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DEPARTMENT OF ENERGY, MINES AND RESOURCES

PAPER 73-17

PEMBERTON (EAST HALF) MAP-AREA, BRITISH COLUMBIA

J. A. Roddick and W. W. Hutchison

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(Report and Map 13-1973)

J. A. Roddick and W. W. Hutchison

DEPARTMENT OF ENERGY, MINES AND RESOURCES

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Map 13-1973 Pemberton (east half) map-area, British Columbia ..... in pocket

ABSTRACT

Pemberton (east half) map-area lies across the northeastern margin of the Coast Crystalline Belt between 50 and 51 degrees N and 122 and 123 degrees W. The flanking rocks consist of essentially unmetamorphosed sedimentary and volcanic strata ranging in age from Middle Triassic (and (?) older) to Recent. They form a broad, gently northwest-plunging antiform lying between the main mass of the Coast Crystalline Belt, and on the northeast, the Yalakom Fault zone. A series of granodiorite and quartz diorite plutons, an extension of the Coast Crystalline Belt, intrude the southwestern limb of the antiform. Northeast of the Yalakom Fault zone, deformation is slight and the Cretaceous sediments form an open syncline, plunging gently to the northwest. Within the major antiform, however, the strata are strongly and more or less equally deformed. Except for parts of the Lower Cretaceous Jackass Mountain Group, pre-Upper Cretaceous strata are marine, and younger rocks continental. Tertiary rocks are only slightly or not deformed, although steep dips may be present near faults.

The plutonic rocks are mainly quartz diorite, granodiorite and diorite; gabbro, quartz monzonite and granite are rare. Nearly all of the plutonic rock east of Lillooet River and north of the latitude of Duffey Lake, and in three granodiorite bodies in the southeastern part of the map-area, is massive, whereas the rest is mainly foliated. The plutons have sharp, locally crosscutting, but normally concordant contacts with older strata, and either sharp or gradational contacts with other plutonic rocks.

Known mineral occurrences are plotted, but as only one month was spent in the map-area, examination of them was not possible.

RÉSUMÉ

La région de Pemberton (demi-feuille est) est située de part et d'autre de la bordure nord-est de la Zone cristalline côtière, entre le 50e et le 51e degré de latitude nord, et le 122e et le 123e degré de longitude ouest. Les roches latérales sont surtout formées de strates sédimentaires et volcaniques qui n'ont pas été métamorphisées, dont l'âge varie du Trias moyen (et (?) plus ancien) au Récent. Elles forment une structure de type anticlinal, étendue, à léger pendage vers le nord-ouest, reposant entre la masse principale de la Zone cristalline côtière et la zone faillée de Yalakom au nord-est. Un prolongement de la Zone cristalline côtière formé d'une série de plutons de granodiorite et de diorite quartzeuse pénètre le flanc sud-ouest de la structure anticlinale. Au nord-est de la zone faillée de Yalakom, la déformation est peu importante et les sédiments du Crétacé forment un synclinal ouvert, plongeant légèrement vers le nord-ouest. Toutefois, les strates situées à l'intérieur de l'anticlinal principal sont fortement et plus ou moins également déformées. Si on excepte des parties du groupe de Jackass Mountain du Crétacé inférieur, les strates du Crétacé pré-supérieur sont d'origine marine, et les roches plus jeunes sont d'origine continentale. Les roches du Tertiaire ne sont que légèrement déformées (lorsqu'elles le sont), bien qu'il puisse y avoir des plongements abrupts près des failles.

Les roches plutoniques sont surtout de la diorite quartzeuse, de la granodiorite et de la diorite; le gabbro, la monzonite quartzeuse et le granite sont rares. La presque totalité de la roche plutonique à l'est de la rivière Lillooet et au nord du lac Duffey, ainsi que dans les trois amas de granodiorite de la partie sud de cette région est massive, tandis que le reste de la roche est surtout foliacé. Le contact

des plutons avec les strates plus vieilles est brusque, entrecroisé par endroits, mais habituellement en concordance, et il est soit brusque, soit graduel avec les autres roches plutoniques.

Les venues minérales connues sont indiquées, mais leur examen n'a pas été possible pendant l'unique mois passé dans cette région.

PEMBERTON (EAST HALF) MAP-AREA, BRITISH COLUMBIA

INTRODUCTION

Pemberton E1/2 map-area is an entirely mountainous region lying east of the zone of high precipitation that characterizes the western half of the Coast Mountains. High points on most of the ridges, which are narrow-crested and precipitous, exceed an elevation of 7,500 feet, several exceed 8,500 feet and the highest in the map-area, Dickson Peak, reaches 9,217 feet. All but the highest ridges have been glaciated. The main valleys are deeply covered by glacial and glacial-outwash deposits as well as more recent alluvial material.

About one month was spent in the map-area by the writers in 1970 as part of Coast Mountains Project. J.A. Jeletzky and J.W.H. Monger joined the party for about 10 days to study the Jackass Mountain Group and Bridge River Group, respectively. Most of the short time available was spent in parts of the area that had not previously been mapped. Parts of this report consequently are summarized from the earlier publications, especially those by C.W. Drysdale (1916), C. Camsell (1918), W.S. McCann (1922), C.E. Cairnes (1925, 1937, 1943) and G.B. Leech (1953). The index map indicates the areas covered by these workers.

GENERAL GEOLOGY

The axis and northeastern margin of the Coast Crystalline Belt pass northwesterly across the map-area. The outer limit of the crystalline belt is marked by a series of granodiorite to quartz diroite plutons, known as the Bendor Intrusions, which have pierced the southwestern flank of a broad northwest-trending antiform that dominates the north half of the map-area. The antiform is irregularly bounded on the southwest by the main mass of the Coast Crystalline Belt and on the northwest by the Yalakom Fault zone. The structure has a maximum width of about 30 miles and plunges gently to the northwest.

With the possible exception of the schist and gneiss of units A and B, the oldest, as well as the most abundant, stratified rocks in the area belong to the Bridge River Group and are extensively exposed in the core of the antiform. They consist of a thick, highly deformed assemblage of chert, argillite and greenstone that yielded, in one place, Middle Triassic conodonts. These rocks can be traced southeasterly into the Hozameen Group of Hope map-area. The Bridge River Group is overlain by an equally deformed, and apparently conformable section of Upper Triassic clastic and volcanic rocks that form the Cadwallader Group. In places this group is divisible into a basal, mainly sedimentary formation (the Noel), a middle volcanic sequence (Pioneer Formation), and an upper unit (Hurley Formation) that closely resembles the basal unit. The Cadwallader Group is exposed mainly on the southwestern flank and around the nose of the antiform, and is all but completely removed from the northeastern flank by the Yalakom Fault zone.

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Jurassic rocks are uncommon in the map-area. A small plate of Lower Jurassic clastic sediments, however, is thrust westward over Lower Cretaceous (Taylor Creek Group) strata in the northwest corner of the map-area, and slices of Relay Mountain Group (Upper Jurassic to Lower Cretaceous) are fault-bounded in Yalakom Valley.

The Lower Cretaceous is well represented by a thick clastic assemblage (Jackass Mountain Group) which forms an open syncline that plunges gently to the northwest in the northeastern corner of the map-area, and by the partly coeval Taylor Creek Group farther west. Locally Upper Cretaceous sedimentary rocks (Kingsvale Group) lie conformably on the Jackass Mountain Group.

The Lower Tertiary rocks are characterized by scattered areas of slightly deformed silicic volcanic rocks and minor clastic sediments, and the Upper Tertiary by flat-lying basalt flows, and silicic breccias and flows.

The ages of formation of the intrusive rocks are not known, but certain facts bearing on the time of emplacement are available. The ultrabasic rocks which occur mainly in Shulaps Range and in Cadwallader Creek Valley intrude and are restricted to Middle and Upper Triassic rocks. Quartz diorite, granodiorite and diorite, the main granitic rock types, form plutons that are in part traceable into Scuzzy pluton in Hope map-area from which Late Cretaceous isotopic dates have been obtained.

