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GEOLOGY AND MINERAL OCCURRENCES OF THE TASEKO - BRIDGE RIVER AREA

By P. Schiarizza, P.Geo., R.G. Gaba, P.Geo., J.K. Glover, P.Geo., J.I. Garver and P.J. Umhoefer

Contributions by D.A. Archibald, T.P. Poulton, H.W. Tipper, F. Cordey, M.J. Orchard, J.A. Jeletzky, J.W. Haggart, J.F. Basinger, A.R. Sweet and R.M. Friedman

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SUMMARY

The Taseko - Bridge River map area covers about 3200 square kilometres of mountainous terrain centred 200 kilometres north of Vancouver. It lies between latitudes 50°45′ and 51°15′ north and longitudes 122°00′ and 123°30′ west, and covers NTS map areas 92O/2 and 92O/3 and portions of map areas 92O/1, 92J/14, 92J/15 and 92J/16. Geological mapping of the area was funded by the 1985-1990 Canada - British Columbia Mineral Development Agreement. Its main objectives were to stimulate and focus mineral exploration by improving the geoscience database for the area and providing a geological framework within which to interpret mineral occurrences, alteration zones and geochemical anomalies. This information contributes to an assessment of the overall mineral resource potential of the area, thus providing guidelines for future mineral exploration and land-use designations.

The map area comprises part of the southeastern Coast Belt, which is underlain by a number of distinct Late Paleozoic to Mesozoic lithotectonic assemblages that originated in ocean basin, volcanic arc and clastic basin environments. These assemblages are juxtaposed across complex systems of contractional, strike-slip and extensional faults of mainly Cretaceous and Tertiary age, and are intruded by plutonic rocks of mid-Cretaceous through early Tertiary age. This strongly tectonized belt extends southward into the north Cascade Mountains of northern Washington state, and separates the Intermontane Belt to the east from predominantly plutonic rocks of the southwestern Coast Belt.

The Taseko - Bridge River area is underlain by late Paleozoic and Mesozoic rocks of the Bridge River, Cadwallader and Methow terranes, together with Permian ophiolitic rocks of the Shulaps and Bralorne-East Liza complexes, and Jura-Cretaceous clastic sedimentary strata of the Tyaughton basin. These Paleozoic and Mesozoic rocks are locally overlain by Paleogene volcanic and sedimentary rocks, and by Miocene to Pliocene plateau lavas. They are intruded by Cretaceous and Tertiary stocks and dikes of mainly felsic to intermediate composition, and by a batholith of Late Cretaceous granodiorite which occupies much of the southwestern part of the map area.

The Bridge River Terrane is represented mainly by the Bridge River Complex, an assemblage of chert, argillite, greenstone, gabbro, blueschist, serpentinite, limestone and clastic sedimentary rocks, with no coherent stratigraphy. Dated cherts and limestones within the complex range from Mississippian to late Middle Jurassic in age, and blueschist-facies metamorphic rocks yield Middle to Late Triassic Ar-Ar radiometric dates. Their wide age range and structural complexity, together with the presence of blueschist-facies metamorphic rocks, suggest that these rocks represent an accretion-subduction complex that formed in Middle Triassic to latest Middle Jurassic time. The upper part of Bridge River Terrane comprises a succession of clastic sedimentary rocks, formerly included in the Noel Formation, that are here assigned to the informal Gun Lake and Downton Lake units. These rocks are included within the Cayoosh assemblage, a thick coherent succession of clastic metasedimentary rocks that conformably overlies the Bridge River Complex to the south of the Taseko - Bridge River area. They are also correlated with the basal part of the Tyaughton basin succession (lower Relay Mountain Group) to the north. The Jura-Cretaceous Truax Creek conglomerate, which occurs as a narrow fault-bounded lens spatially associated with the Gun Lake unit, may represent a younger part of the Cayoosh assemblage, correlative with the middle part of the Relay Mountain Group.

Cadwallader Terrane includes the Upper Triassic Cadwallader and Tyaughton groups together with Lower to Middle Jurassic rocks of the Last Creek formation and Junction Creek unit. The most extensively exposed component is the Hurley Formation of the Cadwallader Group, which consists of upper Carnian to upper Norian sandstone, siltstone, conglomerate and minor micritic limestone that were deposited mainly as turbidites. The Hurley Formation is stratigraphically underlain by mafic volcanic rocks that are also part of the Cadwallader Group, and is locally overlain by a succession of Lower to Middle Jurassic shales, siliceous argillites and siltstones assigned to the Junction Creek unit. The Tyaughton Group and Last Creek formation, which are restricted to the northwestern exposures of Cadwallader Terrane, are facies equivalents of the Hurley Formation and Junction Creek unit. The Tyaughton Group comprises middle to upper Norian nonmarine and shallow-marine conglomerate, sandstone and minor limestone, while the overlying Last Creek formation is a transgressive sequence comprising upper Hettangian to Sinemurian conglomerate and sandstone grading upward into upper Sinemurian to middle Bajocian shale. The volcanic rocks of the Cadwallader Group have trace element compositions similar to island arc tholeiites, and the clastic rocks of the Hurley Formation, Tyaughton Group and Last Creek formation contain clasts of limestone, basalt, andesite, dacite, rhyolite and granitoids. The Cadwallader Terrane is therefore interpreted as part of a Late Triassic volcanic arc and fringing clastic apron.

Ophiolitic rocks in the Taseko - Bridge River area are assigned to the Shulaps Ultramafic Complex and the Bralorne-East Liza Complex. The Shulaps Complex covers most of the northern Shulaps Range and consists of two major structural divisions: an upper unit of harzburgite and dunite with a mantle tectonite fabric, and a structurally underlying serpentinite mélange unit comprising sheared serpentinite with knockers of ultramafic cumulates, layered to isotropic gabbros, amphibolite, rodingite, and volcanic and sedimentary rocks. Late Paleozoic radiometric dates from plutonic and metamorphic knockers within the serpentinite

mélange unit are interpreted as the age of ocean-floor plutonism and metamorphism associated with construction of Shulaps oceanic crust. Large-scale structural inversion of the original ophiolite stratigraphy occurred in mid-Cretaceous time during its thrust-emplacement above Cadwallader Terrane, which lies beneath the Shulaps Complex across a southwest-vergent thrust system that is exposed in the southwest corner of the Shulaps Range. The Bralorne-East Liza Complex consists of greenstone, diorite, tonalite, gabbro and serpentinite that are imbricated with Cadwallader Terrane throughout the southern part of the Taseko - Bridge River area. It includes rocks previously assigned to the Bralorne and President intrusions, as well as some rocks that had been included in the Pioneer Formation of the Cadwallader Group. These rocks are lithologically similar to the plutonic and volcanic knockers found within the Shulaps serpentinite mélange unit, and have yielded similar Late Paleozoic radiometric dates. They may represent slices of Shulaps oceanic crust that were imbricated with Cadwallader Terrane during obduction of the Shulaps Complex.

Rocks assigned to Methow Terrane underlie the northeastern part of the Taseko - Bridge River area and are separated from the other major tectonostratigraphic assemblages of the area by the Yalakom dextral strike-slip fault or by the pre-Yalakom Camelsfoot fault. The oldest part of the succession (units lmJys, mJyv and mJcs) consists of Lower to Middle Jurassic siltstone, shale, volcanic-lithic sandstone and local volcanic rocks that correlate with the arc-derived Dewdney Creek Formation of the Ladner Group. The basement to these Jurassic rocks is locally exposed to the southeast of the Taseko - Bridge River area, where it comprises poorly dated mafic volcanic and associated mafic to ultramafic plutonic rocks of the Spider Peak Formation and Coquihalla serpentine belt. These ophiolitic rocks may correlate with the Shulaps Ultramafic Complex, which is faulted against the Jurassic rocks of Methow Terrane in the Taseko - Bridge River area. Jurassic rocks of the Methow Terrane are disconformably overlain by a thick succession of Lower to mid-Cretaceous clastic sedimentary rocks that comprise the Jackass Mountain Group. Although they are lithologically and stratigraphically distinct, provenance studies indicate that the Jackass Mountain Group correlates with parts of the Taylor Creek Group in the upper Tyaughton basin. Furthermore, Jura-Cretaceous rocks within parts of Methow Terrane outside the Taseko - Bridge River map area correlate with the Relay Mountain Group of the Tyaughton basin, which overlies both Bridge River and Cadwallader terranes. The Upper Jurassic to mid-Cretaceous rocks included in Methow Terrane are therefore part of an overlap assemblage (Tyaughton - Methow basin) that links the Middle Jurassic and older part of Methow Terrane with Bridge River and Cadwallader terranes.

The Tyaughton basin is represented by a belt of Jura-Cretaceous clastic sedimentary rocks that extends from the Taseko - Bridge River area northwestward to beyond Chilko Lake. The lower part of the basin is represented mainly by the upper Middle Jurassic to Lower Cretaceous Relay Mountain Group, which is well exposed in the central part of the map area. Local occurrences of Lower Cretaceous volcaniclastic strata near the western limit of Relay Mountain exposures, here assigned to the Tosh Creek succession, may represent a transitional unit between Relay Mountain clastics and coeval volcanic rocks within the western part of the Coast Belt. The basal contact of the Relay Mountain Group is not exposed, but indirect evidence suggests that it was deposited on the Bridge River Complex, which is inferred to underlie the main belt of Tyaughton basin rocks from the study area northwestward to Chilko Lake. However, since correlative Jura-Cretaceous siltstones and fine-grained sandstones that are exposed very locally in the Camelsfoot Range (Grouse Creek unit) are in apparent stratigraphic contact with Cadwallader Terrane, and a separate belt of Jura-Cretaceous rocks assigned to the Relay Mountain Group 100 kilometres to the northwest is in stratigraphic contact with Middle Jurassic rocks of Methow Terrane, the unit is interpreted to be an overlap assemblage.

The upper part of the Tyaughton basin consists of synorogenic clastic sedimentary rocks of the Taylor Creek Group and Silverquick formation, which were deposited during the episode of mid to Late Cretaceous contractional deformation that characterizes the southeastern Coast - north Cascades orogen. These strata rest unconformably above the Bridge River Complex in the southern part of the map area, and disconformably above the Relay Mountain Group farther to the northwest. They contain detritus derived from uplifted Bridge River Complex, Cadwallader Terrane and associated ophiolitic complexes within the orogen itself, as well as detritus derived from a volcanic source to the west. The coeval Jackass Mountain Group, which comprises the upper part of Methow Terrane, consists mainly of arkosic sedimentary rocks that were derived from a source area to the east or northeast. However, to the southeast of the Taseko - Bridge River area, mid-Cretaceous rocks of the Methow Terrane also include chert-rich units that were derived from a western source area within the southeastern Coast - north Cascades orogen. These relationships suggest that mid-Cretaceous rocks were deposited in two sub-basins (Tyaughton and Methow) that were largely separated by intrabasinal highlands underlain mainly by Bridge River Terrane. Separation of the two sub-basins was not complete, however, as provenance studies, including fission-track dating of detrital zircons, indicate that a unit of arkosic sedimentary rocks within the Taylor Creek Group was derived from the same source area as the voluminous arkosic sediments of the Jackass Mountain Group.

The Tyaughton basin deposits are overlain by Upper Cretaceous nonmarine volcanic and volcaniclastic rocks of the Powell Creek formation, across contacts that range from conformable to markedly unconformable. These volcanics are part of a magmatic arc that migrated eastward across the Coast Belt in Early to Late Cretaceous time. Clastic sedimentary rocks of the Taylor Creek and Relay Mountain groups, which underlie the main exposure belt of the Powell Creek formation, were deposited in a back-arc setting with respect to older volcanic and plutonic components of this arc, which occur farther west in the Coast Belt.

The structure of the Taseko - Bridge River area is dominated by a system of northwest to north-trending faults that reflect a protracted history of mid-Cretaceous to Tertiary contractional, strike-slip and extensional deformation.

These Cretaceous to Tertiary map-scale structures are superimposed on older structures that have been documented only within the Shulaps and Bridge River complexes. The early structures within the Shulaps Complex comprise synplutonic faults and ductile shear zones that formed during Early Permian construction of Shulaps oceanic crust. Those within the Bridge River Complex include penetrative foliations within Middle Triassic blueschist-facies rocks, as well as the outcrop-scale brittle faults that pervade the complex, leading to a pronounced lenticularity of lithologic units. These structures are attributed to deformation within an accretion-subduction complex. This deformation was apparently operative, perhaps episodically, from the Middle Triassic to at least late Middle Jurassic time, after which the Bridge River Complex was depositionally overlain by clastic sedimentary rocks of the Relay Mountain Group and Cayoosh assemblage.

The oldest map-scale structures within the area are systems of mid to early Late Cretaceous contractional faults. These are recognized across much of the map area, but their continuity is disrupted by younger faults. Synorogenic clastic rocks of the upper Tyaughton basin were deposited during this contractional deformation, as indicated by the predominance of locally derived detritus and angular unconformities beneath the Albian Taylor Creek Group and the Upper Cretaceous Silverquick and Powell Creek formations. The most prominent structures are southwest-vergent thrust faults that imbricate mid-Cretaceous and older rocks of the Tyaughton basin, Bridge River Complex, Cadwallader Terrane and Bralorne-East Liza and Shulaps complexes. The most common stacking order preserved in these thrust belts consists of the Shulaps Ultramafic Complex above imbricated Cadwallader Terrane and Bralorne-East Liza Complex, which themselves are above Bridge River Complex and Relay Mountain Group. Somewhat younger southwest-vergent reverse and reverse-sinistral faults locally reverse this predominant stacking order and place the Bridge River Complex above the Cadwallader Group and Bralorne-East Liza Complex. Northeast-vergent thrust faults and folds are evident locally, and may in part be coeval with the southwest-vergent reverse and reverse-sinistral faults.

