sagenopteris mclearni Berry

Remarks: The above assemblage is considered to have an Aptian and/or early Albian age.

Cat. No. 7870

Location: ridge 4 miles W. of south end Tatlayoko Lake, lat. 51°27'N., long. 124°34'W.

Faunule: Isoetites horridus (Dawson) Brown
Fontainea grandiflora Newberry

Remarks: Age interpretation based only on the above two species records only some time interval in Albian-Cenomanian. Fontainea grandiflora was collected previously in Canada from Albian (late Albian), but in U.S.A. found to occur in the Raritan Formation, presumably in beds of Cenomanian age. Provenance of Isoetites horridus was the Dunvegan Formation, so that a Cenomanian age of the above florule is somewhat more likely than an Albian age.

Cat. No. 7875

Location: Mt. Waddington area, ridge to west of south end Tatlayoko Lake at highest point.

Remarks: Plant remains which are restricted to poorly preserved roughly ribbed, unbranched axes that appear to be shoots or rhizomes, possibly of Equisetites lyelli (Mantell). They furnish insufficient evidence for interpretation of age.

Cat. No. 7880

Location: Mt. Waddington area, ridge west of south end of Tatlayoko Lake near highest point.

Florule: Cladophlebis virginiensis (Fontaine) Berry
Acrostichopteris foliosa (Fontaine) Berry
Sagenopteris williamsii (Newberry) Bell
Otozamites klipsteinii (Dunker) Seward
Metasequoia smittiana (Heer) Bell
?Czekanowskia cf. rigida Heer

Remarks: The florule contains some specific elements present at locality 7881 (see below) with the important addition of Elatocladus (Metasequoia) smittiana (Heer) Bell. It indicates an age equivalent to that of the flora of Lower Blairmore considered to be Aptian and/or early Albian.

Cat. No. 7881

Location: Mt. Waddington area, ridge to west of south end of Tatlayoko Lake.

Florule: Cladophlebis virginiensis (Fontaine) Berry
Sagenopteris williamsii (Newberry) Bell
Otozamites klipsteinii (Dunker) Seward
Plilophyllum (Anomozamites) montanense (Fontaine) Bell

Remarks: The presence of Sagenopteris williamsii and of Otozamites klipsteinii (occurring in the British Wealden) is indicative to the writer of a late Aptian or early Albian age to which the flora in Lower Blairmore is likewise assigned.

Cat. No. 7882

Location: cirque beyond ridge to west of south end of Tatlayoko Lake.

Florule: Coniopteris brevifolia (Fontaine) Bell
Cladiphlebis virginiensis (Fontaine) Berry
Sagenopteris williamsii (Newberry) Bell

Remarks: Although the first two species noted above as members of the florule are too long ranging to be of value in refined age interpretation, the presence of Sagenopteris williamsii, which so far has never been recorded from formations earlier than Lower Blairmore, is apparently indicative of an Aptian and/or early Albian age, or about the same age as florules of localities 7880 and 7881.

Cat. No. 7879

Location: Mt. Waddington area, east side Tatlayoko Lake, west slope Potato Range (Sect. JA 67-2, Unit 45, p. 37).

Florule: Coniopteris brevifolia (Fontaine) Bell
Equisetites lyelli (Mantell) Unger

Remarks: Identification of E. lyelli is supported by presence of leaf sheaths. In western Canada its time range based on earlier collections was from early Neocomian to early Albian inclusive. Coniopteris

brevifolia has a like time range, and the presence of the two species in this florule strongly favours a Lower Cretaceous age rather than a Jurassic one.

Cat. No. 7859

Location: Potato Mt. west side, lat. 51° 36'N., long. 124° 19'30"W.

Florule: Coniopteris brevifolia (Fontaine) Bell
Gleichenites nordenskiöldi (Heer) Seward

Remarks: C. brevifolia is too long-ranging for refined time correlation, ranging from late Jurassic to late Albian inclusive. G. nordenskiöldi has so far as presently known a shorter time range being particularly characteristic of Aptian and/or early Albian to late Albian inclusive, and it is considered probable that the beds of loc. 7859 lie within this age interval.

Discussion (H. W. T.)

The writer is confident that the preceding eleven collections were obtained from Early Cretaceous map-units dated by marine fauna. For most of the collections Bell prefers an Aptian and/or early Albian age but the evidence from this area suggests that this flora may not have such a restricted range.

The collections numbered 7909, 7865, 7871, 7869, 7870, 7875, 7880, 7881, and 7882 are from the upper part of map-unit 12 of late Hauterivian and (?) younger age (pp. 56, 57). Five of the collections are assigned an Aptian and/or early Albian age by a comparison with the Lower Blairmore flora and one is believed to be of Albian-Cenomanian age with a preference for Cenomanian. The last mentioned collection, Cat. No. 7870, comes from strata closely associated with stratigraphically higher and lower beds that yield fossil plants comparable to the Lower Blairmore flora; it must therefore be considered as the same age as the Lower Blairmore flora in spite of the apparent anomalous occurrence of two genera known from younger formations. Two collections, Cat. Nos. 7875 and 7909 do not indicate a precise age determination but as they are from the same map-unit as the other collections, they are presumed to be the same age.