Faults are abundant near the north edge of the map-area and especially concentrated in Yalakom River Valley. Many probably exist also in the southern part of the area but there they are difficult to detect and evaluate.

STRATIFIED ROCKS

Bridge River (Fergusson) Group (Map-unit 1)

The oldest stratified rocks, with the probable exception of units A and B whose ages are not known, form the Bridge River Group (unit 1), and are exposed mainly along the wide axial zone of a broad, complex, antiformal structure that plunges to the northwest along an axis that passes through Shalalth and Tyaughton Lake and contains the main valleys of Bridge River and Seton Lake.

Drysdale (1916) introduced the term 'Bridge River series' for these rocks and the usage was continued by McCann (1922). Cairnes (1937) maintained, however, that the term was not sharply defined by Drysdale and had been variously applied by other workers. He therefore proposed the term 'Fergusson series', derived from Mount Fergusson, and applied it to a comparatively small area near the Bridge River gold mining camp. In modern usage 'Group' has supplanted 'series', and Fergusson Group and Bridge River Group are used synonymously. Since the strata underlie nearly the whole of Bridge River Valley, Bridge River Group is the more appropriate of the two terms and is preferred in this report.

The group consists mainly of a thick sequence of thin-bedded chert, cherty argillite, and argillite intercalated with altered basaltic flows and minor limestone. Although apparently considerable, the thickness of the assemblage is not known because of complex folding and faulting, and the lack of easily recognizable marker horizons. The base of the unit has not been observed.

Dark to light grey weathering chert and dark cherty argillite are the most abundant rock types but locally dark argillite is dominant. The chert commonly forms lensoid and nodular layers up to about 3 inches thick separated by thin flims of dark argillite. Consequently the rock has been referred to as ribbon-chert even

though few outcrops present a strongly laminated appearance owing to intricate crumpling, minor faults and myriad closely-spaced quartz stringers. Close-spaced joints in the argillite and chert result in a characteristic chunky rubble.

Grey-green to chocolate-brown weathering, massive greenstone gives the impression of being more abundant than it actually is because of its high resistance to weathering. Most outcrops appear to have been flows or breccias of basic andesite to basaltic composition, judging from specific gravity determinations which commonly fall between 2.93 and 3.00. Most of the greenstone is intensively shattered. Fresher specimens are dark green or brown on the weathered surface and dark green on the fresh surface. Locally it is amygdaloidal and exhibits pillow structure. At the head of Copper Creek the greenstone is a volcanic breccia containing some fragments of limestone as well as highly fractured volcanic rock.

Pods of light grey to buff-grey weathering limestone are scattered throughout the Bridge River Group. Most are 50 feet thick or less, with a few as thick as 300 feet, and only rarely are they traceable for more than a few hundred feet along strike. On the west side of Shulaps Creek, however, about 4 1/4 miles from its mouth, a bed of limestone 30 feet thick can be traced for at least 3,000 feet. It is not known whether the sparse isolated occurrences of limestone are the result of intricate faulting or discontinuous original deposition. Most of the limestone is extensively veined by recrystallized carbonate. Recrystallization has destroyed most fossils, but on the east side of Tyaughton Creek immediately above the Bridge River road, an assemblage of conodonts was collected by J.W.H. Monger and identified as Middle Triassic by B.E.B. Cameron (Cameron and Monger, 1971).

Most of the exposed Bridge River Group exhibits only a pumpellyite-prehnite metamorphic grade but near Bendor pluton, along the northeast side of Shulaps Range, and in the valley of Cayoosh Creek higher metamorphic grades are found. In those places the group is represented by rocks such as phyllite, biotite-quartz schist (locally garnetiferous), micaceous quartzite, chlorite and graphitic schist, and rare skarn and dioritized greenstone. From the ridges of the Shulaps Range into Yalakom Valley, pumpellyite-prehnite-bearing rocks appear to grade into biotite schist. Outcrops are not continuous, however, and structural breaks may be present. Evidence there and in Cayoosh Valley suggests that the deeper parts of the group are metamorphosed. If this inference is valid then the apparent aureole of metamorphosed rocks around Bendor pluton may represent higher grade rocks dragged up from depth rather than contact thermal effects. At the eastern contact of the granodiorite body underlying the lower part of Lost Valley Creek (east side of Anderson Lake), the intrusive sharply crosscuts the Bridge River Group and has induced some plastic flowage in phyllitic sediments.

Cadwallader Group (Map-units 2 - 4)

The Cadwallader Group comprises the Noel (unit 2), Pioneer (unit 3) and Hurley (unit 4) formations. Most of the group outcrops southwest of Bendor Range in a northwest-trending belt which, with associated granitic intrusions, is more than 25 miles wide. The sedimentary strata that dominate the northeast half of the belt differ from the underlying Bridge River Group in being more argillaceous, less cherty, and, in most places, distinctly bedded.

The Cadwallader Group is primarily an Upper Triassic sedimentary sequence (Noel and Hurley formations) which is interrupted in places by thick volcanic assemblages of the Pioneer Formation. North of Pemberton, the latter formation contains intercalated sedimentary strata which are equivalent to the Hurley Formation. Where

the Pioneer Formation is lacking, the Noel and Hurley formations cannot at present be distinguished from another. Although locally thick, the Pioneer volcanic rocks probably were rapidly deposited and represent no great time interval.

No modern work has been done on the fauna of the Cadwallader Group, but its mid-Late Triassic age was established by H.W. Shimer (Clapp and Shimer, 1911), from collections made in 1911, by W.S. McCann (1922) in the Cadwallader Creek area, and in 1924 by C.E. Cairnes (1925). McCann's collection contained the following fauna:

Isastrea whiteavesi Clapp and Shimer
I. vancouverensis C. and S.
Calamophyllia suttonensis C. and S.
C. dawsoni C. and S.
Montlivaltia cf. *gosaviensis* Frech.
Terabratula suttonensis C. and S.
Pleuromya pearsonensis n. sp.
Megalodon canadensis n. sp.
Myophoria sp.
Turcicula mecanni n. sp.

Cairnes' collection was identified as:

Isastrea cf. *vancouverensis*
Calamaphyllis suttonesis ?
Calamophyllia sp.

The Cadwallader Group fossils are similar to those in the Sutton Formation of Vancouver Island (Clapp and Shimer, 1911), which belong to the Suessi Zone of the Upper Norian (Upper Triassic). In view of the considerable thickness of the Cadwallader Group, it may span a larger part of the Upper Triassic than the scanty fossils presently available indicate.

Noel Formation

The Noel Formation (unit 2) consists of at least 1,200 feet of well-bedded argillite in beds a fraction of an inch to several inches thick with minor lenses of chert, thin beds of greenstone, and pebble to cobble conglomerate. In most places, the sequence appears to be conformable on the Bridge River Group and both seem equally deformed. No fossils have been collected from recognizable Noel strata.

Pioneer Formation

The Pioneer Formation (unit 3), consisting mainly of greenstone, was defined and previously restricted to the occurrence in Cadwallader Valley. In this report, the term is extended on fossil evidence to include the large volcanic assemblage (unit 3a) north of Pemberton. The formation varies considerably from place to place in composition, texture and structure. Some of the greenstone has been derived from flows and some from pyroclastic rocks. Every gradation has been observed from the fragmental parts of the Pioneer Formation into the overlying Hurley Formation. The Pioneer greenstone also grades into and is cut by diorite that is identified locally as the Bralorne Intrusions (see description of map-unit P2a for discussion of this relationship). The Pioneer Formation attains a thickness of

at least 1,000 feet in Cadwallader Valley but is much thicker north of Pemberton. The greenstone crosscuts Bridge River Group sediments in lower Carl Creek but does not cut the adjoining Hurley Formation. Locally it appears to cut also the Noel Formation although the evidence is not conclusive. The Pioneer Formation nevertheless is thought to be younger than the Noel and is known to be older than the overlying Hurley strata into which it grades.