The mid to Late Cretaceous contractional faults are cut by younger systems of dextral strike-slip faults, which formed in Late Cretaceous through Middle to Late Eocene time. These are the most prominent and continuous structures in the Taseko - Bridge River area. They include the Yalakom fault, which was the locus of about 115 kilometres of dextral displacement. Several of the dextral faults are linked through transfer zones or steps, which localized zones of transpressional or transtensional deformation. The most prominent transfer zone occurs within the Shulaps Range between the Yalakom fault and the Marshall Creek fault to the southwest. This zone includes greenschist to amphibolite facies schists derived from the Bridge River Complex, which had previously been interpreted as part of an inverted metamorphic aureole related to mid-Mesozoic obduction of a hot Shulaps ophiolite. However, more recent data show that the schists formed during emplacement of Middle Eocene granitoid intrusions, and underwent synmetamorphic dextral transpressive deformation that was probably related to dextral movement along the adjacent Yalakom fault. The schists are in part bounded by a system of late Middle Eocene normal faults that postdate the transpressional structures. Uplift and exhumation of the metamorphic rocks beneath this normal fault system is interpreted to have resulted from the initiation of the Marshall Creek fault as an important component of the dextral fault system, with consequent development of a right-stepping extensional transfer zone between it and the northwestern part of the Yalakom fault.

The Taseko - Bridge River map area includes the northern part of the Bridge River mining camp, British Columbia's foremost historical gold producer. Most of the camp's production came from the Bralorne and Pioneer mines, just to the south of the Taseko - Bridge River area, which operated from the late 1920s to 1971 and produced a little more than 7 million tonnes of ore grading about 18 g/t Au and 4 g/t Ag. The production from these mines, and from similar deposits in the southern part of the map area, came from mesothermal gold-quartz veins associated with early Late Cretaceous reverse-sinistral faults that formed during the latter stages of the protracted episode of Cretaceous contractional deformation. Coincident with development of structurally-controlled Bralorne-style mesothermal veins in the Bralorne - Gold Bridge area, was intrusion of a large Late Cretaceous granodiorite batholith to the west and northwest. The batholith itself contains numerous porphyry occurrences, and a single hypothermal sulphide-arsenide-oxide vein occurrence. The porphyry occurrences pass outward into vein occurrences in the adjacent country rock that occur locally for 40 kilometres along the northeastern contact of the pluton. In the western part of the area, mineral assemblages in an extensive alteration zone directly north of the batholith suggest conditions transitional between porphyry and epithermal environments.

A younger pulse of magmatism and related mineralization occurred in latest Cretaceous to Paleocene time. Intrusions and associated mineral occurrences of this age are concentrated along the dextral-slip Castle Pass fault system between Carpenter Lake and Tyaughton Creek, and may in part have been controlled by a prominent extensional bend in the fault system. Mineral occurrences are mainly polymetallic and stibnite veins, including the past-producing Minto and Congress mines, but the belt also includes skarn and mercury showings. Polymetallic vein and porphyry occurrences that occur along the general strike of the belt west of Big Creek are associated with porphyry intrusions that may also be of this age.

Porphyry occurrences and associated polymetallic veins also occur within and adjacent to Middle Eocene granodiorite plutons that were localized within transpressional transfer zones linking the Yalakom, Fortress Ridge and Chita Creek dextral fault systems. Epithermal-style mineralization at Big Sheep Mountain is associated with a plutonic-volcanic stock that was intruded into a slightly younger extensional transfer zone between the Marshall Creek and Yalakom faults. Eocene dextral strike-slip faults also host a number of cinnabar±stibnite occurrences, some of which are past producers of mercury. Higher temperature scheelite-stibnite veins occur locally along one of these fault systems, in an area with abundant syn-faulting feldspar porphyry dikes.

Late Paleocene to early Eocene porphyry mineralization at the Poison Mountain deposit is associated with small quartz diorite stocks that intrude Methow Terrane. This is the only mineral occurrence in the area northeast of the Yalakom fault; because it predates much of the Eocene dextral strike-slip, it may have originated a considerable distance northwest of the main belt of mineral occurrences on the other side of the fault.

The geological relationships established within the Taseko - Bridge River area, in combination with data from other parts of the belt, suggests the following general scenario for the tectonic evolution of the southeastern Coast - north Cascades orogen:

(1) Easterly-directed subduction of the Bridge River ocean basin in Middle Triassic to latest Middle Jurassic time, beneath an overriding oceanic plate represented by late Paleozoic ophiolitic rocks of the Shulaps and Bralorne-East Liza complexes. Upper Triassic to Middle Jurassic arc volcanics and arc-derived clastic sedimentary rocks of Cadwallader and Methow terranes formed on the overriding plate in response to this subduction, and the northeastern part of the Bridge River Complex accumulated as an accretionary complex at the leading edge of the overriding plate.

(2) Emergence or arrival of a western crustal block, including the southwestern Coast Belt and Wrangellia Terrane, in late Middle Jurassic time. The subsequent Late Jurassic to Early Cretaceous history of Bridge River, Cadwallader and Methow terranes is dominated by deposition of clastic sediments derived mainly or entirely from this western block. In the north, these clastic deposits are represented by the Relay Mountain Group, which overlaps Methow and Cadwallader terranes, as well as the adjacent Bridge River accretion-subduction complex. Clastic sediments farther south are represented by the Cayoosh assemblage, which was deposited, in part, above stratigraphically coherent portions of the Bridge River Complex which were not affected by subduction-related deformation.

(3) Final collapse of the Bridge River basin, including overlying clastics of the Cayoosh assemblage and Relay Mountain Group, in Early to Late Cretaceous time, giving rise to the southeastern Coast - north Cascades contractional orogen. Shortening of the basin, by way of predominantly southwest-directed thrust faults, was coincident with east-dipping subduction of adjacent oceanic lithosphere along the outboard margin of the Insular Belt, and eastward migration of the resultant magmatic arc from the western Coast Belt to the eastern Coast Belt. Synorogenic clastic sediments of the Tyaughton - Methow basin were derived partly from the western Coast Belt, partly from uplifted highlands within the orogen itself, and partly from a continental source east of the orogen. The influence of the latter source area suggests that the deformation within the southeastern Coast - north Cascades orogen may have included its collapse against the North American continental margin, and/or have been coincident with major uplift of adjacent North American rocks. Although many geologically-based interpretations suggest that the eastern source terrane comprised adjacent rocks of the Intermontane and Omineca belts, paleomagnetic data suggest that this interaction occurred 3000 kilometres farther south along the continental margin.

(4) Late Cretaceous to Late Eocene dextral strike-slip faulting, following an abrupt change in motion of offshore ocean plates from east to northeast-directed orthogonal convergence with the North American margin to north-directed oblique convergence. These dextral faults include the Yalakom - Hozameen and Fraser River - Straight Creek fault systems, which account for 200 to 300 kilometres of mainly Tertiary displacement. Paleomagnetic data suggest that this tectonic regime also resulted in about 3000 kilometres of Late Cretaceous to Paleocene northward translation of the entire southeastern Coast - north Cascades orogen, together with the western Coast and Insular belts, from the latitude of northern Mexico to its present position relative to the North American craton. More than half of this displacement apparently occurred on structures along or near the present day boundary between the southern Coast and Intermontane belts, although fault systems with the appropriate sense and timing of displacement have not been documented along this boundary.

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CHAPTER 1 INTRODUCTION

LOCATION, TOPOGRAPHY AND ACCESS

The Taseko - Bridge River map area covers about 3200 square kilometres of mountainous terrain centred 200 kilometres north of Vancouver. It lies mainly within the Chilcotin Ranges of the Coast Mountains, but also covers parts of the adjacent Leckie, Dickson and Bendor ranges to the southwest, as well as a part of the Camelsfoot Range to the northeast. It lies between latitudes 50°45′ and 51°15′ north and longitudes 122°00′ and 123°30′ west, and covers NTS map areas 92O/2 and 92O/3 and portions of map areas 92O/1, 92J/14, 92J/15 and 92J/16.

The Bridge River, including Downton and Carpenter lakes, flows eastward along the southern margin of the map area to empty into the Fraser River near Lillooet, 5 kilometres east of the area's eastern boundary (Figure 1). Major tributaries of the Bridge River that flow southeastward through the map area include Gun, Tyaughton and Relay creeks and the Yalakom River. Major drainages in the northern part of the area, including the Taseko River and Beece, Big, Dash and Churn creeks, flow northward to the Chilcotin and Fraser rivers.

Total relief within the Taseko - Bridge River area is considerable; Taseko Mountain in the northwestern corner of the area reaches a height of 3061 metres above sea level (Photo 1), while the elevation along the Bridge River in the southeastern corner of the area is only 300 metres. The northwestern part of the area, west of Big Creek and south and southwest of Mount Sheba, is characterized by high, rugged mountains. Elevations range from 1500 metres to over 3000 metres, with treeline at about 1800 metres. The mountains are somewhat lower, and distinctly less rugged to the southeast, where elevations range from 600 metres along Carpenter Lake to 2700 metres on Relay Mountain. The terrain gradually becomes lower and more subdued northward, and is characterized by rolling tree-covered ridges and broad valleys along the northern margin of the map area, in the vicinity of Churn, Dash and Lone Valley creeks (Photo 2). This area marks a transition into the Chilcotin Plateau to the north; west of Big Creek, this transition occurs along the Dil Dil Plateau at elevations of 2000 to 2300 metres. The Shulaps Range, in the southeastern segment of the map area, is an isolated welt of high, rugged mountains ranging up to almost 2900 metres in elevation (Photo 3). These are bounded by the Yalakom River and Camelsfoot Ranges on the northeast, by the Bridge River and Carpenter Lake to the south and southwest, and by a belt of relatively subdued topography bordering Tyaughton Creek to the west.

Permanent settlement in the Taseko - Bridge River map area is restricted to the area around Gold Bridge (Photo 4) and Bralorne, in the southwestern corner of the area, and the vicinity of Moha, along the lower Yalakom River valley in the southeast. Access to these areas, and the entire southern margin of the map area, is by a good gravel road that follows the Bridge River and Carpenter Lake from Gold Bridge to Lillooet. Gold Bridge and Bralorne can also be reached from

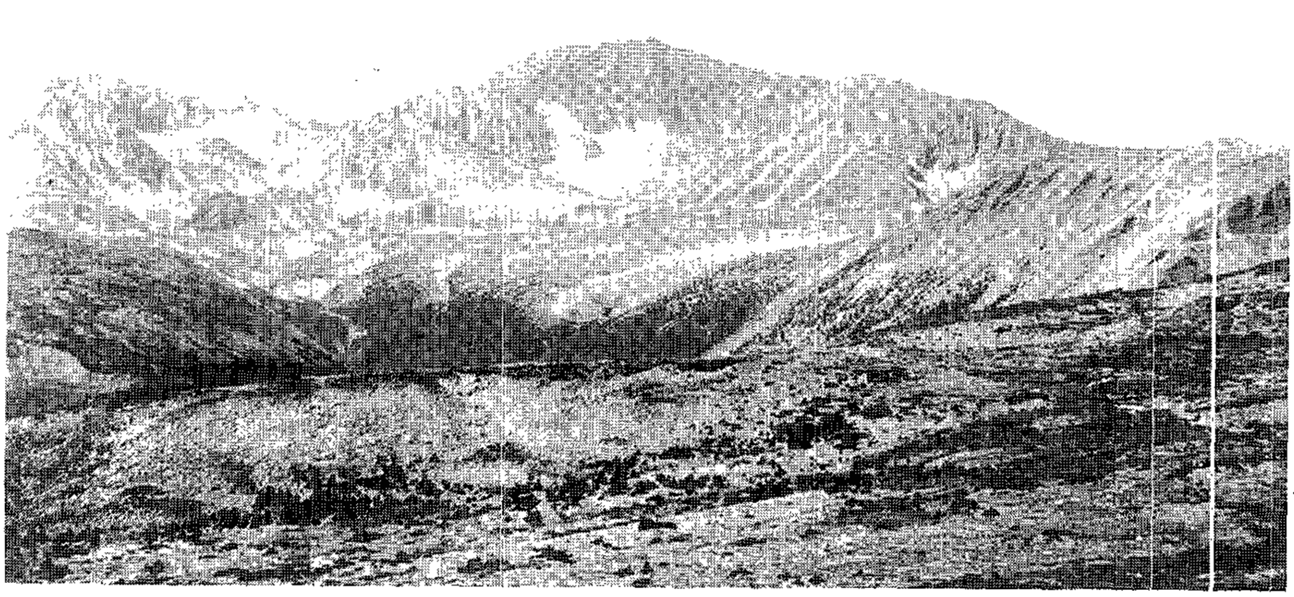

Photo 1. Taseko Mountain, viewed southwestward from just north of the study area.

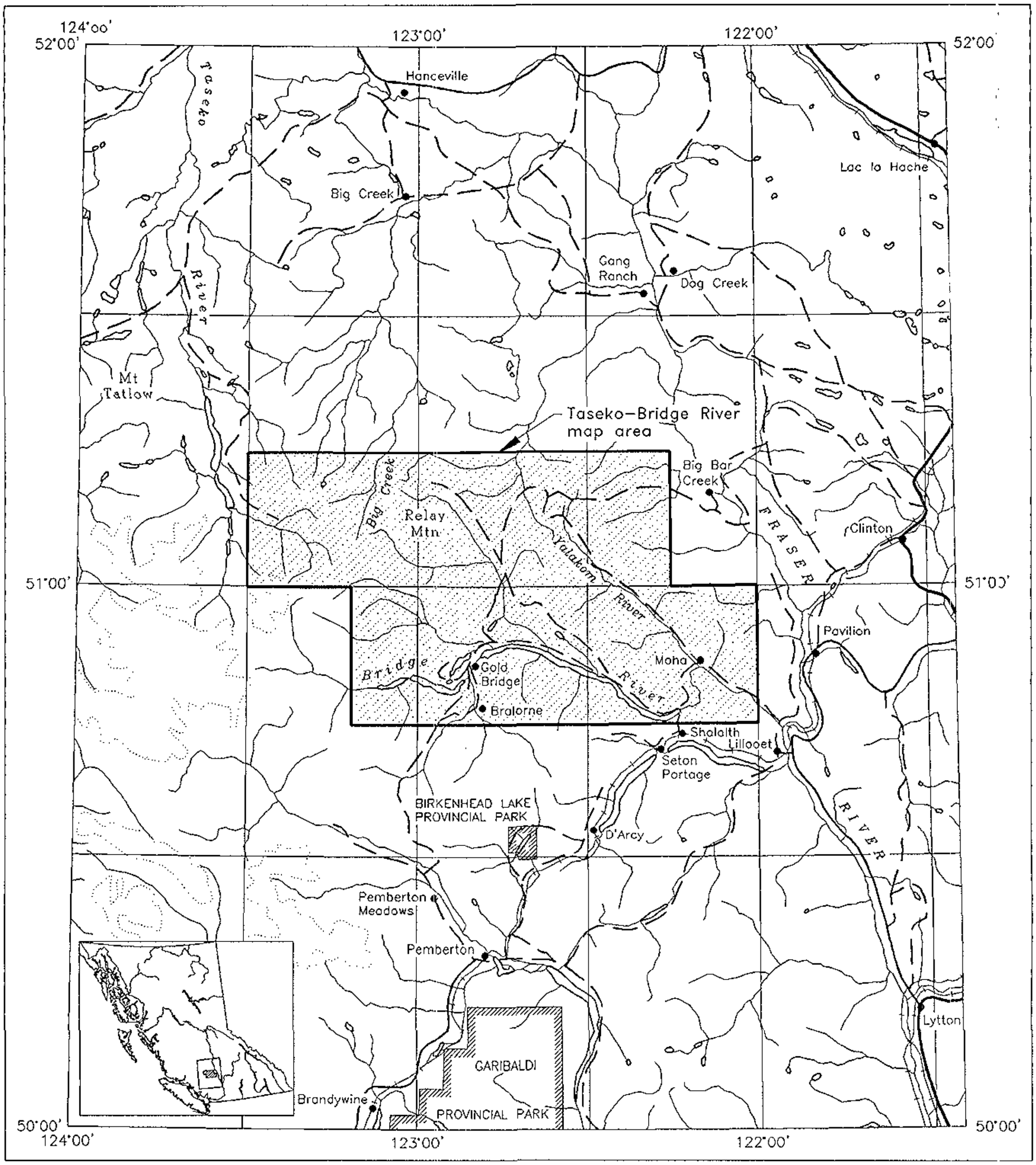

Figure 1. Location of the Taseko - Bridge River map area.