If the flora of these collections is in fact partly or entirely comparable with the Lower Blairmore flora of the Rocky Mountain Foothills region, then it is necessary to conclude that in the western Cordillera the Lower Blairmore flora is found also in the late Hauterivian strata. A similar situation exists in Skeena River area of northern British Columbia where ammonites of Aptian and (?) uppermost Barremian age and of late lower to middle Hauterivian age presumably have been obtained from sedimentary sections that yielded a Lower Blairmore flora.

Two collections, Cat. Nos. 7859 and 7879, were obtained from map-unit 10 of Relay Mountain Group. One collection was from Section JA 67-2, unit 45 (p. 37) and both collections are dated precisely by marine fauna as middle to late Valanginian age. Bell's remarks indicate a preference for a range of Aptian and/or early Albian to late Albian age but the faunal evidence indicates that a wider range is probable for this flora.

Late Jurassic Flora

Cat. No. 7860

Location: lat. 51°36'N., long. 124°11'W.

Florule: Cladophlebis virginiensis Fontaine
Nilssonia sp. Bell
Baiera sp. cf. gracilis Bunbury

Remarks: Inadequate preservation, particularly of veins in leaves or pinnae precludes very satisfactory specific identifications, and generic assignment must in many instances be based upon dimensions, shape, disposition on axes, associated species, etc. Specifically, however, each of the above three forms in the florule closely resemble species occurring in both Lower Cretaceous and Middle and Upper Jurassic beds. C. virginiensis is practically indistinguishable from C. denticulata except for rarity of marginal teeth. Nilssonia sp. Bell (Geol. Surv. Can. Mem. 285, Pl. 49, Fig. 4) has few reliable features that would separate it specifically from the species, yet in the Hazelton Group of Hazelton-Cedarville area it is associated in the same beds with Coniopteris brevifolia, Cladophlebis virginiensis and Ginkgo nana, a circumstance that favours an age in the Lower Cretaceous. In specimens referred above to Baiera sp. cf. gracilis only a few well preserved veins are present and the form could scarcely be differentiated from B. gracilis from Middle and Upper Jurassic beds. But in the Hazelton Group, again in the Hazelton-Cedarville area, it is associated with Czekanowskia cf. rigida, Coniopteris brevifolia, Phlebopteris? elongata, Ginkgo pluripartita and Cladophlebis virginiensis. None of these with the possible exception of Ginkgo nana and G. pluripartita is likely to be restricted to beds of post-Jurassic age, although the presence of the two Ginkgo species may be considered to favour a Neocomian age rather than a late Jurassic one.

Cat. No. 7874

Location: west side of north end Chilko Lake, B.C., Tullin Mountain (same locality as Cat. No. 7860).

Florule: Cladophlebis virginiensis Fontaine
Nilssonia sp. Bell 1956
Baiera sp. cf. gracilis Bunbury

Remarks: (See remarks Cat. No. 7860). Some specimens in present lot are much better preserved than those in locality 7860, particular the veins. In Cladophlebis virginiensis for example they are seen to divide generally only once like the most dominant forms in the Lower Cretaceous elsewhere in western Canada. Moreover the pinnules all appear to lack marginal dentitions so prevalent in the Jurassic C. denticulata. So too in the Nilssonia sp. present in above florule the veins were fairly well marked and, like specimens gathered from the Lower Cretaceous in Canada, number 25-30 cm. Considerable variation was noted in size of pinnae attached to a common rachis, their width commonly varying from 6 to 12 mm and considering specimens from all axes observed variation in widths of pinnae was up to 2 cm and lengths up to 3 cm. Preservation of veins was much poorer in Baiera cf. gracilis, but seemingly they were spaced about 0.5 mm apart.

One specimen including petiole was 10 cm long. Only two bifurcations into narrow ribbon-like segments were noted in the leaves, and in the few specimens present in the assemblage prevailing width of segments was about 3 mm, widths being greater immediately below bifurcations. The first bifurcation took place close to the top of petiole, the second at variable intervals from 1-5 cm. Ends of segments were bluntly pointed.

A Neocomian age rather than a late Jurassic one was favoured for florule of locality 7860, and the same preference applies to the above assemblage.

Cat. No. 8016

Location: Mt. Waddington map-area, B.C. a prominent WNW-trending spur of western slope of Potato Range, top of which lies 1/2 mile north of its highest 7,238-foot summit, collected 70-75 feet below top of unit 13 in place and some 1,100 feet down slope from 120-foot high bluff of unit 37 which blocks crest of spur. (Sect. JA 67-2, Unit 13, p. 14)

Florule: Coniopteris yukonensis Bell
Cladophlebis virginiensis (Fontaine) Berry
Nilssonia sp. cf. orientalis and cf. N. yukonensis Hollick

Remarks: The general upward curvature of the veins of the Nilssonia sp. is like that of N. yukonensis, but no apices of the pinnae were noted, which precludes positive identification with Hollick's species.