North of Pemberton map-area unit 3a is dominated by greenstone, much of it derived from volcanic breccia, but includes also widespread but thin layers of rhyolite, rhyolitic breccia, dacite, siliceous tuff and andesitic feldspar porphyry. Minor amounts of volcanic conglomerate (containing quartz monzonite boulders), phyllite, siliceous argillite and fossiliferous limestone are also present. The thickness of map-unit 3a, is not known but appears to exceed 5,000 feet north of Pemberton. Fossils collected from the ridge southeast of Tenquille Lake indicate a Late Triassic (Norian) age and are similar to those collected from Hurley strata by Cairnes (1925).

Hurley Formation

The Hurley Formation (unit 4) consists of probably more than 1,500 feet of argillite, limestone, tuff and conglomeratic beds. The well-layered argillaceous and tuffaceous rocks are in places indistinguishable from those in the Noel Formation, but the Hurley sediments are distinctly limy. Also green andesitic flows several feet thick and coarse conglomeratic strata are more characteristic of the Hurley Formation. The conglomeratic beds in the Hurley Formation contain pebbles of greenish volcanic rock, light-coloured felsic rocks, porphyries, dark argillite and chert, as well as many granitic and few dioritic rocks. These strata are as much deformed as the older formations.

Map-Unit 5

A small area in the northwest corner of the map-area is underlain by Lower Jurassic sediments (unit 5). They consist mainly of dark argillite and shale, with minor limestone, sandstone, and pebble conglomerate. Limy concretions are characteristic of some argillite beds. The assemblage is in fault contact with the Hurley Group and is thrust westward over Lower Cretaceous Taylor Creek Group (unit 8). Ammonites collected from unit 5 are of earliest Jurassic age. (Jeletzky and Tipper, 1968.)

Relay Mountain Group (Map-unit 6)

The Relay Mountain Group outcrops in the map-area only in Yalakom River Valley, where it is in fault contact with the Bridge River and Jackass Mountain groups. The unit is not well-exposed in Pemberton map-area, but in Taseko Lakes map-area to the north, it consists of a thick sequence of argillaceous sediments intercalated with fine to coarse greywacke and rare beds of grit, pebble conglomerate and volcanic rock. There the unit ranges in thickness from 5,000 to 9,000 feet (Jeletzky and Tipper, 1968). Fossils indicate an age extending from early Late Jurassic (Oxfordian) well into the Early Cretaceous (Barremian).

Jackass Mountain Group (Map-unit 7)

Recognized Jackass Mountain Group is restricted to the northern part of the map-area. J.A. Jeletzky examined the main occurrence of the group in Camelsfoot Range, and his report forms the basis of the following description. There it forms an open, northwest-trending syncline plunging gently to the northwest. The southwestern flank of the syncline in Yalakom River Valley is cut by numerous faults. In Camelsfoot Range the Jackass Mountain Group is subdivided into four units, but elsewhere information is insufficient for subdividing the group. The group comprises more than 14,000 (13,848 feet were measured) feet of greywacke, argillite and conglomerate, and rare thin coal beds. It ranges the Lower Cretaceous from Hauterivian to Albian.

The four subdivisions of the Jackass Mountain Group in Camelsfoot Range do not match either the subdivisions used by Jeletzky and Tipper (1968) in the adjacent part of Taseko Lakes map-area or those used by Duffell and McTaggart (1952) in the adjacent part of Ashcroft map-area. The discrepancies can be attributed to lateral facies changes and to complications introduced in most of the sections by faulting. Jeletzky described the sections that he examined in Camelsfoot Range as follows:

Map-unit 7a; Coaly clastic unit: This unit consists mainly of carbonaceous to coaly siltstone and shale intercalated with up to 35 per cent of carbonaceous to coaly sandstones. It is about 1,250 feet thick in the lower part of Ore Creek where a fault-bounded section was measured. Possibly 2,000 feet of almost exclusively shaly rocks belonging to this unit were cursorily surveyed on the mountainous eastern banks of Yalakom River, 2.4 to 3.5 miles northwest of the mouth of Junction Creek. There the base is covered and possibly faulted, and the top is conformable with and possibly gradational into the overlying variegated clastic unit.

The siltstone and shale that form most of the coaly clastic unit are dark grey to black and weather grey, dark brown and rusty. They are interbedded, however, with considerable siltstone and shale that is lithologically indistinguishable from that in the variegated clastic and the grey siltstone-shale unit.

In the coaly clastic unit, the siltstone and shale form beds 20 to 500 feet thick that are intercalated with brownish grey to dark grey, fine- to coarse-grained polymictic sandstone (subgreywacke) and greywacke beds 5 to 100 feet thick. These arenites are commonly carbonaceous to coaly and rich in fossil wood and other plant fragments. The sandstone (subgreywacke), which is greatly predominant, consist of fine to medium, well-sorted, rounded grains, many of which are quartz. The greywackes are coarse grained, gritty, and finely pebbly, and resemble those in the overlying rocks. Arenaceous beds are common in Ore Creek sections but rare or absent in those measured north of Junction Creek.

No marine fossils or diagnostic fossils of any kind were found in the unit. The abundance of coaly particles, fossil wood and other plant remains throughout the unit indicates that it is largely or entirely nonmarine, and presumably palustral or alluvial.

The lowermost exposed beds are faulted either against *Buchia*-bearing, Upper Jurassic to early Lower Cretaceous siltstones and shales (Jeletzky, 1967), or against older rocks. Yet the unit appears to be younger than the *Buchia*-bearing beds because of its general structural setting, and the conformable nature of its contact with the overlying variegated clastic unit, which contains Barremian fossils about 4,700 feet above the contact. A Hauterivian age for the unit seems probable. It is lithologically similar and presumably equivalent to the nonmarine lower part

of Division A of the Jackass Mountain Group (Duffell and McTaggart, 1952). The unit also appears to be the nonmarine equivalent of the Hauterivian part of the Relay Mountain Group (Jeletzky and Tipper, 1968).

Map-unit 7b; Variegated clastic unit: This unit consists mainly of a regular alternation of thick beds of siltstone and shale, with arenaceous rocks. Minor beds of coarser clastic rocks are intercalated at irregular intervals. About 6,135 feet of the unit were measured in the poorly exposed but apparently continuous section at the head of the northern confluents of Ore Creek. About 6,410 feet were estimated to be present in the section, also apparently continuous, near the northern headwaters of Applespring Creek.

The siltstones and shales of this unit are lithologically similar to the overlying grey siltstone-shale unit that is next described. They form recessively weathering, poorly exposed units ranging in thickness from several hundred to 1,600 feet. Most of the rocks are fine grained and banded or thinly laminated. They are intercalated with rare to common beds of fine- to coarse-grained greywacke, grit and pebble conglomerate 6 inches to 5 feet thick that recur at intervals ranging from several feet to several scores of feet. Local sole markings, graded and convolute bedding suggest a turbiditic origin for some of these rocks.

The intervening arenaceous units range from 60 to 1,300 feet thick and consist of grey-blue, brown or rusty, fine- to coarse-grained, commonly gritty and pebbly greywacke with minor interbeds of buff to light grey arkose. Within the arenaceous members partings, laminae, and interbeds 1 inch to 5 feet thick are locally abundant. Mainly in the middle of the unit but elsewhere the sandstones contain more or less regularly recurring beds and lenses, 6 inches to about 20 feet thick, of grit and pebble conglomerate which consists mainly of well-rounded clasts of plutonic rocks but also includes sedimentary and volcanic rocks. They commonly form 5 to 20 per cent of the thickness of the enclosing arenaceous unit.