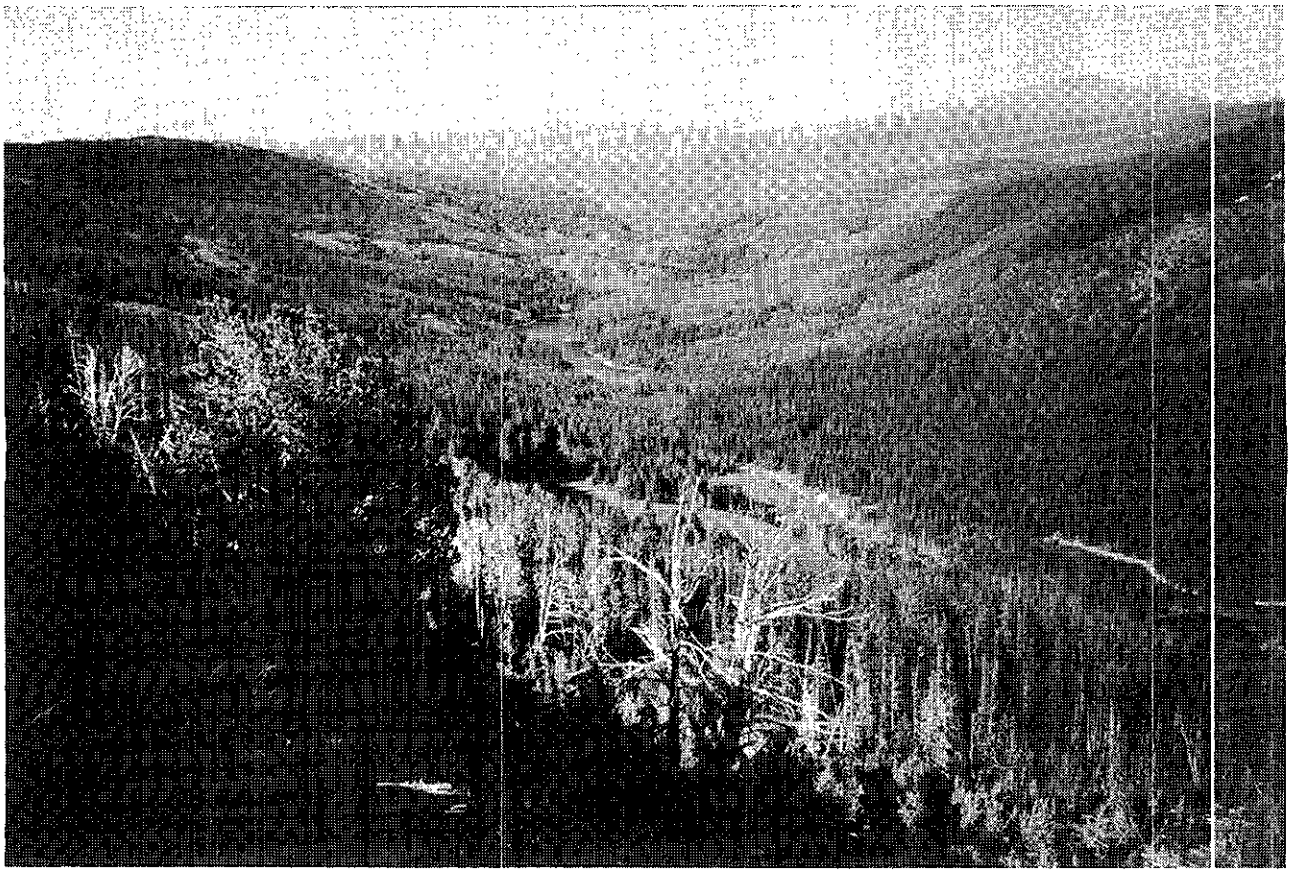

Photo 2. View to the northeast from the slopes west of upper Mud Creek; Red Mountain on right-hand skyline.

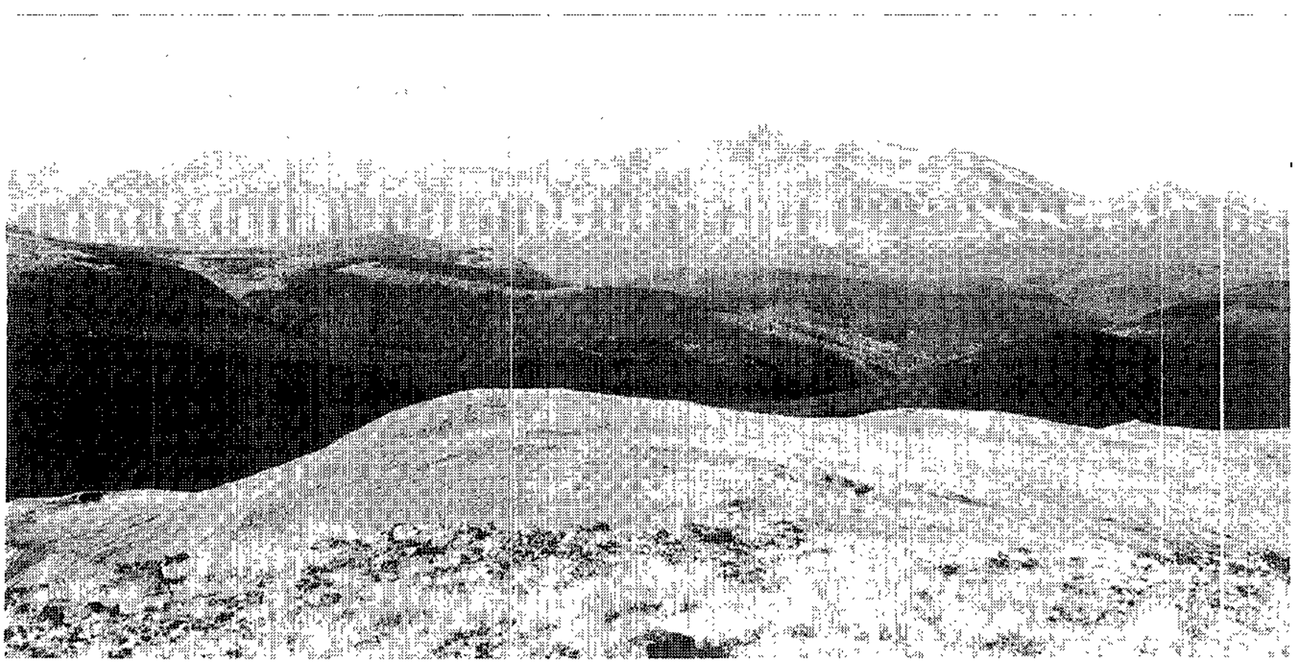

Photo 3. North end of the Shulaps Range, viewed southward from the Camelsfoot Range.

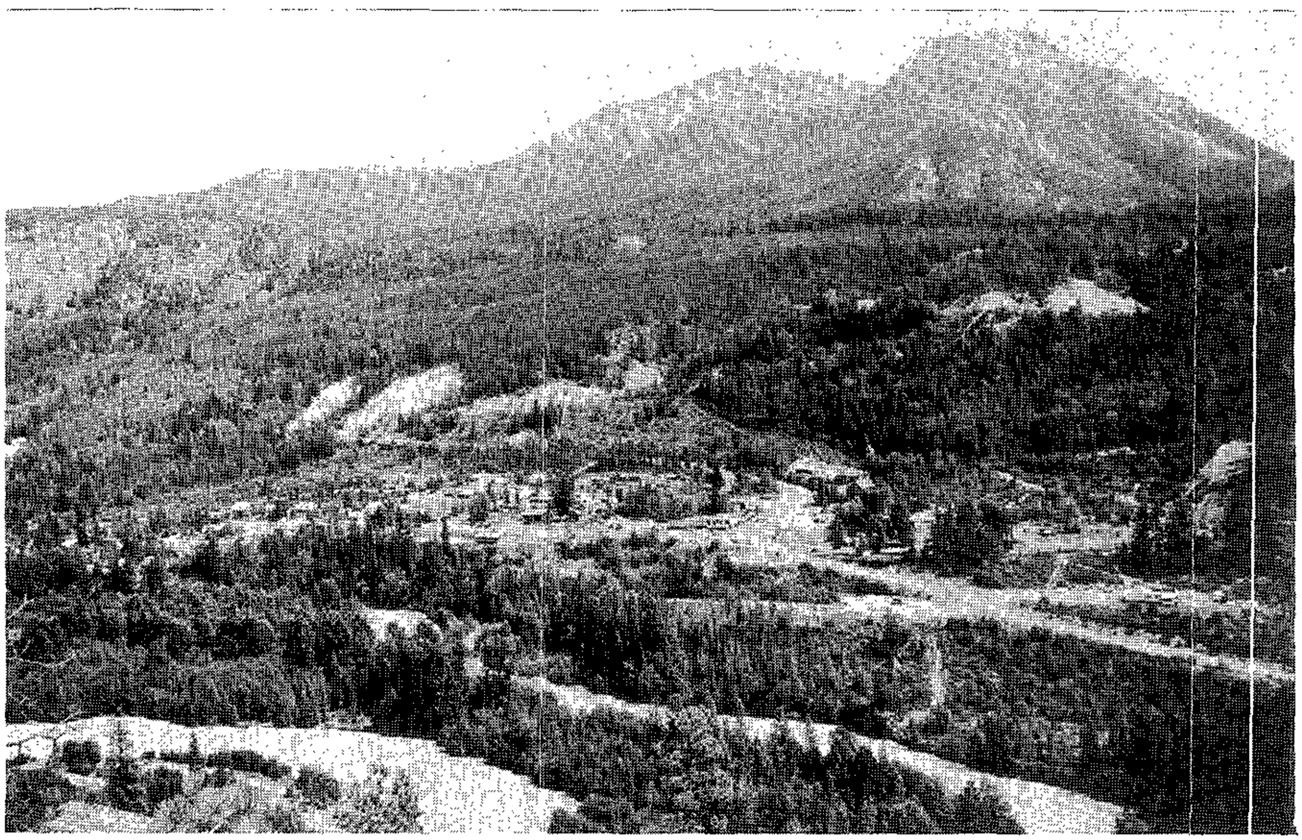

Photo 4. The town of Gold Bridge viewed from the north side of the Bridge River; Mount Fergusson in the background.

Pemberton by way of a seasonal road along the Hurley River. A road that branches from the Carpenter Lake road at Marshall Creek leads to an extensive network of logging roads that covers parts of the drainage basins of Liza, Noaxe, Mud, Relay and Paradise creeks. This network is also accessible via the Tyaughton Lake road, which branches from the Carpenter Lake road 10 kilometres northeast of Gold Bridge, and by a road that follows the Yalakom River to Poison Mountain and then extends eastward to Mud Creek through the drainage divide at Swartz and Mud lakes. A seasonal road that extends eastward from Poison Mountain leads to a Fraser River ferry-crossing at Big Bar Creek.

The northwestern part of the map area, including the entire 92O/3 sheet, is not accessible from Gold Bridge by road, but is traversed by an excellent network of trails, with trailheads at Gun Creek, Tyaughton Lake, Taylor Creek, the junction of Tyaughton and Relay creeks, and upper Relay Creek. The northwestern part of the area can also be accessed from Highway 20 between Williams Lake and Bella Coola, via a road that extends southwest from Hanceville to the Nemaia valley. A seasonal road that branches southward from this road follows the Taseko River as far as Battlement and Granite creeks.

Permanent helicopter bases are located in Pemberton Meadows, 45 kilometres south of Gold Bridge, and in Lillooet, 65 kilometres east-southeast of Gold Bridge. Seasonal helicopter bases are commonly established in the Gold Bridge area during the summer months.

REGIONAL GEOLOGIC SETTING

The Taseko - Bridge River project area lies along the northeast margin of the southern part of the Coast Belt, one of the five morphogeological belts of the Canadian Cordillera. The Coast Belt extends for more than 1700 kilometres from northern Washington state to the southern Yukon, and is characterized by rugged mountains underlain in large part by Late Jurassic to early Tertiary granitic rocks of the Coast Plutonic Complex. The Intermontane Belt to the east is underlain by Quesnel, Cache Creek and Stikine terranes (Intermontane superterrane), which were amalgamated and accreted to the western margin of North America by Early to Middle Jurassic time. The Insular Belt to the west is underlain by the composite Insular superterrane, which consists mainly of Wrangellia and Alexander terranes. Mid-Cretaceous southwest-directed contractional faults are prominent structures in several areas within and along the western margin of the Coast Belt, and coeval to slightly younger east-directed thrusts are locally prominent in the eastern part of the belt (Rubin *et al.*, 1990; Rusmore and Woodsworth, 1991b). These structures and associated magmatism were interpreted by Monger *et al.* (1982) to reflect crustal thickening associated with the accretion of the Insular superterrane to the western margin of North America (Intermontane superterrane) in mid-Cretaceous time. Other workers, including van der Heyden (1992), suggest that the Insular superterrane was amalgamated with the Intermontane superterrane by Middle Jurassic time, and the Coast Belt is a long-lived (Middle Jurassic to Tertiary) Andean-style magmatic arc built across both superterranes. In this interpretation, the mid-Cretaceous contractional structures within the Coast Belt are intraplate structures that in part collapsed a series of intra-arc basins. Further debate about the relationships between Insular, Coast and Intermontane belts relates to their mid-Cretaceous paleolatitudes. Many geological models place them at approximately their present location along the North American margin, whereas several sets of tilt-corrected paleomagnetic data suggest that in mid-Cretaceous time parts of the Coast Belt lay about 1800 km south of presently adjacent rocks of the Intermontane Belt, which themselves were about 1200 kilometres south of their current position with respect to the North American craton (Ague and Brandon, 1992; Irving *et al.*, 1993; Wynne *et al.*, 1993).