C. yukonensis was previously gathered from the Tantalus Formation of Yukon Territory from which a dozen associated species were gathered, on a basis of which Bell could only conclude that age was late Jurassic (Portlandian) or early Neocomian.

Cat. No. 8015

Location: Mt. Waddington, west-northwest trending spur of west slope of Potato Range, top of which is located 1/2 mile north of its 7,238-foot-high summit, collected from level 25-30 feet below top of unit 13 in place, and some 1,000 feet down slope, in bluff (about 120 feet high) of unit 37 that blocks crest of spur. (Sect. JA 67-2, unit 13, p. 14)

Remarks: The greater part of the rock pieces contain only very small and poorly preserved megaplant fragments, none of which is identified. Remaining rock pieces contain fragments of ultimate pinnae of a fern that has the appearance of Taxites williamsi (Brongniart) Seward. If actually that species, the age is considered to be Jurasic in much of the upper part of which, T. williamsi is a common species. The venation of the pinnules, however, gathered at locality 8015 is so poorly preserved that the species may well be a form of Cladophlebis virginiensis like some that were gathered from locality 8016.

Cat. No. 7876

Location: East of Tatlayoko Lake, west side of Potato Range (same as Cat. No. 8016).

Florule: Cladophlebis virginiensis (Fontaine) Berry
Nilssonia canadensis? Bell

Remarks: C. virginiensis has too long a stratigraphic range to be of much use in interpretation of age. At this locality the specimens are like those commonly occurring in Lower Cretaceous beds. Some of them are indistinguishable from C. virginiensis forma fisheri Knowlton. The Nilssonia canadensis was found in Kootenay beds at Canmore, Alberta, as well as in part of the Hazelton-Cedarville area, although rare in both. The writer had previously considered that a Necomian age for the above Hazelton Group containing the Nilssonia was somewhat more favourable to a late Jurassic age, but from meagre florules the age can only be confidently regarded as within limits of late Jurassic-Albian.

Cat. No. 7877

Location: Mt. Waddington area, east of Tatlayoko Lake, west side Potato Range (Same as Cat. No. 8016).

Florule: Cladophlebis virginiensis (Fontaine) Berry
Nilssonia canadensis Bell
Coniopteris brevifolia? (Fontaine) Bell
?Equisetites lyelli (Mantell) Unger
?Baiera sp. cf. gracilis (Bean) Bunbury
?Pityophyllum cf. nordenskiöldi (Heer) Krystofovich

Remarks: Questionable identifications of a majority of species in this florule precludes their use in age determination. The florule accordingly can only be considered to be an age within the limits of late Jurassic-Albian as for florule of loc. 7876.

Cat. No. 7878

Location: Mt. Waddinton map-area, east side of Potato Range. (Same as Cat. No. 8016)

Florule: Cladophlebis virginiensis (Fontaine) Berry
?Equisetites lyelli (Mantell) Unger
Nilssonia canadensis? Bell

Remarks: Interpretation of age of the above florule cannot more reasonably be regarded than within some time interval of late Jurassic-Albian as for beds of localities 7876 and 7877.

Discussion (H. W. T.)

The collections considered by the writer to be Late Jurassic do not provide conclusive evidence of their age. For one or two collections, Bell prefers an Early Cretaceous age whereas others have elements that suggest possible Jurassic affinities. All can be placed in a general Late Jurassic-Early Cretaceous age.

Two collections, 7860 and 7874, are from the same locality. Marine fauna of late Oxfordian to early Kimmeridgian age were collected near the locality and suggests the age of the flora as Late Jurassic. These are from the lower part of the Relay Mountain Group, map-unit 9.

The other five collections are from the same bed, unit 13 of Section JA67-2, map-unit 9 of the Relay Mountain Group; the two collections discussed in the preceding paragraph could have the same stratigraphic position. The bed is 269 feet stratigraphically below a bed with a marine Berriasian fauna and 118 feet above a bed with a marine Portlandian fauna.

The flora must be therefore in age somewhere between mid-Late Jurassic and early Early Cretaceous. Because of lithologic similarities the flora-bearing unit appears more closely related to the underlying Jurassic than the overlying Cretaceous beds. For this reason the flora is considered by the writer to be Late Jurassic.

Late Triassic Flora

Cat. No. 79689

Location: lat. 51°22'N., long. 124°23'30"W.

Florule: *Equisetites* sp. cf. *sarrani* (Zeiller) Zeiller

Remarks: Types of E. sarrani were gathered from Rhaetic beds of Indo-China (Tonkin). The specimen compared with it represents only a pith-cast and no leaf-sheaths were seen. Superficially, except that the ribs do not alternate at the nodes, the specimen resembles pith-casts of *Calamites gigas* from Pennsylvanian strata. *Equisetites* comparable with *sarrani* are particularly common in Rhaetic beds and a late Triassic age seems to be a reasonable assignment for beds of above locality.

Discussion (H. W. T.)

The collection was obtained from map-unit 3 of early Norian and (?) Karnian age.