An apparently Aptian marine fauna including *Inoceramus* n. sp. aff. *neocomiensis* (d'Orbigny) and *Eotetragonites* sp. indet., was found in the uppermost 200 feet of the division. Another marine fauna, apparently Barremian, which includes *Quoieccia* ex gr. *aliciae* Crickmay and *Acroteuthis (Boreioteuthis)* ex gr. *impressa* (Gabb) occurs about 1,100 feet below the top of the Applespring Creek section. A second apparently Barremian fauna including trigoniids *Q.* ex gr. *aliciae* Crickmay and *Yaadia* cf. *lewisagassizi* Crickmay was found about 1,400 feet below the top of the same section. The middle and lower parts of the unit contain marine fossils but no diagnostic forms were found.

The variegated clastic unit appears to be in part at least a marine facies of the predominantly conglomeratic, nonmarine Division B (or French Bar Formation) of the Ashcroft and Taseko Lakes map-areas (Duffell and McTaggart, 1952, and Jeletzky and Tipper, 1968). The unit includes, however, some beds that are equivalent to the marine upper part of Division A of the Jackass Mountain Group in Ashcroft map-area, judging from the presence of Barremian fossils in both units.

Map-unit 7c; Grey siltstone-shale unit: This unit consists mainly of thinly bedded intercalated siltstone and shale. In places about 1/3 of the rock is made up of beds, pods or lenses, 1 inch to 4 inches thick and 1 foot to 5 feet long, of very fine, light grey siliceous greywacke interbedded with siltstone and shale so as to give the rock a strikingly banded appearance. The unit is at least 1,713 feet and may be more than 2,000 feet thick.

The siltstone and shale beds are dark to light grey, friable to hard and flinty, and grade from sandy siltstone through silty shale to pure shale. They range from 1/4 inch to 6 inches thick. These flysch-like rocks locally exhibit graded bedding

and sole markings suggestive of turbiditic origin. The unit contains several friable, pure shale members 50 to 450 feet thick that include concretions and bands of dark to dull grey, cryptocrystalline limestone which weather whitish or tan. In sections near Birch Mountain in Ore Creek basin, the mainly argillaceous rocks of the middle part of the unit contain numerous 1- to 7-foot-thick interbeds, lenses and pods of coarse- to fine-grained greywacke and pebble to cobble conglomerate rich in plutonic clasts ranging in composition from alaskite to diorite. The shales and siltstones themselves are commonly arenaceous, gritty and pebbly in this interval. Graded bedding in the greywacke and conglomerate, and well-developed sole-markings in the former suggest that the rocks are turbidites. The rocks become more shaly to the southeast; as an apparently complete section in the headwaters of Applespring Creek does not contain any significant arenaceous or conglomeratic beds.

Well-preserved late lower Albian *Brewericeras (Leconteites) lecontei* fauna in turbiditic, pebbly siltstones 1,001 to 1,013 feet stratigraphically below the top of the unit indicates its equivalence with the lower part of flysch-like Albian and (?) Aptian clastics of Mount Waddington map-area (Jeletzky, 1967), with the dark grey siltstone unit of the Jackass Mountain Group in the Manning Park area (Jeletzky, 1970), and presumably with the apparently unfossiliferous shales of the pre-*Brewericeras (Brewericeras) hulenense*-bearing part of the shaly facies of Taylor Creek Group in Taseko Lakes map-area (Jeletzky and Tipper, 1968). No unit lithologically similar to the grey siltstone-shale unit was recorded in the Jackass Mountain Group in Ashcroft map-area by Duffell and McTaggart (1952), but it may be represented by an offshore facies of the lower part of their Division C.

Map-unit 7d; Massive greywacke unit: This unit consists mainly of greenish grey greywacke, grit, pebble conglomerate and minor sandy mudstone. About 4,750 feet of the unit was measured in its longest, apparently continuous section across Birch Mountain, but as both lower and upper contacts are faults, its total thickness is greater.

The greywacke, which is probably tuffaceous and forms resistant ridges, is mostly gritty and pebbly, massive to indistinctly bedded, and commonly spheriodally weathering. Similarly coloured, hard, massive, fine- to medium-grained greywacke, make up intercalated beds that are particularly common in the basal and uppermost parts of the unit, where they may be 50 to 125 feet thick. Friable, fine to very fine greywacke and mudstone form rare thin beds or laminae.

Throughout the unit grains and clasts are poorly rounded and sorted. Dark minerals and feldspar grains strongly predominate, whereas quartz grains are notably scarce. Volcanic clasts appear to be the most common but various sedimentary, metamorphic and plutonic clasts are present.

Most of the massive greywacke and associated rocks form beds 150 to 1,100 feet thick and are separated by 30- to 70-foot-thick, recessive units of a thinly laminated, fine to very fine grained greywacke, and pure to sandy mudstone. Light coloured arkose is very rare or absent, except in the topmost beds which appear to be transitional into the Kingsvale Group.

No plant or animal remains were seen in the massive greywacke unit, except for the lowermost exposed conglomeratic unit of the Birch Mountain section which yielded a fragment of an unusually evolute *Tetragonites*? n. sp. ex aff. *kitchini* Krenkel suggestive of a general Albian age for the basal beds at least. These basal beds, however, cannot be older than the late early Albian *Brewericeras (Brewericeras) hulenense* zone because of the early lower Albian fauna found in the underlying grey siltstone-shale unit. The middle and upper parts of the unit probably span most or all of middle and late Albian time if the inferred latest Albian and/or Cenomanian age of the overlying Kingsvale sediments is correct.

The massive greywacke unit seems to be a rapidly deposited, probably entirely marine unit owing to the absence of plant remains or coaly particles and the presence of rare marine fossils. The common presence of directional sole markings, graded bedding and penecontemporaneous slumping in the finer, thinly bedded greywacke and mudstone interbeds suggest a turbiditic origin for at least some of the rocks. No lateral facies changes were noted in the unit within the investigated area.

The massive greywacke unit is lithologically similar to and appears to grade laterally into the Division C of the Jackass Mountain Group in the adjacent parts of Ashcroft and Taseko Lakes map-areas (Duffell and McTaggart, 1952, and Jeletzky and Tipper, 1968). It appears to be equivalent of the greater upper part of the Taylor Group of the western parts of Taseko Lakes map-area.

Taylor Creek Group (Map-unit 8)

Along the northern boundary of the map-area two small blocks of Taylor Creek Group (unit 8) rocks lie in fault-contact with the Bridge River Group. The Taylor Creek Group consists mainly of black to dark grey limy shale and subgreywacke but is characterized by beds of chert pebble conglomerate up to 200 feet thick and volcanic interbeds made up of tuff, breccia and dark green to purple flows. Jeletzky and Tipper (1968) estimated that the thickness is no more than 4,000 feet near the north edge of the map-area. The group has yielded rare but diagnostic marine fossils of latest Early Cretaceous (Albian) age.

Kingsvale Group (Map-unit 9)

The assemblage of nonmarine arkose, greywackes, grit and fine pebble conglomerate that apparently lies conformably on and possibly grades into the Jackass Mountain Group has been assigned (by Jeletzky) provisionally to the sedimentary facies of the Kingsvale Group. The top of the unit is not exposed. Carbonized plant fragments and the coaly character of many of the beds indicate a continental origin. Slump-folds indicate a northeastern source area for the Kingsvale sediments. In Taseko Lakes map-area the Kingsvale sediments are thought to be transitional between Lower and Upper Cretaceous (Albian and/or Cenomanian).

Map-Unit 10

On the northeast side of Mission Ridge a small area is overlain by sediments (unit 10) of probable Early Tertiary age. They consist mainly of thin- to medium-bedded shale and lesser amounts of sandstone, arkose and conglomerate. Graded bedding in the shale indicates that the beds are right side up. Some of the shale is sandy and grades into conglomerate. The arkose is thick bedded and intercalated with shale and siltstone. One 6-inch shale bed yielded plant fossils. The conglomerate consists chiefly of chert and volcanic fragments, poorly sorted and derived probably from the Bridge River Group. The rocks are moderately folded. The trend varies from southwest to northwest and the dip varies from 15 to about 50 degrees in most places although vertical dips were noted locally.