Recent geological studies indicate that the southern Coast Belt can be divided into western and eastern parts (Figure 2) based on differences in plutonic rocks, terranes and structural style (Monger *et al.*, 1990; Monger and Journeay, 1994). The southwestern Coast Belt consists of about 80 per cent Middle Jurassic to mid-Cretaceous plutonic rocks. Its western boundary is a Late Jurassic magmatic front along which granitic rocks of the Coast Belt intrude Triassic and Jurassic rocks of Wrangellia Terrane along a linear system of northeast-side-down Jurassic faults (Nelson, 1979; Monger, 1991a). The Late Jurassic plutonic rocks extend across the entire width of the southwestern Coast Belt, and enclose pendants and septa of Jurassic Wrangellian rocks in the western and central portions. At the southeast corner of the southwestern Coast Belt, this same suite of Jurassic plutonic rocks intrudes lower units of the Harrison Terrane, which includes Middle Triassic cherty argillites and mafic volcanics (Camp Cove Formation) overlain by Middle Jurassic andesitic to dacitic volcanics of the Harrison Lake Formation (Arthur *et al.*, 1993). Stratigraphically above the Harrison Lake Formation are upper Middle Jurassic to Upper Jurassic sedimentary and andesitic volcanic rocks that are coeval with some of the Jurassic plutons in the southwestern Coast Belt. These are unconformably overlain by Lower Cretaceous sedimentary and volcanic rocks of the Peninsula and Brokenback Hill formations. A similar unconformity is present elsewhere in the southwestern Coast Belt, where it separates volcanic and sedimentary rocks of the Lower Cretaceous Gambier Group from older assemblages, including Late Jurassic plutonic rocks (Monger, 1993).

The southeastern Coast Belt, including the Taseko - Bridge River area, contains a smaller percentage of granitic rocks than the southwestern belt, and these are mid-Cretaceous through Early Tertiary in age. Supracrustal rocks include a number of distinct, partially coeval lithotectonic assemblages, including Bridge River, Cadwallader and Methow terranes, that originated in ocean basin, volcanic arc and clastic basin environments. These lithotectonic units are Late Paleozoic to Cretaceous in age, and are juxtaposed across complex systems of contractional, strike-slip and extensional faults of mainly Cretaceous and Tertiary age. Upper greenschist to amphibolite facies metamorphic rocks are exposed in the south-central part of the belt, where they formed and were exhumed during early Late Cretaceous contractional deformation (Journeay, 1990; Journeay and Friedman, 1993). These metamorphic rocks rest structurally above rock units comprising the eastern edge of the southwestern Coast Belt across an imbricate system of east-dipping early Late Cretaceous thrust faults. The metamorphic grade decreases to prehnite-pumpellyite facies farther north, where terranes of the southeastern Coast Belt are imbricated across similar polyphase, predominantly southwest-directed, mid to early Late Cretaceous contractional faults in the Taseko - Bridge River area. Still farther north, near 52° North latitude, rocks of the eastern Coast Belt are imbricated by slightly younger northeast-directed thrust faults of the Eastern Waddington thrust belt (Rusmore and Woodsworth, 1991b, 1994). The upper faults of this Late Cretaceous thrust system separate these rocks from overlying Jurassic plutonic rocks characteristic of the southwestern Coast Belt (van der Heyden *et al.*, 1994).

Lithotectonic units and mid-Cretaceous contractional structures of the southeastern Coast Belt extend southward into the north Cascade mountains of Washington State (Misch, 1966; McGroder, 1991; Monger, 1991b; Monger and Journeay, 1994), which includes a central belt of greenschist to amphibolite facies metamorphic rocks (Cascade metamorphic core) flanked by lower grade rocks to the west and east (Figure 2). The western belt is an imbricate stack of west-vergent thrust sheets referred to as the northwest Cascades and San Juan Islands thrust systems. The eastern part of the orogen, referred to as the eastern Cascades foldbelt, comprises low-grade rocks deformed by both northeast and southwest-directed folds and thrust faults. Methow and Bridge River terranes are the principal components of the eastern Cascade foldbelt and, after restoring about 100 kilometres of dextral offset along the Fraser fault, they extend northwestward into easily identified correlatives within the southeastern Coast Belt exposed in the Taseko - Bridge River area. Bridge River Terrane also has probable correlatives within the Cascade metamorphic core, as well as in the upper thrust slices of the northwest Cascades and San Juan Islands thrust systems (Monger, 1991b; Miller *et al.*, 1993b; Monger and Journeay, 1994). The northwest Cascades system marks an abrupt southern limit to the extensive belt of Jura-Cretaceous plutonic rocks which characterize the southwestern Coast Belt, although lower thrust slices of the system locally include rocks correlative with Harrison Terrane. Furthermore, Monger (1991b) and Monger and Journeay (1994) point to the possible correlation of the Cretaceous-Tertiary Western Mélange Belt in the foothills of the northwest Cascade system with the Pacific Rim Complex and Leech River schist, which are thrust beneath Wrangellia along the western and southern coasts of Vancouver Island (*see* Figure 2). This correlation suggests that the southwestern Coast Belt and adjacent Wrangellia Terrane can be regarded as the southern end of a huge block that has been incorporated into a long-lived accretionary complex represented in part by the southeastern Coast - north Cascade orogen (Monger, 1986; Monger and Journeay, 1994).

East of the Fraser fault the eastern boundary of the southeastern Coast - north Cascade orogen is the Pasayten

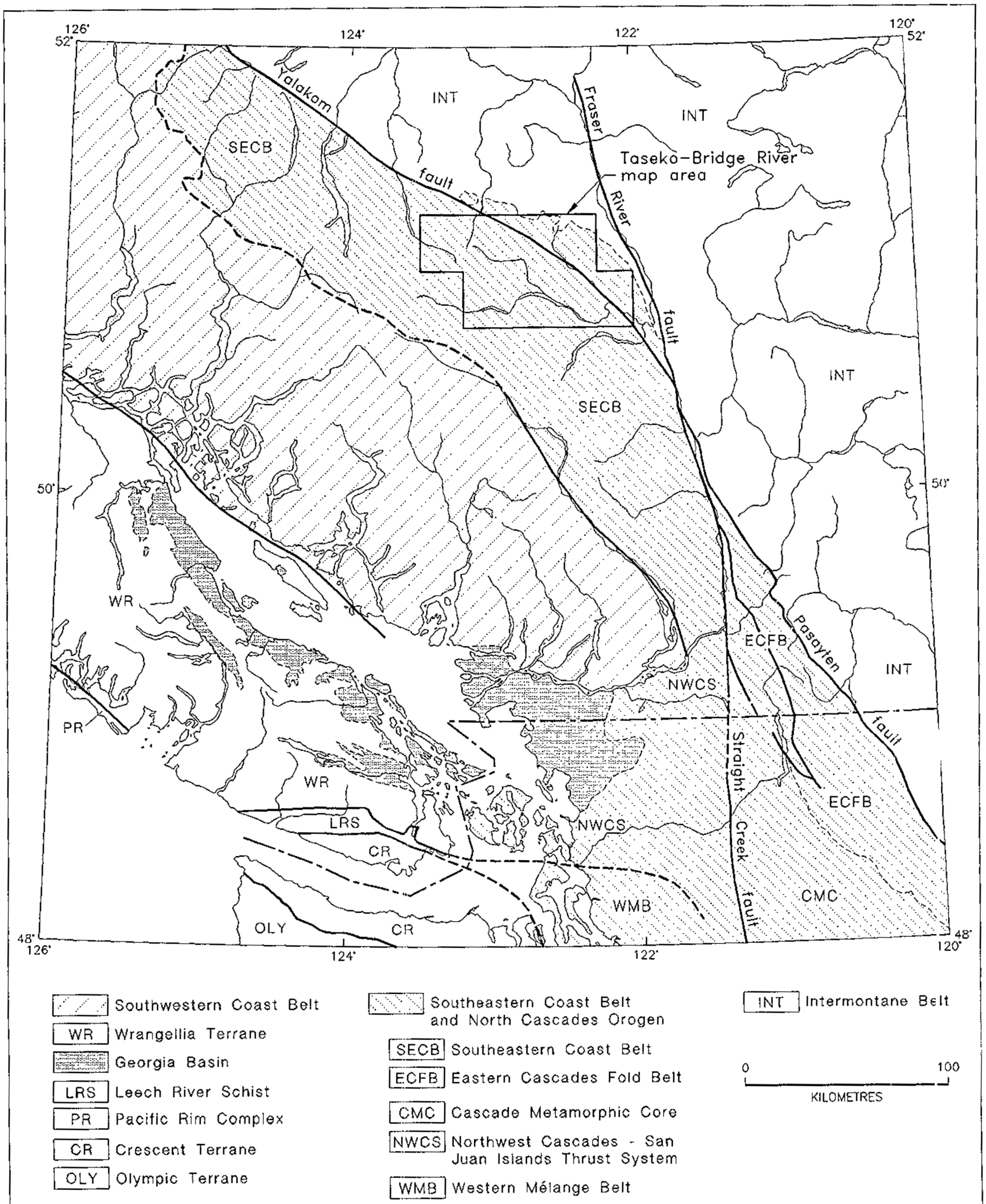

Figure 2. Regional geologic setting of the Taseko - Bridge River map area.

fault zone, which has been traced continuously for more than 200 kilometres and separates Methow Terrane from a belt of Mesozoic plutonic rocks along the western edge of the Intermontane Belt (Monger, 1989; Monger and McMillan, 1989). This belt includes Late Triassic granodiorite within the Mount Lytton Complex, which has been correlated with similar plutons of the Quesnel Terrane (Parrish and Monger, 1992), the Middle to Late Jurassic Eagle tonalite, which intrudes the Nicola Group of Quesnel Terrane (Greig, 1992; Greig *et al.*, 1992), and a suite of Early Cretaceous plutonic rocks that include the Okanogan Range batholith (Hurlow and Nelson, 1993) and the Fallslake plutonic suite (Greig *et al.*, 1992). The Cretaceous plutons are probably related to continental arc volcanics of the late Early Cretaceous Spences Bridge Group, which overlaps Quesnel and Cache Creek terranes a short distance east of the boundary (Thorkelson and Smith, 1989). Latest motion on the Pasayten fault zone was Eocene, and this was superimposed on a zone of mid-Cretaceous sinistral transpressional deformation documented within the plutonic rocks along the western edge of the Intermontane Belt (Greig, 1992; Hurlow, 1993).

West of the Fraser fault, the northeastern boundary of the southeastern Coast Belt is largely obscured by Eocene and younger deposits, but corresponds in part to the Slok Creek and Hungry Valley fault systems, which separate Methow Terrane from a succession of Cretaceous volcanic and sedimentary rocks to the northeast. (Tipper, 1978; Read, 1988; Monger and McMillan, 1989). These Cretaceous rocks of the Intermontane Belt include Lower Cretaceous volcanic and comagmatic intrusive rocks correlated with the Spences Bridge Group, as well as overlying mid to Upper Cretaceous sedimentary and volcanic rocks that have been correlated with the Silverquick - Powell Creek succession of the adjacent Coast Belt (Green, 1990; Hickson, 1992; Mahoney *et al.*, 1992). Farther to the northwest, the Eocene Yalakom fault marks the physiographic boundary between the Coast and Intermontane belts, as well as the northeastern limit of terranes and clastic basin deposits that are unequivocally part of the southeastern Coast Belt (Riddell *et al.*, 1993; Schiarizza *et al.*, 1995). In the vicinity of Chilko Lake these assemblages are juxtaposed against Jurassic volcanic rocks included within Stikine Terrane (Tipper, 1969a,b; Schiarizza *et al.*, 1995), demonstrating that the northeastern boundary of the southeastern Coast - north Cascade orogen cuts obliquely across the triad of terranes, Quesnel, Cache Creek and Stikine, that make up the Intermontane Belt. The lithotectonic assemblages and mid-Cretaceous contractional structures characteristic of the southeastern Coast Belt are not recognized beyond 52° North latitude, having apparently pinched out between Stikine Terrane to the northeast (across the Yalakom fault), and Jurassic-Cretaceous plutons characteristic of the southwestern Coast Belt to the west (in part across the Eastern Waddington thrust belt).

PREVIOUS GEOLOGICAL WORK

Interest in the geology and mineral potential of the southern part of the Taseko - Bridge River area was first aroused in 1858, when placer gold was discovered in the lower Bridge River. Prospecting up-river soon led to the discovery of gold in Gun Creek, and then in the Hurley River and Cadwallader Creek. The first claims covering lode gold occurrences were staked along the Hurley River in 1896, and many of the important mineral properties in the Bridge River area were located prior to the turn of the century.

Early reports on the Bridge River area (Robertson, 1911; Camsell, 1912, 1919; Bateman, 1914a,b; Brewer, 1914) were concerned mainly with descriptions of individual mineral occurrences and mining operations. Drysdale (1916, 1917) provided the first regional geologic map (together with cross-sections and a table of formations) of the area encompassing the Bridge River valley from Gun Lake to the Shulaps Range. This same area was described by McCann (1922), who published a revised geological map and the first complete description of the lithologic units, structure and mineral occurrences of the area. A later detailed study by Cairnes (1937) covered a belt extending from Cadwallader Creek north-northwest to lower Gun Creek that included all known occurrences of Bralorne-style mesothermal gold-quartz veins. Cairnes (1943) extended this mapping westward into the Dickson Range and as far north as Tyaughton Creek and Mount Sheba; mercury and tungsten deposits in the eastern part of this area were described by Stevenson (1940, 1943). Leech (1953) mapped most of the Shulaps Range, from Shulaps Creek northwestward to Quartz Mountain, and provided the first detailed descriptions of the Shulaps Ultramafic Complex. Roddick and Hutchison (1973) incorporated the work of Drysdale, McCann, Cairnes and Leech, as well as more recent studies by Jeletzky (1967, 1971) and J.W.H. Monger (Cameron and Monger, 1971), into their 1:250 000-scale map and brief summary report of the Pemberton (East Half) map area. Their map was in turn incorporated into Woodsworth's (1977) 1:250 000-scale compilation of the entire Pemberton (92J) map sheet. During the same time period, further work by Pearson (1975, 1977) in the Bridge River mining camp led to an interpretation of district-scale metal zoning proposed by Woodsworth *et al.* (1977).