Map-Unit 11

An area of about 12 square miles is underlain by Tertiary volcanic rocks (unit 11) north of Tenquille Lake. The rocks are mainly andesite but include also volcanic breccia, basalt and minor dacite. These volcanic rocks, in places flat lying and elsewhere moderately dipping, are difficult to distinguish from older greenstone from the air. Most of the andesite is dark grey weathering, porphyritic, and commonly massive although faint stratification can usually be discerned when the rock is viewed from a distance. The volcanic breccia consists mainly of highly porphyritic andesite fragments. The basalt is dark grey on the fresh surface and weathers a dark brown. Locally pillows are well developed suggesting extrusion on a lake bottom. At one place the volcanic breccia is dark green weathering and massive except for vertical columnar jointing. Minor whitish weathering dacite flows are cut in places by the basic volcanic rocks. The dacite shows columnar jointing and strongly developed horizontal cleavage that produces plates about 1/4 inch thick. These volcanic rocks appear to be older than the acid flows in the southeast corner of the map-area and the flat-lying basalt remnants to the north near Noel Mountain.

Map-Unit 12

In the southeast corner of the map-area are three erosional remnants of a once extensive cover of silicic volcanic breccias and flows. Although a section through these rocks has not been examined, spot observations indicate an assemblage of about 3,000 feet of pale pink-weathering rhyolitic to dacitic pyroclastics and flows. Fragment size in the breccia varies from place to place, but for large volumes of rocks it may not exceed 2 inches across. Locally, however, blocks may exceed 3 feet across. The fragments consist mainly of rhyolite, some with prominent, large quartz eyes, and dacite. In places clasts of granodiorite are common, and rarely a few clasts of diorite and basic volcanic rock similar to that in map-unit 3a are present. On the ridge north of the head of Mehatl Creek, horizontal flows of alternating greenish dacite and whitish rhyolite give part of the ridge a 'layer cake' appearance. In most places the rocks are about horizontal, with local dips up to 30 degrees. The volcanic assemblage overlies unconformably plutonic and metamorphic rocks. The overlain plutonic rocks include the 70-million-year-old Scuzzy pluton (unit 4), and a high level pluton of possible Late Miocene age (see map-unit 4a). The depth of dissection of the volcanic rocks and plutonic rocks beneath them indicates an age no younger than Pliocene for the volcanic rocks. Map-unit 12 is therefore tentatively assigned to the latest Miocene or Early Pliocene, but, as the conclusion is based mainly on the age of unit 4a, and that, in turn, is based on a very long range correlation with the granite-syenite pluton on King Island (Bella Coola map-area), it is little more than a deflected guess.

Also assigned to map-unit 12 is a long narrow mass of light grey to buff-weathering flow and tuff on the northeast side of Bridge River Valley. Beneath them at Jones Bluff (on Jones Creek) McCann found 150 feet of soft shales, sandstones and conglomerate with a few thin seams of lignite, probably related to map-unit 10. On the basis of lack of deformation, he assigned the sediments to the post-Lower Cretaceous. According to McCann, the flow is andesitic with hornblende phenocrysts and represents the extrusive equivalent of the nearby Rexmount Porphyry (unit 12a).

Rexmount Porphyry (Map-unit 12a)

Named by Drysdale (1916) after the small settlement on Bridge River, the Rexmount Porphyry is exposed for about 22 miles mainly along the crest of the southern part of Shulaps Range, but extending also to the south side of Mission Ridge above Seton Lake. It consists of a uniform, light weathering porphyry of dacitic composition with phenocrysts mainly of plagioclase, but also of pseudomorphous chlorite and quartz. The Rexmount Porphyry intrudes Bridge River Group rocks and minor ultrabasic rocks related to the Shulaps mass. According to Leech (1953) a basalt dyke southeast of Burkholder Lake contains numerous xenoliths of ultrabasic rock and Rexmount Porphyry, but whether the dyke is Miocene or of younger age is not known. Both Drysdale (1916) and McCann (1922) thought the age of the Rexmount Porphyry to be Tertiary and favoured Eocene or Oligocene. Present evidence puts no tight restraints on the age, but infers that it may be younger than previously thought.

Map-Unit 13

Three remnants of young but pre-Pleistocene basalt flows cap the ridge north and south of Noel Mountain. The thickest remnant occurs about a mile northwest of Noel Mountain. It consists of a 'layer-cake' sequence of about 13 dark basalt flows, each 10 to 50 feet thick. The original thickness may have been greater as the top is now eroded away. The basalt is dark red to blackish weathering. The remnant 2 miles southwest of Noel Mountain consists partly of highly vesicular dacite. Flat-lying basalt underlies a small area on the northeast side of Camelsfoot Range. Map-unit 13 is thought to be equivalent to the plateau basalts to the north of Late Miocene or Pliocene age.

Map-Unit 14

The main valleys contain widespread glacial outwash and alluvial deposits locally several hundred feet thick. The floors and lower slopes of the valleys are commonly plastered with till and boulder clay, with remnants of end moraines here and there. Higher on the valley sides, parts of lateral moraines remain from the last valley glaciers. Erratics and striations appear on ridges at least as high as 6,500 feet above sea level.

Stream deposits of sand and gravel are ubiquitous in the valley floor and commonly cover the glacial deposits. Thick stream deposits are conspicuous in the lower parts of tributaries to the main valleys. As suggested by McCann (1922) these deposits probably formed when the tributaries were dammed by late glaciers in the main valleys.

Bridge River Ash

The whitish ash layer that locally reaches 2 feet in thickness in Bridge River Valley was known at least as early as 1911 (Robertson, 1911). It was studied recently by Nasmith, Mathews and Rouse (1967) whose paper also summarized earlier reports and is the source of the following brief description.

The Bridge River ash forms a narrow fan that originates in the upper reaches of Lillooet River near Plinth Peak (40 miles northwest of Pemberton) and extends

about 300 miles northeasterly into westernmost Alberta near latitude 52°. It consists mainly of dust-size shards but within the map-area, it is characterized by dacite pumice fragments. In most of Bridge River Valley, the ash forms a thin layer commonly concentrated at the top of the soil profile. On outcrops of bedrock where the ash was not protected by vegetation, it has been washed away. Although no source vent has been found, it cannot be far from the foot of Plinth Peak where the ash is as much as 100 feet thick and some pumice blocks are more than 3 feet across.

A specimen of the ash obtained from a peat bog near Jesmond (about 20 miles northwest of Clinton), where it lies at a depth of about 5 feet, yielded a radiocarbon age of 2,440 ± 140 (GSC-529) years. A second ash layer occurs in the bog at a depth of about 14 feet. This has been identified as the Mount Mazama (Oregon) ash which is known to be about 6,600 years old.

PLUTONIC ROCKS

The northeastern margin of the presently exposed Coast Plutonic Complex is marked by the Bendor Intrusions which consist of a northwest-trending string of mainly granodioritic plutons extending from Duffey Creek to the northwestern end of Bendor Range. To the southwest, the terrain is underlain mainly by plutonic rocks which are chiefly quartz diorite, but include also granodiorite and diorite. Gabbro forms a small body east of Liza Lake, and is a minor component of the Shulaps ultrabasic body (unit U), of some dioritic areas (unit 2), and of some diorite-greenstone complexes (unit P2a). In the southern part of the map-area, roughly equidimensional bodies of diorite (P2) are engulfed in a matrix of mainly later quartz diorite which has subsequently admitted northwesterly-trending plutons of granodiorite. Contacts between plutonic rocks and essentially unmetamorphosed pre-Tertiary strata are mainly sharp and concordant, but locally crosscutting. Interplutonic contacts may be sharp or gradational, the latter commonly representing only minor changes in K-feldspar or quartz content.

Gabbro (Map-unit P1)

A body of gabbro outcropping between Liza Lake and the headwaters of Jim Creek was mapped by G.B. Leech (1953, p. 39), who described it as a light to dark grey-green rock with a grain size ranging from fine to pegmatitic. Mafic minerals, which commonly form 40 per cent of the rocks, consist of diopside altered partly or entirely to hornblende, actinolite and chlorite. Where less altered, the rock is a diopside pyroxenite. In places, the mafic and felsic minerals are segregated to form discontinuous layers about one inch thick which grade into massive gabbro. Although variable, steep easterly dips dominate. The contacts are difficult to interpret because most are occupied by serpentinite. The gabbro, however, contains inclusions of Hurley Formation 2 1/2 miles east of Liza Lake, and was therefore emplaced in Late Triassic time or later.

Diorite (Map-unit P2)

Diorite forms three main bodies each about 8 miles across in the southern third of the map-area, and a minor north-border phase of a quartz diorite pluton in the Cadwallader Range.

The diorite that underlies the area about Lizzie Lake is very heterogeneous and consists mainly of hornblende and plagioclase, with minor biotite. Grain size varies from fine to coarse, even within a single hand specimen, and the texture is inconsistent because of irregular segregations of hornblende in equidimensional clusters, bands and streaks. Locally the diorite grades into gabbro which may be either layered with bands 6 to 30 inches wide or orbicular. Here and there the diorite passes into amphibolite through zones of dioritized amphibolite. Basic dykes cut many of the dioritic outcrops, and some contain abundant diorite fragments. Epidote veins are ubiquitous in the dioritic rocks, but intense epidotization is localized in narrow zones adjacent to the dykes. Layering (rare) and foliation (common) in the diorite dip steeply in most places, but has no consistent trend. No contact between the diorite and surrounding quartz diorite was observed.

The diorite which underlies the upper part of Twin Ore Creek, 10 miles to the north, is not as complex as the Lizzie Lake body. It consists mainly of medium- to coarse-grained hornblende > biotite diorite, which is commonly massive except along its western margin where it is faintly foliated. Most of the diorite is dark grey, due to dark, locally purplish, feldspar. In places the diorite grades into quartz diorite, and rarely into coarse-grained hornblendite. Chloritized mafic minerals and epidote veins are common. Here and there pegmatite veins cut the diorite. Its western boundary, with quartz diorite, appears to be gradational; the other contacts were not observed.

The third main diorite body, which underlies the headwaters of Ure Creek, is moderately heterogeneous but appears superficially much more complex because it is cut by a network of comparatively young andesitic dykes. Most of the diorite is fine- to medium-grained with local gradations into quartz diorite and coarse-grained hornblendite. In places it contains about 5 per cent elongated amphibolite inclusions. Zones of agmatite locally form 10 to 20 per cent of the outcrop. The central part of the body consists of chloritized quartz diorite with a well-developed foliation which strikes northeast and dips steeply southeast. The core is cut by massive diorite apophyses from the surrounding mass, one of the rare instances in the Coast Mountains of diorite being apparently younger than adjacent quartz diorite. The network of younger dykes, which are unfoliated, have chilled margins and are probably basaltic, forms 20 to 50 per cent of the outcrop within the area mapped as diorite and extends also into the quartz diorite to the west and northwest.

Bralorne Intrusions (Map-unit P2a)

The Bralorne Intrusions underlie areas of minor extent but of considerable economic importance in Cadwallader Creek Valley. Time did not permit the authors to study these unusually complex rocks although Cairnes' (1937) description of their conflicting relationships is a demand for a thorough study. He divided them into two main types, diorite and soda granite, but within that range are included gabbro, pyroxenite, augite diorite, hornblende diorite, 'greenstone-diorite', quartz diorite, soda granite and aplite.

The Bralorne diorite is a dark, greenish grey rock with an irregular texture and is characteristically converted to an angular agmatite by a network of light-coloured veins which vary from aplite to mixtures of epidote, zoisite carbonate and quartz. The diorite ranges, even within a small outcrop, from very fine grained where it is indistinguishable from the Pioneer greenstone, to coarse grained. The plagioclase is commonly albitic and the amphibole, pale green and ragged. When the 'diorite' appears to be freshest, the plagioclase may consist of andesine, labradorite or even bytownite, and augite may be abundant. In such places the rock is actually

a gabbro or rarely a pyroxenite. In these rocks the amphibole has evidently formed by replacing augite. Cairnes suggested that the calcium liberated by such replacement accounts for the epidote minerals and carbonate that are abundant in the Bralorne diorite.

Relationships between the Pioneer greenstone and the Bralorne diorite have precipitated much controversy. Not only do rock masses within the Bralorne diorite grade into greenstone identical to that of the Pioneer Formation, but within the latter are many gradations into coarser grained rock which is indistinguishable from typical Bralorne diorite. These features could be accounted for in terms of random recrystallization or dioritization of the Pioneer greenstone, were it not known that the diorite intrudes the overlying Hurley Formation. Cairnes pointed out, however, that this diorite is commonly coarser grained and more evenly textured than the 'greenstone-diorite' and is actually gradational into soda-granites. He concluded, therefore, that two diorites are present, one formed either from the greenstone or as a more slowly cooled phase of it, and a later intrusive diorite.

The soda-granite is closely related to Cairnes' later diorite. It forms randomly distributed, irregularly shaped masses within and grading into the augite diorite, as well as dyke-shaped bodies that have sharp contacts with diorite. A single contact may be sharp at one place and gradational in another. Although the soda-granite is generally randomly distributed through the diorite, underground workings revealed a concentration of the silceous rock along the northern margin of the main body of augite diorite near the Pioneer and Bralorne mines. The only essential difference between it and the common Bralorne diorite that contains albitic plagioclase is the abundance of quartz, which may form as much as 50 per cent of the soda-granite. The quartz content, however, is highly variable and K-feldspar is absent (at least not recognized), consequently soda-granite commonly grades into quartz diorite and thence into diorite. The soda-granite contains minor amounts of ragged, pale amphibole (identical to that in the diorite) and biotite; both are commonly chloritized.

The transition from diorite to soda-granite is commonly marked at first by a few irregular patches of soda-granite in the diorite which become increasingly abundant until the rock is wholly soda-granite. The transition zone is a few yards wide where revealed in one adit. The larger masses of soda-granite send dyke-like apophyses into the bordering diorite, but they consist of a finer grained and more altered rock than the soda-granite.

Although the origin of the soda-granite, or perhaps more accurately, of the quartz concentrations, is not known, it is spatially closely related to the gold deposits of the district.

Another diorite-greenstone complex underlies an elongate area extending about 6 miles northward from the southwest end of Anderson Lake. It is very heterogeneous and grades irregularly from greenstone, through dioritized greenstone, to diorite some of which is coarse grained and some unusually leucocratic.

Quartz Diorite (Map-unit P3)

The quartz dioritic mass west and south of Pemberton is a heterogeneous unit with abundant inclusions, gneissic zones and irregular areas of dark dioritic rock. Northwest-trending foliation with vertical or steep northeast dips is well developed in most outcrops. Mafic minerals form about 15 per cent of the rocks, but range commonly from 5 to 20 per cent. Hornblende is more abundant than biotite. K-feldspar is generally absent but may form up to 3 per cent of the rock.

Quartz ranges from 2 to 30 per cent and averages about 10 per cent. The quartz diorite weathers greenish grey, owing to epidote stringers and chloritization of the mafic minerals which indicate widespread, low-temperature alteration. Possibly related to this alteration are swarms of basic dykes, particularly common in a 10-mile-wide zone extending southeasterly from the icefield at the west edge of the map-area, north of Rutherford Creek to beyond the upper part of the creek. In the vicinity of Mount Weart, dykes may form 60 to 80 per cent of the outcrop. The quartz diorite includes screens of irregularly layered gneiss (not shown on map), especially abundant on the ridge and valley side north of the lower reaches of Rutherford Creek. Amphibolitic inclusions form about 5 per cent of the quartz diorite, but are irregularly distributed. Contacts of the quartz diorite with the diorite body at the head of Ure Creek are gradational; contacts with the volcanic rocks of map-unit 3a are commonly sheared.