The northern part of the study area was less accessible, and consequently explored considerably later than the Bridge River district. The earliest published report is that of Bateman (1914a), whose reconnaissance survey between Lillooet and Chilko Lake included traverses along the Taseko River valley and Battlement Creek. Bateman made brief mention of the limonite (bog iron) deposits, within and adjacent to the Taseko River valley, that had first been discovered and staked several years earlier. MacKenzie (1921a) described the geology around these limonite deposits in considerable detail, and also briefly discussed the geology between Taseko Lake and French Bar Creek (MacKenzie, 1921b). Dolmage (1929) provided more detailed coverage of the area extending from Powell and Granite creeks eastward to Relay Mountain and Gun Creek. His geologic map accurately portrays the division between mainly Cretaceous volcanic rocks west of Mount Sheba and Big Creek, and older, fossiliferous sedimentary rocks to the east. The work of Cairnes (1943) established that these sedimentary rocks range from Late Triassic to Early Cretaceous in age, and subsequent workers in the northern part of the area concentrated mainly on the stratigraphy and paleontology of these fossiliferous sedimentary rocks. These studies include descriptions of the Upper Triassic Tyaughton Group by Tozer (1967, 1979); of Lower and Middle Jurassic rocks by Frebold (1951, 1967), Frebold *et al.* (1969), Tipper (1977), O'Brien (1985) and Poulton and Tipper (1991); and of latest Middle Jurassic through Lower Cretaceous rocks by Jeletzky (1967), Frebold and Tipper (1967), and Jeletzky and Tipper (1968). Many of these studies were undertaken in support of regional mapping of the Taseko Lakes (92O) area, begun in 1961 by H.W. Tipper; the geology of part of this area was published in 1963 at 1:253 440-scale (Tipper, 1963), and the geology of the entire Taseko Lakes map area was published in 1978 at 1:125 000-scale (Tipper, 1978). Published studies relating to the economic geology of the northern part of the area include a description of the Poison Mountain porphyry copper deposit by Seraphim and Rainboth (1976), and McMillan's (1983) study of the porphyry copper deposits in the Granite Creek area.

A number of recent theses studies were completed within the Taseko - Bridge River area just prior to our project, and have contributed significantly to our understanding of many aspects of the geology. These include Nagel's (1979) research on part of the Shulaps Ultramafic Complex; a study by Kleinspehn (1982, 1985) of the Jackass Mountain Group; work by Potter (1983, 1986) and Cordey (1986, 1988) on the Bridge River Complex; a study of the Cadwallader Group by Rusmore (1985, 1987); and investigations of alteration and mineralization adjacent to the lower Taseko River by Bradford (1985) and Price (1986).

Descriptions of the geology in the vicinity of many of the mineral occurrences within the area are found in Annual Reports of the British Columbia Minister of Mines dating from the turn of the century. Further descriptions of specific mineral showings may be found in assessment reports on file at the offices of the Ministry of Energy, Mines and Petroleum Resources in Victoria and Vancouver.

PRESENT STUDY

The Taseko - Bridge River 1:50 000-scale regional mapping program was funded by the 1985-1990 Canada - British Columbia Mineral Development Agreement. Its main objectives were to stimulate and focus mineral exploration by improving the geoscience database for the area and providing a geological framework within which to interpret mineral occurrences, alteration zones and geochemical anomalies. This information contributes to an assessment of the overall mineral resource potential of the area, thus providing guidelines for future mineral exploration and land-use designations.

The project is based on four years of geological mapping, carried out during the summers of 1986 through 1989. The first two years were directed by J.K Glover and the final two by P. Schiarizza. Preliminary interpretations were published as 1:50 000-scale Open File maps and short papers following each field season (Glover and Schiarizza, 1987; Glover *et al.*, 1887, 1988a,b; Schiarizza *et al.*, 1989a,b, 1990a,b). Office-based studies by P. Schiarizza and R.G. Gaba during the following two years led to significant revision and refinement of these earlier interpretations. These revisions are incorporated in 1:50 000-scale Geoscience maps covering the entire project area (Schiarizza *et al.*, 1993a,b,c,d), and in the final report presented here. The project's database is also incorporated in the January 1992 MINFILE releases covering the Pemberton (92J) and Taseko Lakes (92O) map areas.

The Taseko - Bridge River mapping program was carried out in conjunction with detailed mapping in the Relay Mountain and Eldorado Mountain areas by P.J. Umhoefer and J.I. Garver as part of their doctoral research at the University of Washington (Umhoefer *et al.*, 1988; Garver *et al.*, 1989a,b; Umhoefer, 1989; Garver, 1989). Part of our mapping in the Shulaps Range - Mission Ridge area was carried out in cooperation with M.E. Coleman who was conducting research for an M.Sc. thesis at Carleton University (Coleman, 1989, 1990, 1991). The project was also supported by a ^{40}Ar-^{39}Ar radiometric dating program carried out by D.A. Archibald of Queen's University (Archibald *et al.* 1989, 1990, 1991a,b); by a detailed study of part of the Shulaps Ultramafic Complex undertaken by T.J. Calon, J.G. Malpas and R.W.J. Macdonald of the Memorial University of Newfoundland (Calon *et al.*, 1990; Macdonald, 1990a,b); and by a radiolarian dating program conducted by F. Cordey of the Geological Survey of Canada (Cordey, 1990, 1991; Cordey and Schiarizza, 1993).

The southern part of the Taseko - Bridge River area overlaps the area mapped by B.N. Church of this Ministry during a contemporaneous mineral deposit study of the Bridge River mining camp (Church, 1987a, 1989, 1990a,b, 1996; Church and MacLean, 1987a,b,c; Church *et al.*, 1988a,b, 1995; Church and Pettipas, 1989; Dostal and Church, 1992, 1994). Another mapping project directed by G.P. McLaren of this Ministry covered the Taseko Lakes (McLaren and Rouse, 1989a,b) and Chilko Lake (McLaren, 1990) areas directly west of the Taseko - Bridge River area. Our program also interleaves with two regional mapping projects by the Geological Survey of Canada: one directed by J.M. Journeay in the Pemberton map area (Journeay and Csontos, 1989; Journeay, 1990, 1993; Journeay and Northcote, 1992; Journeay *et al.*, 1992; Journeay and Friedman, 1993; Journeay and Mahoney, 1994; Mahoney and Journeay, 1993; Monger and Journeay, 1994); and one directed by C.J. Hickson covering the Taseko Lakes map area (Hickson, 1990, 1992; Hickson *et al.*, 1991, 1994; Hickson and Higman, 1993; Read, 1992; van der Heyden and Metcalfe, 1992; Friedman and van der Heyden, 1992; Broster and Huntley, 1992; Mahoney, 1992, 1993; Mahoney *et al.*, 1992). Contemporaneous theses studies that have made significant contributions to our understanding of regional metallogeny include C.H.B. Leitch's work on the Bralorne-Pioneer mine (Leitch, 1989, 1990; Leitch *et al.*, 1989, 1991a,b), and a study by P.J. Maheux on fluid inclusions and stable isotopes from a spectrum of deposits within the Bridge River camp (Maheux, 1989; Maheux *et al.*, 1987).

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The Taseko - Bridge river mapping project was initially proposed by H.W. Tipper of the Geological Survey of Canada. He, together with J.W.H. Monger and G.J. Woodsworth, also of the Geological Survey of Canada, spent considerable time and effort introducing us to the geology of the region by way of discussions and field trips at the outset of the project; we thank them very much for their encouragement and free exchange of ideas. During the later stages of the project we benefited from discussions, field trips and cooperative research with J.M. Journeay and F. Cordey, also of the Geological Survey of Canada.

The project benefited immensely from prompt fossil identifications by paleontologists of the Geological Survey of Canada. These included macrofossil identifications by T.P. Poulton, J.W. Haggart and the late J.A. Jeletzky; conodont identifications by M.J. Orchard; and palynomorph identifications by A.R. Sweet.

Our understanding of the economic geology of the area has increased through discussions with C.H.B. Leitch, presently with the Geological Survey of Canada, as well as from interaction with numerous industry geologists, including R.M. Britten, R.W. Lane, W.D. Melnyk, H. Marsden, L.A. Dick, J.H. Perry, J. Miller-Tait and C.J. Sampson.

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CHAPTER 2
LITHOLOGIC UNITS

INTRODUCTION

The Taseko - Bridge River map area is underlain by several distinct, partially coeval, Late Paleozoic to Mesozoic tectonostratigraphic assemblages (Figures 4 and 5) that are juxtaposed across a complex system of faults of mainly Cretaceous and Tertiary age. These Paleozoic and Mesozoic rocks are intruded by Cretaceous and Tertiary stocks and dikes of mainly felsic to intermediate composition, and are locally overlain by Paleogene volcanic and sedimentary rocks and by Miocene to Pliocene plateau lavas. They are intruded by a large mass of Late Cretaceous granodiorite, referred to as the Dickson-McClure batholith, along the southwestern margin of the map area. The pre-Tertiary tectonostratigraphic assemblages within the map area are briefly described in the following paragraphs.

Bridge River Terrane: The Bridge River Terrane is represented mainly by the Bridge River Complex, an assemblage of chert, argillite, greenstone, gabbro, blueschist, serpentinite, limestone and clastic sedimentary rocks with no coherent stratigraphy (Potter, 1983, 1986). Dated cherts and limestones within the complex range from Mississippian to late Middle Jurassic in age (Cordey and Schiarizza, 1993; F. Cordey, Appendix 2; M.J. Orchard, Appendix 1), and blueschist-facies metamorphism occurred in the Middle to Late Triassic (Archibald *et al.*, 1990, 1991a,b). The wide age range, structural complexity and presence of blueschist-facies metamorphic rocks suggest that this assemblage accumulated as an accretion-subduction complex. The upper part of Bridge River Terrane comprises a thick coherent succession of clastic metasedimentary rocks referred to as the Cayoosh assemblage that conformably overlies the Bridge River Complex to the south of the Taseko - Bridge River area (Journeay and Northcote, 1992; Mahoney and Journeay, 1993; Journeay and Mahoney, 1994). The Cayoosh assemblage is locally represented in the southern part of the Taseko - Bridge River area by an undated succession of siltstones and sandstones that were in part included in the Noel Formation of Cairnes (1937, 1943), and are here assigned to the informal Gun Lake and Downton Lake units. A narrow fault-bounded lens of Jura-Cretaceous conglomerate, here referred to as the Truax Creek conglomerate, is spatially associated with the Gun Lake unit and may have been derived from higher in the section.

Cadwallader Terrane: Cadwallader Terrane includes the Upper Triassic Cadwallader and Tyaughton groups together with Lower to Middle Jurassic rocks of the Last Creek formation and Junction Creek unit (Rusmore, 1987, Umhoefer, 1990). The most extensively exposed component is the Hurley Formation of the Cadwallader Group, which consists of upper Carnian to upper Norian sandstone, siltstone, conglomerate and minor micritic limestone that were deposited mainly as turbidites. The Hurley Formation is stratigraphically underlain by mafic volcanic rocks that are also part of the Cadwallader Group, and is locally overlain by a succession of Lower to Middle Jurassic shales, siliceous argillites and siltstones assigned to the Junction Creek unit. The Tyaughton Group and Last Creek formation are facies equivalents of the Hurley Formation and Junction Creek unit that are in fault contact with the Cadwallader Group northwest of Gold Bridge. The Tyaughton Group comprises middle to upper Norian nonmarine and shallow-marine conglomerate, sandstone and minor limestone, while the overlying Last Creek formation is a transgressive sequence comprising upper Hettangian to Sinemurian conglomerate and sandstone grading upward into upper Sinemurian to middle Bajocian shale. The volcanic rocks of the Cadwallader Group have trace element compositions similar to island arc tholeiites, and the clastic rocks of the Hurley Formation, Tyaughton Group and Last Creek formation contain clasts of limestone, basalt, andesite, dacite, rhyolite and granitoids, suggesting that Cadwallader Terrane represents part of a Late Triassic volcanic arc and fringing clastic apron. Rusmore *et al.* (1988), Umhoefer (1990) and Rusmore and Woodsworth (1991a) point out general similarities between Cadwallader Terrane and the Triassic - Jurassic rocks of Stikine terrane, and suggest that they may be correlative or related portions of the same arc system.