The quartz dioritic rocks between Lillooet Lake and Scuzzy pluton are generally medium grained, less altered and less heterogeneous than those just described, but are far from being homogeneous. Average composition of 35 specimens is 18 per cent mafic minerals (range 4 to 35 per cent, hornblende dominant), 1.6 per cent K-feldspar (range 0 to 15 per cent), and 9 per cent quartz (range 0 to 22 per cent). Epidote and chlorite are common near Lillooet Lake. Most outcrops show moderate to well-developed foliation trending northwesterly, with a slight preponderance of steep southwest dips. North of Twin Two Creek, however, the quartz diorite is massive. Irregularly distributed amphibolitic inclusions form up to 20 per cent of the rocks. The quartz diorite intrudes or alters the Lizzie Lake diorite and is in turn intruded along sharp contacts by Scuzzy pluton. Acid volcanic rocks unconformably overlie the quartz diorite and other plutonic rocks in the southeastern corner of the map-area.

The quartz diorite body that extends from near the west end of Duffey Lake to Gates River is medium to coarse grained, massive and almost devoid of amphibolitic inclusions. Most specimens contain about 20 per cent mafic minerals, but the hornblende biotite ratio is variable. Quartz is about equally abundant, and K-feldspar rarely exceeds about 1 per cent. Mean specific gravity is about 2.75. The same plutonic terrane extends south of Duffey Lake where it is much the same, except for a slight increase in specific gravity to about 2.77. In most places, biotite and hornblende are about equal in abundance, but biotite commonly forms conspicuous button-like plates. A narrow tongue of Bridge River Group phyllite extends into the quartz diorite 2 miles south of Duffey Lake. The phyllite is partly converted into irregularly layered gneiss at the contact, which is sharp and concordant with the foliation in the gneiss and with the local foliation in the quartz diorite. No detached fragments of the phyllite appear in the plutonic rock.

East of an intervening body of granodiorite and a tongue of Bridge River Group rocks (much larger than that previously mentioned) is another substantial mass of quartz diorite. Compared to that south of Duffey Lake, this rock is more leucocratic (mafic minerals about 15 per cent), contains 1 to 2 per cent K-feldspar and is less dense (mean specific gravity of about 2.70). It differs also in that biotite almost invariably exceeds hornblende in abundance, and in fact, hornblende is commonly absent. The quartz diorite is generally free of amphibolitic inclusions, and is massive and light grey weathering.

The quartz diorite body that extends southwestward from Hurley River across Birkenhead Lake, consists of a clean medium- to coarse-grained, massive rick, which is characterized by button-like plates of biotite. The mineralogical composition of the pluton, based on 13 specimens, is 17 per cent mafic minerals (ranging from 9 to 24 per cent) with biotite dominant, except near Hurley River, 2.6 per cent K-feldspar

(range 0 to 6 per cent), 15 per cent quartz (range 11 to 38 per cent), and the remainder chiefly plagioclase. Epidote, both as veins and discrete grains, is common in the central part of the quartz diorite body. In most places, amphibolite inclusions form less than 1 per cent of the rock, but locally attain a maximum of about 3 per cent. Contacts between the quartz diorite and Cadwallader Group are sharp with little metamorphic effect. The contact between the quartz diorite and the granodiorite to the north was not seen, but as the two rocks are indistinguishable except for the greater K-feldspar content of the granodiorite, a gradation contact is suspected.

Granodiorite (Map-unit P4)

Spetch Creek pluton

Spetch Creek pluton extends 20 miles northwesterly from near Joffre Creek and has a width ranging up to 10 miles. Except for its southern end, the pluton is intrusive into Upper Triassic volcanic rocks (map-unit 3a). Most of it consists of a clean, homogeneous, medium- to coarse-grained granodiorite, which is massive except near Lillooet Lake, where it is foliated parallel with the shore. Average composition of 22 specimens of Spetch Creek pluton is 12 per cent mafic minerals (range, 8 to 22 per cent) with biotite generally dominant, 8 per cent K-feldspar (range, 0 to 24 per cent), 22 per cent quartz (range 2 to 40 per cent), and the remainder mainly plagioclase. Some diorite outcrops at the mouth of Joffre Creek, and quartz monzonite appears north of the head of that creek. Whether they are phases of Spetch Creek pluton or rocks of a different age is not known. In most outcrops, amphibolitic inclusions form less than 1 per cent of the rock, locally they form as much as 5 per cent. Here and there epidote, aplite and pegmatite veins cut the granodiorite. The mean specific gravity of the 22 specimens collected is 2.70.

Scuzzy pluton

Most of the Scuzzy pluton lies in Hope map-area to the southeast, but it extends 24 miles into Pemberton map-area. Exposures of the pluton are divided by an overlying mass of early Tertiary volcanic rocks (map-unit 12) into two areas in which the rock is similar but not identical. The southern part is more like typical Scuzzy granodiorite in that it is leucocratic massive, homogeneous, and has an average content of 3 per cent mafic minerals (biotite dominant), 12 per cent K-feldspar, 21 per cent quartz, minor muscovite and local garnet. In contrast, the northern part (north of Stein Lake) is commonly foliated and contains more mafic minerals (averaging 11 per cent), less K-feldspar (about 5 per cent), less quartz (about 18 per cent), and no muscovite or garnet. The difference in mean specific gravity which is 2.64 for the south part, and 2.69 for the north, reflects mainly the difference in mafic mineral content. Both parts of the pluton are practically free of amphibolitic inclusions, but the northern area contains a prominent screen of micaceous schists (map-unit B). The white weathering Scuzzy granodiorite has sharp intrusive contacts with the darker flanking quartz diorite. A K-Ar determination on biotite from the main mass of Scuzzy pluton in Hope map-area, indicated a latest Cretaceous age of about 70 million years.

Possibly related to Scuzzy pluton is the triangular body of granodiorite lying 6 miles northeast of the north end of that pluton. It consists of a coarse-grained, clean, whitish weathering granodiorite with about 6 per cent mafic minerals (mainly biotite), 6 per cent K-feldspar, and 15 to 30 per cent quartz. The rock appears very

massive, but the contacts were not observed. The south end of the pluton is overlain by Tertiary volcanic rocks (map-unit 12). The mean specific gravity of 2.65 more closely matches that of Scuzzy granodiorite than Bendor Intrusions.

Map-Unit P4a

On the southern margin of the map-area between Roger and Gowan creeks, is a body of homogeneous, pinkish grey, fine- to medium-grey granodiorite. It contains about 5 per cent mafic minerals with hornblende dominant, 20 per cent K-feldspar, and 6 per cent quartz. In some specimens, the quartz is less than 5 per cent, and the rock becomes a syenodiorite. The rock is characterized by drusy cavities, which are indicative of a high level of intrusion. Non-drusy specimens have a mean specific gravity of about 2.66. Contacts with diorite (P2) and quartz diorite (P3), were not observed. It is overlain by silicic volcanic breccia (unit 12). In some respects, it resembles the Late Miocene granite-syenite body on King Island in Bella Coola map-area, about 300 miles to the northwest.

Granodiorite and Quartz Diorite (Map-units P4 and P3)

Bendor Intrusives (map-unit 4 in Bendor Range)

The several granodiorite plutons underlying the Bendor Range were named the Bendor Intrusives by Cairnes (1937). The largest of these, Bendor pluton, consists mainly of clean, homogeneous, medium- to coarse-grained, light-coloured, biotite-hornblende granodiorite. Quartz diorite and diorite are minor components of the pluton. Foliation is rarely seen. The pluton contains less than 1 per cent small rounded amphibolitic inclusions. Mean specific gravity of seven specimens is about 2.71.