Tyaughton Basin: The Tyaughton basin (Jeletzky and Tipper, 1968) is a belt of Jura-Cretaceous clastic sedimentary rocks that extends from the Taseko - Bridge River area northwestward to beyond Chilko Lake. The lower part of the basin is represented mainly by the upper Middle Jurassic to Lower Cretaceous Relay Mountain Group, which is well exposed in the central part of the Taseko - Bridge River area, southeast of Big Creek. Volcaniclastic strata assigned to the Tosh Creek unit are locally exposed in the northwestern part of the map area and may represent a Lower Cretaceous volcanic facies within the upper part of the group. The basal contact of the Relay Mountain Group is not exposed, but indirect evidence suggests that it was deposited on the Bridge River Complex, and therefore is a facies equivalent of the Cayoosh assemblage. However, Jura-Cretaceous siltstones and fine-grained sandstones that are exposed very locally in the Camelsfoot Range (Grouse Creek unit of Figure 4) are in apparent stratigraphic contact with Cadwallader Terrane, whereas 100 kilometres to the northwest a separate belt of Jura-Cretaceous rocks assigned to the Relay Mountain Group is in stratigraphic contact with Middle Jurassic rocks of Methow Terrane (Tipper, 1969a; Schiarizza *et al.*, 1995). These relationships suggest that the Relay Mountain Group and correlative rocks constitute an overlap assemblage linking Bridge River, Cadwallader and Methow ter-

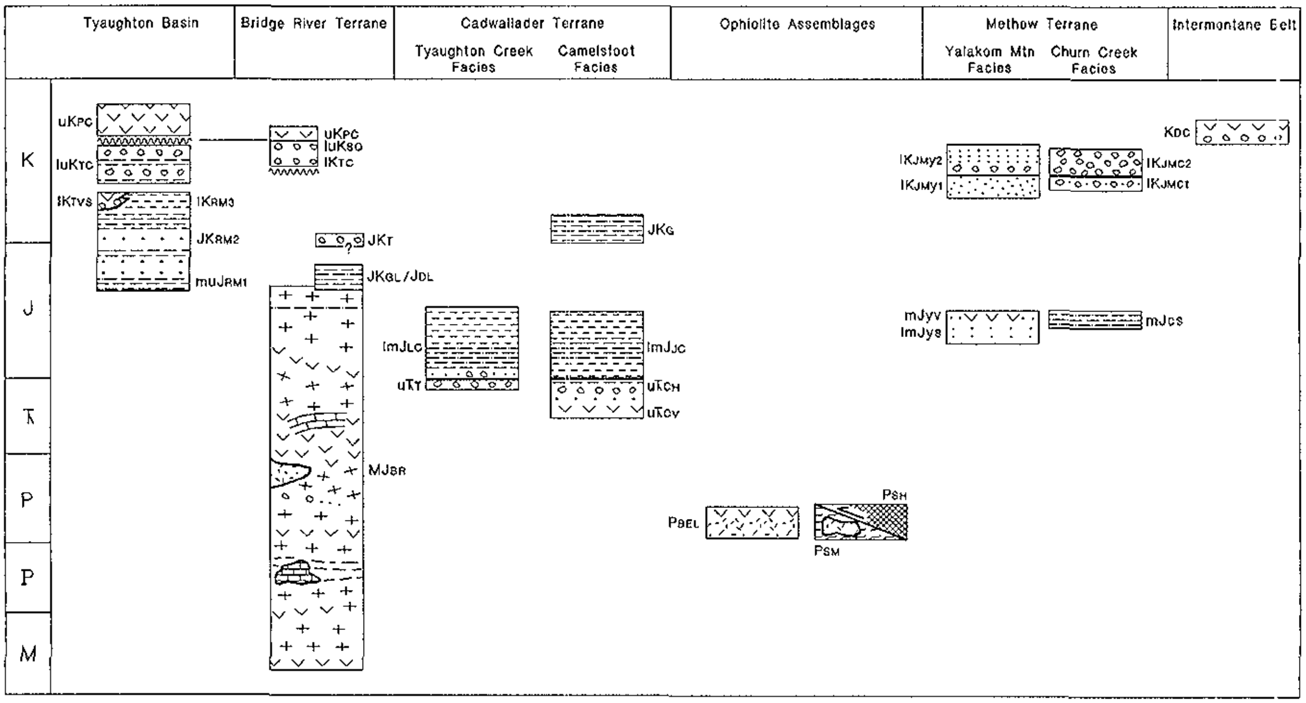

Figure 4. Major tectonostratigraphic assemblages of the Taseko - Bridge River area. Abbreviations, from left to right, are: uKPC=Powell Creek formation; luKTC, lKTC=Taylor Creek Group; lKTVS=Tosh Creek succession; muJRM1, JKRM2, lKRM3=Relay Mountain Group; luKSQ= Silverquick formation; JKT= Truax Creek conglomerate; JKGL= Gun Lake unit; JDL= Downton Lake unit; MJBR= Bridge River Complex; lmJLC=Last Creek formation; uT̄=Tyaughton Group; JKG=Grouse Creek unit; lmJJC=Junction Creek unit; uT̄CH=Hurley Formation; uT̄CV=volcanic unit of the Cadwallader Group; PBEL=Bralorne-East Liza Complex; PSM=Shulaps serpentinite mélange unit; PSH=Shulaps harzburgite unit; lKJMy1, lKJMy2, lKJMc1, lKJMc2=Jackass Mountain Group; lmJys, mJyv, mJcs=Jurassic rocks correlated with the Dewdney Creek Formation; KDC=Dash - Churn succession.

ranes. The upper part of the Tyaughton basin consists of synorogenic clastic sedimentary rocks of the Taylor Creek Group and overlying Silverquick conglomerate, which were deposited during mid-Cretaceous contractional deformation. These strata were deposited above the Bridge River Complex in the Bridge River area, and above the Relay Mountain Group farther to the northwest. They include detritus derived from the Relay Mountain Group, Bridge River Complex, Cadwallader Terrane and associated ophiolitic rocks, as well as detritus derived from a volcanic terrain to the west, and a newly uplifted metamorphic - plutonic belt to the east (Garver, 1992, Garver and Brandon, 1994). The Tyaughton basin deposits are capped by Upper Cretaceous nonmarine volcanic and volcaniclastic rocks of the Powell Creek formation. These rocks are extensively exposed in the northwestern part of the area, where they overlie the Taylor Creek Group across an angular unconformity. Local exposures farther east, however, are in gradational contact with the underlying Silverquick conglomerate.

Ophiolitic Complexes: Ophiolitic rocks in the Taseko - Bridge River area are assigned to the Shulaps Ultramafic Complex and the Bralorne-East Liza Complex. The Shulaps Complex covers most of the northern Shulaps Range and is subdivided into two major structural divisions (Calon *et al.*, 1990): an upper unit of harzburgite and dunite with a mantle tectonite fabric, and a structurally underlying serpentinite mélange unit comprising sheared serpentinite with knockers of ultramafic cumulates, layered to isotropic gabbros, amphibolitic dike fragments, rodingite, and volcanic and sedimentary rocks. Late Paleozoic radiometric dates from plutonic and metamorphic knockers within the serpentinite mélange unit (Archibald *et al.*, 1991a; R. Friedman, Appendix 8) are interpreted to be the age of ocean-floor plutonism and metamorphism associated with construction of Shulaps oceanic crust (Calon *et al.*, 1990). Large-scale structural inversion of the original ophiolite stratigraphy is inferred to have occurred in mid-Cretaceous time during its thrust-emplacement above Cadwallader Terrane, which lies beneath the Shulaps complex across a southwest-vergent thrust system that is exposed in the southwest corner of the Shulaps Range. The Bralorne-East Liza Complex consists of greenstone, diorite, tonalite, gabbro and serpentinite that are imbricated with Cadwallader Terrane throughout the southern part of the Taseko - Bridge River area. It includes rocks that were assigned to the Bralorne and President intrusions by Cairnes (1937, 1943) as well as some rocks that Cairnes included in the Pioneer Formation of the Cadwallader Group. These rocks are lithologically similar to the plutonic and volcanic knockers found within the Shulaps serpentinite mélange unit, and have yielded similar Late Paleozoic radiometric dates (Leitch *et al.*, 1991a). They may represent slices of Shulaps oceanic crust that were imbricated with Cadwallader Terrane during obduction of the Shulaps Complex.

Methow Terrane: As used here, Methow Terrane refers to a distinctive assemblage of Lower Jurassic to mid-Cretaceous rocks that outcrops along the northeastern margin of the southeastern Coast - north Cascade orogen from the vicinity of Chilko Lake southeastward to northern Washington state. This stratigraphic succession has traditionally been referred to as the Methow basin where it occurs in the eastern Cascade foldbelt. It includes two main components: a lower interval of Lower to Middle Jurassic sedimentary and volcanic rocks that are in part lithologically distinct from age-equivalent rocks found in Cadwallader and Bridge River terranes, and a thick succession of overlying mid-Cretaceous clastic sedimentary rocks. Although the latter succession is lithologically and stratigraphically distinct, provenance studies (Garver, 1989, 1992) link it to age-equivalent strata within the upper part of the Tyaughton basin. This link was probably established by Late Jurassic time because Upper Jurassic rocks that are locally preserved within Methow Terrane beyond the limits of the Taseko - Bridge River map area have also been correlated with Tyaughton basin strata (Schiarizza *et al.*, 1995). In the Taseko - Bridge River area Methow Terrane forms a continuous belt that is separated from other components of the southeastern Coast Belt in part by the Tertiary Yalakom fault and in part by the pre-Yalakom Camelsfoot fault (Figure 5). The oldest part of the succession (units lmJys, mJyv and mJcs) consists of Lower to Middle Jurassic siltstone, shale, volcanic-lithic sandstone and local volcanic rocks that correlate with the Dewdney Creek Formation of the Ladner Group (O'Brien, 1986, 1987; Mahoney, 1992, 1993). These rocks are disconformably overlain by a thick succession of Lower Cretaceous clastic sedimentary rocks comprising the Jackass Mountain Group, which occur as two broadly correlative facies belts, each consisting of an upper unit of Albian arkosic sandstones and conglomerates and an underlying Barremian - Aptian unit of mainly volcanic-lithic sandstones and conglomerates (Figure 4).

Intermontane Belt: The Intermontane Belt directly northeast of the Taseko - Bridge River map area is underlain by Cretaceous and Tertiary volcanic, sedimentary and plutonic rocks. Mid-Cretaceous(?) volcanic and sedimentary rocks that are part of this assemblage outcrop within the map area near the confluence of Dash and Churn creeks, where they are in fault contact with Methow Terrane to the southwest. The Dash-Churn succession apparently extends northward to overlie upper Lower Cretaceous rocks that correlate with the Spences Bridge Group. These may be an offset portion of the main belt of Spences Bridge rocks, which overlies Quesnel and Cache Creek terranes to the southeast, on the opposite side of the Fraser fault.

The tectonostratigraphic assemblages within the Taseko - Bridge River map area are cut and juxtaposed by a system of northwest to north-trending faults that reflect a complex history of contractional, strike-slip and extensional deformation. These structures are mainly Cretaceous and Tertiary in age, and postdate much of the internal deforma-

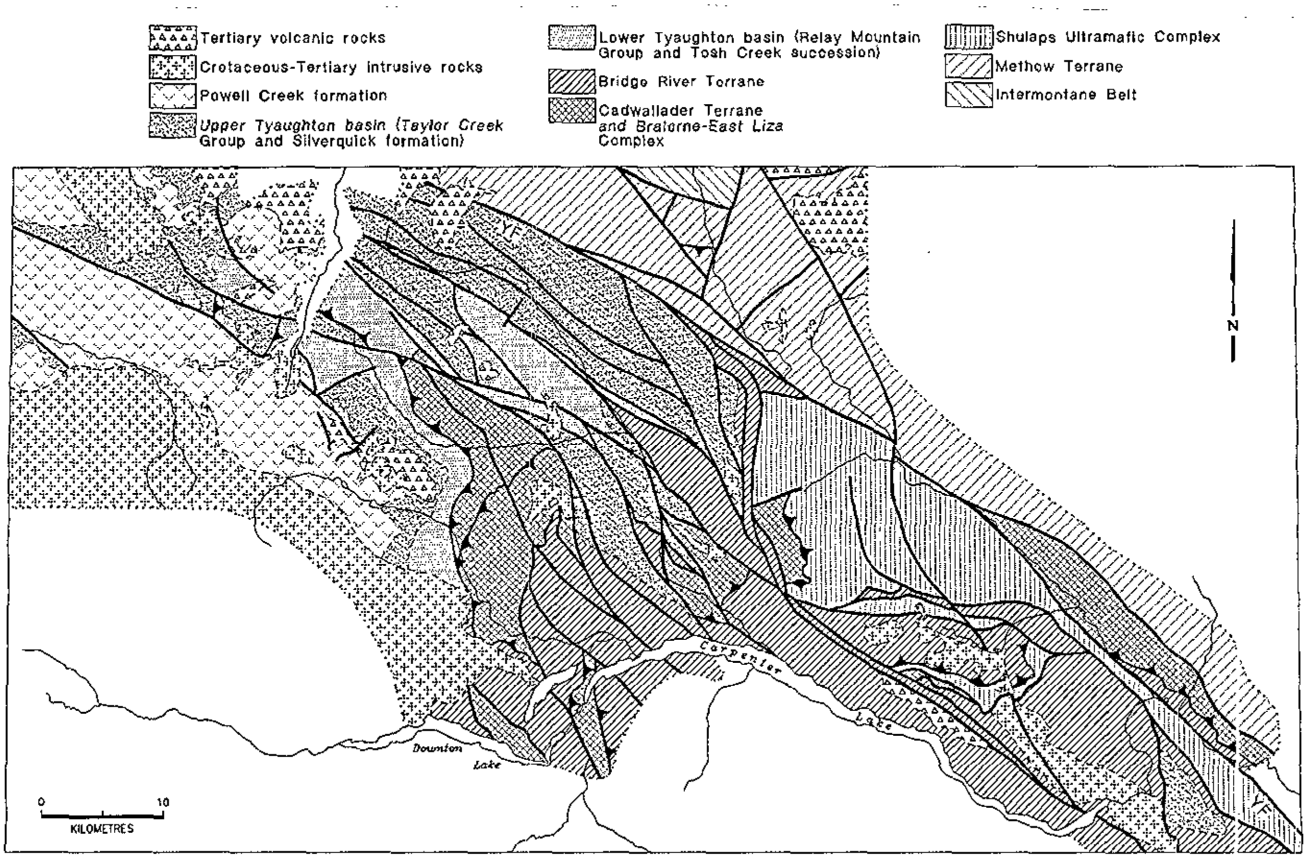

Figure 5. Simplified map showing distribution of the major tectonostratigraphic assemblages in the Taseko - Bridge River map area. YF=Yalakom fault.

tion of the Bridge River Complex, which is inferred to reflect its accumulation as a Triassic - Jurassic accretion-subduction complex. Southwest-vergent thrust faults of mid-Cretaceous age are the earliest map-scale structures recognized. These structures separate the Shulaps Ultramafic Complex from the underlying Cadwallader Terrane and Bralorne-East Liza Complex in the Shulaps Range. Elsewhere they commonly separate imbricated Cadwallader Terrane and Bralorne-East Liza complex from the underlying Bridge River Terrane and Tyaughton basin. Somewhat younger contractional structures, of Late Cretaceous age, include southwest-vergent reverse-sinistral faults as well as northeast-vergent thrust faults and folds. The latest Cretaceous to early Tertiary structural history of the area is dominated by northwest to north-striking faults with dextral strike-slip and normal movement. These include the prominent Yalakom fault, and were active into the Eocene. Neogene plateau lavas postdate all major structures.

BRIDGE RIVER TERRANE

BRIDGE RIVER COMPLEX

The Bridge River Complex includes variably metamorphosed and structurally imbricated chert, argillite, clastic rocks, limestone, mafic extrusive and intrusive rocks, and serpentinite. It underlies much of the southern part of the map area, from the Camelsfoot Range to Downton Lake, and occurs in fault slivers that extend as far north as lower Relay Creek and Mud Lakes (Figure 6). These rocks were previously assigned to the Bridge River Series by Drysdale (1916) and McCann (1922), to the Fergusson Series by Cairnes (1937, 1943), and to the Bridge River Group by Roddick and Hutchison (1973) and Tipper (1978). They include rocks assigned to the Fergusson Group by Church and MacLean (1987a) and Church *et al.* (1988b) but, in agreement with earlier workers, also include some greenstone units that Church assigned to the Pioneer Formation of the Cadwallader Group. The term "complex" (after Potter, 1983, 1986) is preferred to "Group", because of the unit's wide age range, diverse lithology and lack of a coherent stratigraphy.

The Bridge River Complex throughout most of the map area comprises prehnite-pumpellyite-grade chert and greenstone, together with lesser amounts of argillite, tuff, limestone, sandstone, conglomerate, gabbro and serpentinite. These rocks are equivalent to the Carpenter Lake assemblage of Potter (1983, 1986), and contain radiolarians and conodonts ranging from Mississippian to late Middle Jurassic in age. They are characterized by a high degree of internal disruption and brittle faulting, such that lithologic contacts are commonly faults, and individual lithologic units are traceable for only short distances. Blueschist-facies rocks, metamorphosed in the late Middle Triassic, occur within the complex between lower Tyaughton Creek and the headwaters of Taylor Creek. Penetratively deformed green-

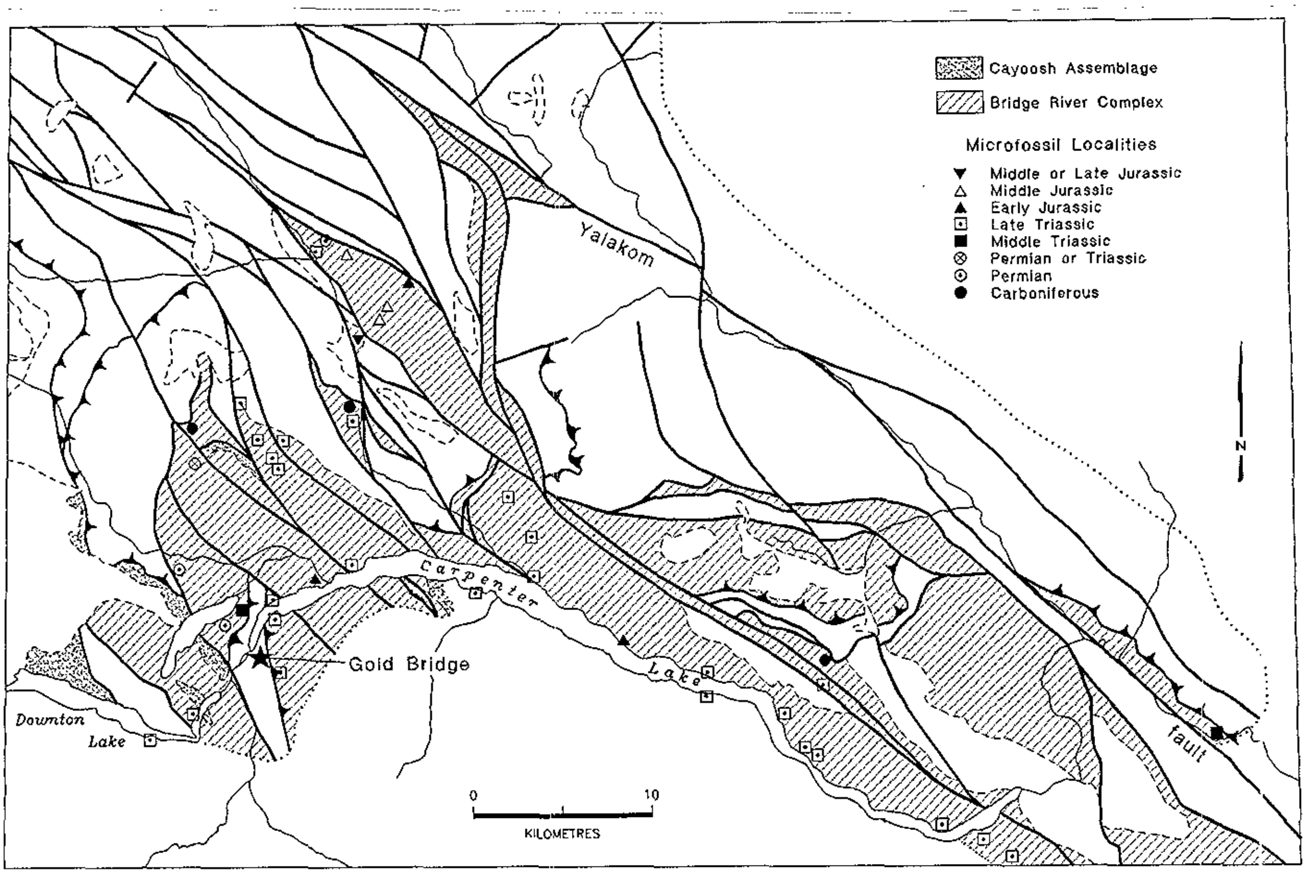

Figure 6. Simplified map showing distribution of the Bridge River Terrane and microfossil age control for the Bridge River Complex.

schist to amphibolite facies schists and phyllites assigned to the Bridge River Complex occur in the southern Shulaps Range and contiguous Mission Ridge. They comprise the Bridge River schists of Potter (1986) and Coleman and Parrish (1991), and were metamorphosed and structurally unroofed in Eocene time, within a structural regime linked to the bounding Yalakom and Marshall Creek faults.

LITHOLOGIC COMPONENTS

Chert, Argillite

Chert is the dominant and most characteristic sedimentary rock type found within the Bridge River Complex. It is mainly light to medium grey but locally is red, green or black. It typically occurs as thin, 1 to 6-centimetre-thick beds separated by very thin interbeds or partings of argillaceous rock (Photo 5). Thicker beds occur locally, and rare unstratified beds or lenses of massive chert are up to a metre or more thick. The chert beds are generally cut by networks of fractures and quartz veinlets, most of which are at a high angle to bedding. Individual beds may be of more or less constant thickness and persistent for several metres or more, but most are lenticular and display complex terminations and bifurcations across argillaceous partings and slip surfaces that are oriented at low angles to bedding.

Argillite typically occurs as partings or millimetre-scale interbeds within bedded chert intervals, but locally attains bedding thicknesses approaching those of the interbedded chert. Rarely, dark grey argillite is the dominant component, and contains subordinate chert as narrow, discontinuous lenses.

Chert occurs throughout the Bridge River complex and is typically structurally interleaved with greenstone and other Bridge River lithologies on the scale of an individual outcrop or series of closely spaced outcrops. In places, however, structural thicknesses of several hundred metres are comprised mainly or entirely of bedded chert; structural thickening by internal folds and faults is evident in some of these thick sections, and is suspected in most others. Contacts with other Bridge River lithologies are most commonly faults, but in places chert has been observed in depositional contact with limestone, clastic rocks and greenstone.

Bridge River chert contains radiolarians and conodonts which provide much of the age control for the complex. Most of the presently available dates range from Middle Triassic to Middle Jurassic (Figure 6), but Permian chert is known from several localities and Carboniferous chert occurs in 2 known localities (Appendix 1, Sample 88JIG-40-15; Appendix 2, Sample 89FC-BR-28). No lithologic attributes specific to cherts of a certain age have been noted.

Greenstone, Diabase, Gabbro

Greenstone, derived from mafic volcanic rocks, is a major constituent of the Bridge River Complex. Most commonly it is structurally imbricated with chert and other

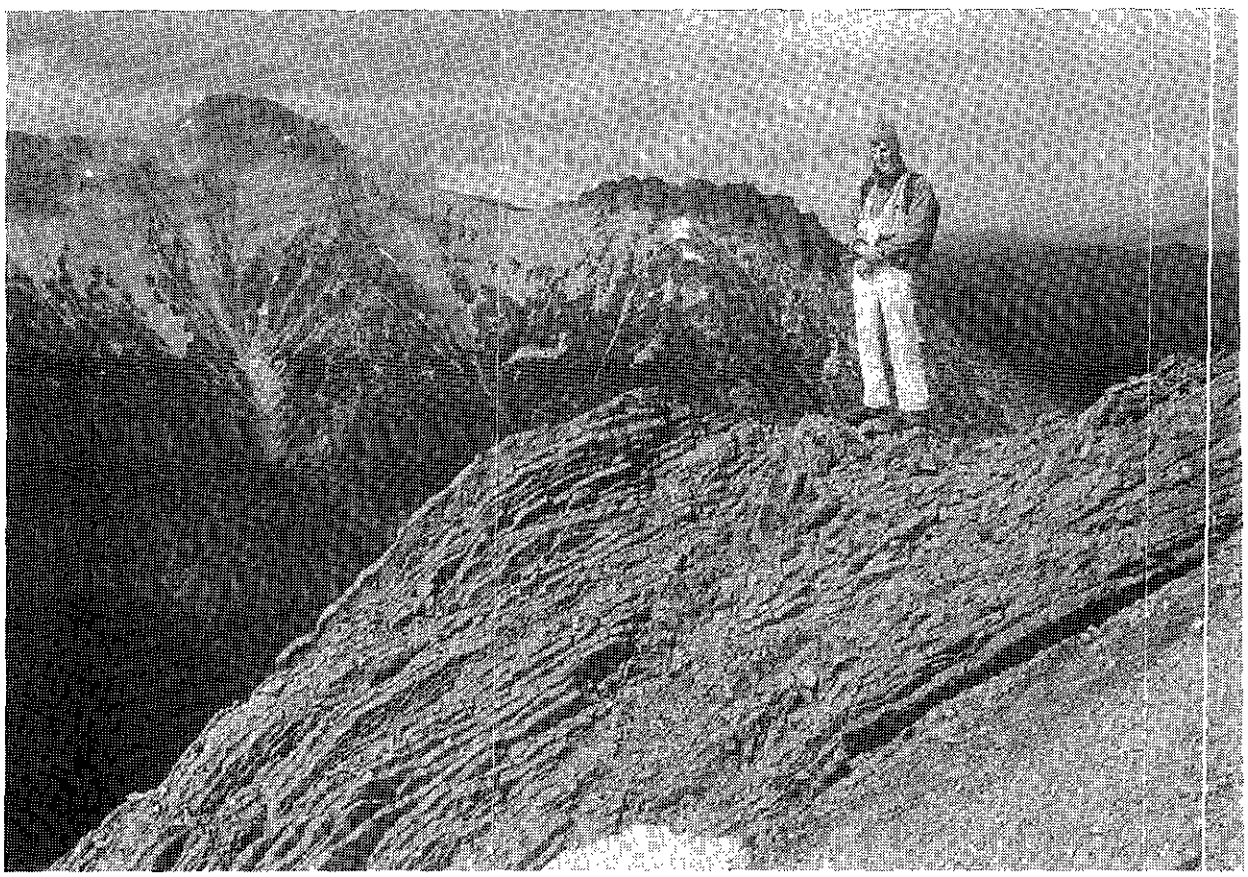

Photo 5. Bedded chert of the Bridge River Complex near the headwaters of Taylor Creek; view is to the northeast with overturned strata of the mid-Cretaceous Silverquick conglomerate in the background.

Bridge River lithologies on the scale of an individual outcrop, but locally it is the only lithology exposed for hundreds of square metres. The greenstones are predominantly dark green or grey-green in colour, but locally are chocolate-brown, purple or mottled green and purple. They are massive to pillowed (Photo 6), aphanitic to very fine grained, and commonly amygdaloidal. Rarely they contain phenocrysts of plagioclase or altered ferromagnesian minerals. Most thin sections examined contain a meshwork of random or aligned saussuritized plagioclase laths interspersed with an alteration assemblage typically dominated by calcite, chlorite and pumpellyite; these same alteration minerals commonly occur as amygdules and veins. Clinopyroxene, generally titaniferous augite, is preserved locally within the groundmass or as relict phenocrysts.

Greenstone breccias occur locally within the Bridge River Complex and consist of angular fragments, up to several tens of centimetres in size, within a green calcareous matrix; the larger fragments commonly comprise pieces of broken pillows. Bedded tuffs are also present and are intercalated with greenstone, limestone and chert. They consist of ash to lapilli-sized fragments of mainly greenstone within a fine-grained altered matrix. One sample of bedded tuff from the south side of Carpenter Lake consisted mainly of altered glass shards.

Medium to coarse-grained diabasic and gabbroic rocks occur locally within the Bridge River Complex but are not abundant. The most extensive exposures occur on the ridge west of Crane Creek, where diabase and medium-grained gabbro occur as sills intercalated with Upper Triassic limestone, chert and argillite of Unit uTBRglc. Irregular bodies of medium-grained clinopyroxene gabbro were also observed in several outcrops northwest of the north end of Gun Lake, where they are intrusive into bedded chert. The chert in this area has yielded Early Permian to Middle Triassic radiolarians, although the specific chert bodies intruded by gabbro have not been dated. Gabbro also occurs at several localities on the north side of Carpenter Lake, between Gun and Tyaughton creeks. It intrudes greenstone at one locality, but elsewhere contacts are faults or are not exposed.

None of the greenstone bodies within the Bridge River Complex have been directly dated. Some of the greenstone, including that within Unit uTBRglc (Figure 3), is Late Triassic in age because it is in depositional contact with Upper Triassic limestone. The greenstone protolith for the blueschist facies rocks within the complex is older, since it was metamorphosed in late Middle Triassic time (see later section). It is suspected that the greenstone within the Bridge River Complex spans a considerable time range, comparable to that of the associated Mississippian to Jurassic chert.

Potter (1983) obtained chemical analyses on 10 greenstone samples from the Bridge River Complex. The greenstones he analyzed have variable geochemical signatures that resemble those of ocean floor tholeiites and more alkalic ocean island-type basalts. Macdonald (1990b) obtained similar results, and concluded that the Bridge River volcanics form a chemically diverse volcanic suite that includes mid-ocean ridge, within plate, and alkalic basalts. Church

Photo 6. Pillowed greenstone of the Bridge River Complex, Carpenter Lake road near the Congress Mine.