Mafic minerals form 4 - 12 per cent of the rock, averaging about 8 per cent. In most specimens, biotite exceeds hornblende. K-feldspar content is low in most places, averaging 4 - 5 per cent, consequently the rock commonly falls close to the quartz diorite-granodiorite boundary. Quartz forms from 4 - 20 per cent of the rock, and averages about 8 per cent. Grains of sphene and magnetite are commonly visible.

The contacts are sharp, crosscutting and clearly intrusive, but inclusions of wall-rock are rare, except for small areas of agmatite at the contact. The pluton commonly sends a network of dykes into the wall-rock. Cairnes (1937), observed that:

"The Bendor intrusives are massive rocks forming bold outcrops which are traversed by widely spaced joints dipping in part at low angles and in part nearly vertically. The low-angle joints are particularly noticeable and from a distance lend a coarsely stratified appearance to the rocks. Contacts with adjoining formations dip steeply outwards from the batholithic masses. The principal contacts within the area have a general northwesterly strike and along these contacts the older formations have approximately the same strike and for the most part dip away from the intrusive masses. The large, batholithic masses of Bendor on either side of the southeast end of Cadwallader Creek valley are probably united at depth, as they dip towards each other and the intervening formations exhibit pronounced thermal metamorphism."

The pluton that lies southeast of Bendor pluton and outcrops on the northwest shore of Anderson Lake is evidently the same rock, although the eastern part

is slightly more basic (a quartz diorite). It too is clean and homogeneous, but contains rare screens of garnet-biotite schist up to 50 feet wide.

The quartz dioritic phase of this pluton extends to the southeast across Anderson Lake. It resembles Bendor pluton in appearance, but K-feldspar forms only about 2 per cent of the rock. As in Bendor pluton, small amphibolitic inclusions form less than 1 per cent of the rock, and sphene is commonly visible. In addition, however, epidote is present in most places. The quartz diorite is moderately well foliated (trending easterly and dipping steeply to the south), where it outcrops along Anderson Lake but massive on the ridges beyond. The southeastern contact between the quartz diorite and metamorphosed Bridge River Group rocks is sharply crosscutting. Phyllite at the contact shows some plastic flowage, but no inclusions of the phyllite appear in the plutonic rock. Apophyses emanating from the pluton are of two types; dykes several feet wide of quartz diorite similar to the main mass, and narrow sills (several inches wide) of quartz monzonite composition consisting of about 60 per cent quartz, 20 per cent plagioclase, 15 per cent K-feldspar, 4 per cent muscovite and 1 per cent biotite. In places, the sills grade into pegmatitic patches.

Two miles south of this pluton is a smaller stock of a similar quartz diorite; the two are probably connected at depth.

Ultrabasic Rocks

The largest body of ultrabasic rocks (map-unit U) in the map-area and one of the largest in the province underlies the northern part of Shulaps Range. Smaller bodies outcrop in the Cadwallader Creek area and northwest of Tyaughton Lake. The geology of Shulaps Range was studied by Leech (1953) and the following description of the ultrabasic rocks there is taken from his report. They consist mainly of red-brown to orange-weathering harzburgite (a rock containing olivine and orthopyroxene), tan-weathering dunite, brown-weathering enstatite pyroxene, and serpentinized, steatitized (altered to soapstone), and carbonatized equivalents of those rocks. The main mass of these rocks, which extends beyond the map-area, is about 20 miles long and in the vicinity of Shulaps Peak, about 8 miles wide. Some of the contacts are definitely faults and possibly all are. As the ultrabasic rock is invariably represented by slickensided serpentine at the questionable contacts, the distinction between faults and an intrusive contact that evidently involved solid serpentinite, cannot be made — a problem that arises also in connection with diapirs of salt, gneiss and with some granitic plutons. North of Marshall Lake, serpentinite cuts limestone of the Hurley Formation (without any thermal effect) and is in turn cut by gabbro (unit P1), and north of the map-area by Rexmount porphyry.

Before serpentinization and other alteration, harzburgite is estimated to have constituted about 85 per cent of the main Shulaps mass. Dunite and pyroxenite forms randomly distributed layers, pods and irregular masses in the harzburgite. The layers are repetitive, and range from a quarter of an inch to about 2 feet in thickness. The harzburgite is easily recognized by its warty weathered surface produced by differential weathering of olivine (less resistant) and pyroxene. Gabbroic bodies appear in the Shulaps mass on the ridge east of Liza Lake where they are spatially associated with diopside pyroxenite (Leech, 1953).

As the Shulaps ultrabasic rocks cut Hurley strata, the emplacement of the main mass is not earlier than the Norian stage of the Upper Triassic. A minimum age is indicated by the presence of chromite in uppermost Jurassic strata in

Yalakom River Valley, north of the map-area. Later movements of the highly mobile serpentinite and of peridotite masses lubricated by it, are probable. Age of crystallization of the primary ultrabasic rock may of course, be much older than Norian, inasmuch as the lack of significant thermal effects on the country rocks is incompatible with the concept of a huge intrusion of ultrabasic magma. A cool solid intrusion of the Shulaps ultrabasic rocks, at least at the present surface, is indicated.

METAMORPHIC ROCKS OF UNKNOWN AGE

Map-Unit A

To this unit are assigned granitoid gneiss and migmatitic complexes that underlie four small areas in the southern half of the map-area. On the west side of Pemberton village is a poorly defined area dominated by fine- to medium-grained heterogeneous quartz diorite which grades into schistose amphibolite bands over distances of about 1 foot to 5 feet across the foliation, and over longer distances parallel with it. No sharp *lit-par-lit* patterns were observed. The amphibolitic bands are rarely more than a few feet wide and commonly contain central layers of epidote, the formation of which seems to have made the amphibolite more resistant to granitization. The foliation in both the plutonic rock and screens trends north to northwesterly and dips 65 to 70 degrees westerly.

Three small areas of unit A lie between Lillooet Lake and the southeast corner of the map-area. A band of rusty weathering amphibolite, schist and irregularly textured quartz diorite trends northeasterly across Lizzie Lake and dips about 45 degrees southeasterly. A vaguely defined area between the head of Gowan Creek and Nahatlatch River is underlain by a banded amphibolitic gneiss that grades into irregularly layered gneiss and minor biotite-hornblende gneiss. These rocks trend northerly and dip about 30 degrees westerly. East of Nahatlatch River a narrow band of gneiss more or less parallels the valley. It consists chiefly of grey to rusty weathering gneiss, some regularly and some irregularly layered. The banded gneiss is very quartzose, with micaceous layers 1/4 to 1 inch thick. Also present are minor amounts of biotite-garnet gneiss, amphibolite, and gneissic diorite. The rocks trend slightly west of north and dip about 60 degrees westerly.

Map-Unit B

Metamorphosed, mainly sedimentary rocks form several narrow bands isolated in plutonic rock. They may have been derived from the lower part of the Bridge River Group or possibly from older rocks.

The band north of Birkenhead Lake trends slightly north of west, and is about 5 miles long, and locally as much as a mile wide. It consists chiefly of rusty weathering phyllite and biotite schist, with feldspathized zones. A thick, dark grey, fine-grained andesitic sill forms the southern border of the band, and is in contact with a peculiar coarse-grained diorite in which plagioclase crystals are held in a matrix of amphibole. The diorite is presumably a phase of the enclosing quartz diorite (P3). Layering in the band is parallel with its elongation and dips vertically.

Several elongate bodies of map-unit B appear in the southeast quarter of the map-area. They consist of steeply dipping, highly micaceous, rusty weathering, flaggy schists containing varying amounts of quartz, biotite, muscovite, garnet, staurolite and possibly sillimanite. These are higher grade metamorphic rocks than the phyllites which form remnants in quartz diorite near the contact with the Bridge River Group to the north, such as that on Gott Peak.

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