(1990a) and Dostal and Church (1992, 1994) also discuss the geochemistry of mafic volcanic rocks from the Bridge River area. They refer to the volcanic suite as the Pioneer Formation, but the samples they discuss are almost entirely from what is here considered to be the Bridge River Complex (sample locations provided by B.N. Church, 1992). Their results are consistent with those of Potter and Macdonald in that the geochemistry of their samples suggests an ocean island to mid-ocean ridge origin.

Limestone

Light grey limestone occurs locally within the Bridge River Complex, and is a significant component of a unit designated as uTBRglc. This unit outcrops in three separate areas: at the north end of Marshall Ridge, between Tyaughton Creek and Marshall Lake; on the ridge system that extends from west of Crane Creek to the heads of North Cinnabar and Taylor creeks; and on both sides of Carpenter Lake a short distance east of Gold Bridge (Figure 3). Unit uTBRglc is dominated by greenstone, but is unique in that limestone is more abundant than other sedimentary rock types. The limestone occurs as tabular beds, from a few centimetres to more than a metre thick, intercalated with bedded chert and/or red calcareous argillite (Photo 7); as podiform lenses ranging from a few centimetres to several tens of metres thick within greenstone; and locally as large lenses (Photo 8) structurally interleaved with contorted chert, sandstone, pebbly mudstone and greenstone. Limestone beds and lenses within Unit uTBRglc have yielded several collections of Late Triassic (Early Norian) conodonts (Appendix 1).

Limestone occurs elsewhere within the Bridge River Complex, but is not nearly so common as it is in Unit uTBRglc. It occurs mainly as discontinuous pods and lenses within greenstone, a number of which have yielded Late Triassic conodonts (Appendix 1). The most persistent body of limestone within the Bridge River Complex, however, is a thin layer that has been traced for about 3 kilometres in the vicinity of lower Mud Creek (Figure 3). This limestone unit is enclosed by a highly sheared assemblage of cherts, chert-pebble conglomerates and limestone-greenstone-chert breccias. Chert within this area is Lower to Middle Jurassic in age, suggesting that the limestone may also be Jurassic; this would explain why samples collected from this limestone body did not yield conodonts.

Clastic Rocks

Sandstone and pebble conglomerate are a relatively minor component of the Bridge River Complex, but occur locally intercalated with chert and argillite. Individual clastic intervals typically comprise planar, thin to medium beds with total thicknesses of only a few metres; thicker accumulations, up to several tens of metres, occur but are rare. Contacts with enclosing chert and argillite are generally concordant, although one eight-metre-thick lens of chert-pebble conglomerate near the outlet of Tyaughton Lake is strongly channeled into underlying bedded chert. Most of the sandstones and pebble conglomerates are composed primarily of grain-supported chert clasts, locally with minor

Photo 7. Light grey limestone beds intercalated with red calcareous argillite, Unit uTBRglc west of Crane Creek.

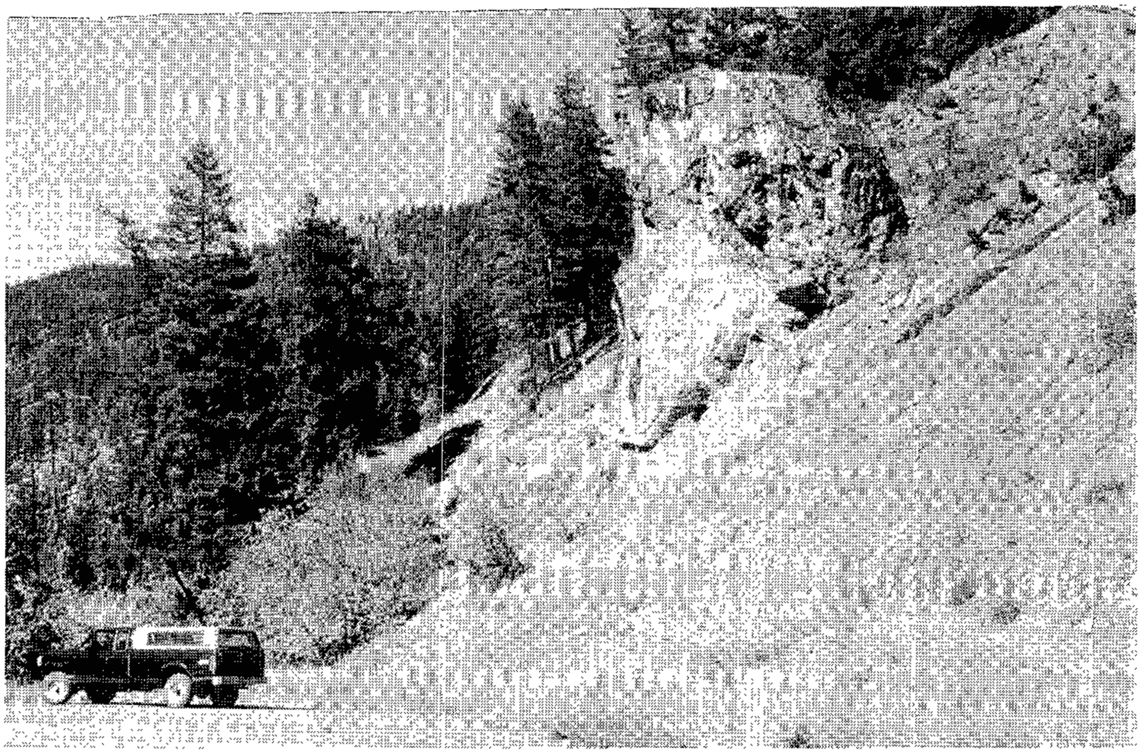

Photo 8. Limestone lens within Unit uTrBRglc at the mouth of Tyaughton Creek.

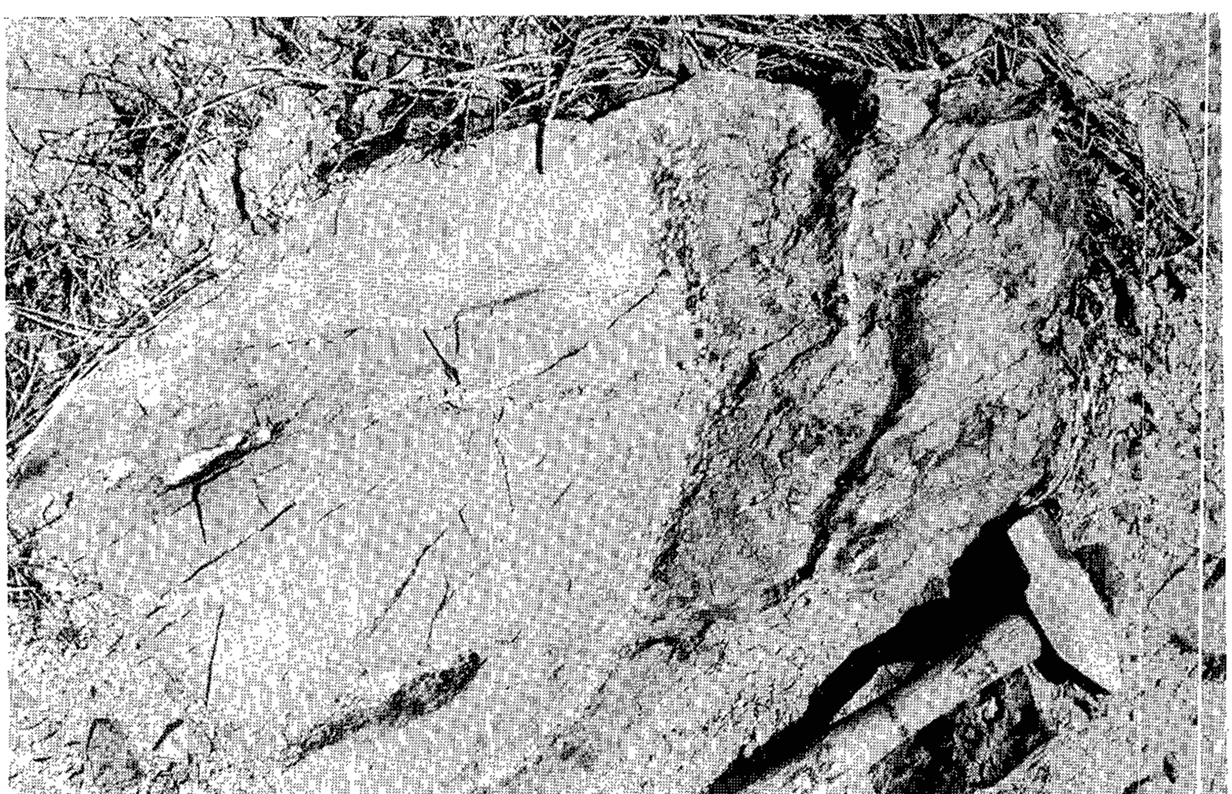

Photo 9. Pillowed metabasalt with blue amphibole in outer variolitic margin, Unit TrBRb southeast of Tyaughton Lake.

proportions of volcanic rock fragments and quartz and feldspar crystals. None of these chert-rich clastic units are dated or are in depositional contact with dated chert, but they are scattered throughout much of the complex and occur in proximity to dated Permian, Triassic and Jurassic cherts. Less common are sandstones and pebble conglomerates composed primarily of volcanic rock fragments and feldspar and quartz crystals. These rocks typically contain subordinate amounts of chert, and locally contain minor amounts of quartz tectonite, siltstone, clinopyroxene, epidote, hornblende and biotite. The volcanic-rich sandstones are also undated, but one three-metre-thick interval occurs in close proximity to Jurassic chert west of the mouth of Gun Creek. Volcanic-rich sandstones also occur adjacent to lower Mud Creek, between Horse Lake and Quartz Mountain, and are reported by Potter (1983, 1986) northeast of lower Carpenter Lake.

Argillite, sandstone and chert are the main components of a unit, designated JBRas, that outcrops in several areas between Liza and Gun lakes (Figure 3). It is overlain by more coherent clastic sedimentary rocks of the Gun Lake clastic unit in several of these areas, and in part also shows a spatial relationship with units TRBRb and uTRBRglc. Sandstone within Unit JBRas includes both chert-rich and volcanic-rich varieties. It occurs as thin to medium beds intercalated with chert and argillite and also as tabular lenses and angular clasts within a sheared argillaceous matrix. Pebble conglomerate occurs locally and consists mainly of chert and volcanic clasts together with argillite, siltstone and limestone clasts. Chert within Unit JBRas varies from well-bedded to brecciated and fragmented, and parts of the unit comprise a mixture of chert and clastic fragments within sheared argillite. Locally, Unit JBRas includes narrow fault-bounded lenses of greenstone, serpentinite and limestone. Well-bedded chert within Unit JBRas on the ridge between Taylor and Pearson creeks contains radiolarians of probable Jurassic age (Fabrice Cordey, personal communication, 1992).

Serpentinite

Serpentinite occurs locally within the Bridge River Complex, typically as narrow slivers along outcrop-scale fault zones. As many of these occurrences are along faults of only local significance, and are far removed from other serpentinite-bearing map units (*e.g.* Bralorne-East Liza and Shulaps complexes), the serpentinite is considered an integral part of the Bridge River Complex. Areas of particularly abundant serpentinite occur on the ridge at the head of Freiberg Creek, in the upper part of Pearson Creek and on the southwestern slopes of the Shulaps Range east of Marshall Lake. Serpentinite is structurally interleaved with a variety of other Bridge River rock types in these areas and is designated as Unit MJBRs on Figure 3. The Freiberg Creek unit, however, occurs in the convergence zone of the Steep Creek and Eldorado faults, and in part contacts the Bralorne-East Liza Complex; it may, therefore, comprise a zone of tectonic mixing along a relatively young fault zone rather than being part of the Bridge River Complex.

Blueschist

Blueschist-facies metamorphic rocks occur within a narrow, discontinuous belt that extends from the head of North Cinnabar Creek southeastward about 14 kilometres to Tyaughton Creek (Unit TRBRb, Figure 3). The blueschist-facies mineral assemblages occur within protoliths that include pillowed and massive basalt, diabase, gabbro and chert; they are therefore inferred to be an integral part of the Bridge River Complex. In the western part of the belt the blueschists are unconformably overlain by the Albian Taylor Creek Group, and locally occur as pebbles and boulders within the basal beds of the group (Garver, 1989). The unconformity is exposed on the overturned limb of a northeast-vergent syncline, and the blueschists are structurally overlain by Unit uTRBRglc across a southwest-dipping thrust fault (Garver, 1991). In the eastern part of the belt, the blueschists are in contact with the Bralorne-East Liza Complex to the north and with clastic rocks of the Bridge River complex (Unit JBRas) to the south. The contacts were observed only along Tyaughton Creek, where they are both west-dipping thrust(?) faults.

The most characteristic lithology within Unit TRBRb is dark blue, fine grained, strongly foliated and crenulated schist. The schists consist mainly of blue amphibole (glaucophane and/or crossite) and lawsonite. White mica is a conspicuous component of some blueschists and is accompanied by blue amphibole, epidote and garnet. Also common within the unit are green, massive to weakly foliated greenstones, pillowed greenstones and diabasic to gabbroic rocks. The massive to weakly foliated rocks generally display relict igneous minerals (clinopyroxene and/or plagioclase) and textures in thin section, but commonly contain blue amphibole, and locally lawsonite, within alteration assemblages dominated by chlorite, stilpnomelane and leucoxene. Pillowed greenstones in the eastern part of the belt commonly have blue amphibole preferentially developed along the outer, variolitic margins of the pillows (Photo 9), as well as in narrow veins cutting the pillows. Grey to greenish-grey metachert and quartz-rich schists occur locally within Unit TRBRb, and rare pods of finely crystalline calcite, possibly derived from limestone lenses, occur within massive to weakly foliated greenstones.

Garver *et al.* (1989c) reported preliminary whole-rock and white mica K-Ar dates from Bridge River blueschists that ranged from 195±6 to 250±9 Ma. More recently, two different samples of white mica from blueschist at the head of North Cinnabar Creek have yielded well-defined Ar-Ar plateau dates of 229.8±1.0 Ma and 230.1 ±1.0 Ma, respectively (Appendix 7, Samples TL-88-1a and TL-88-16; *see* Archibald *et al.*, 1991a, for discussion of sample TL-88-1a). Three other samples of white mica from the same area gave slightly younger plateau dates of 221±1.2 Ma, 223.9±1.8 Ma and 224.9±1.0 Ma, as well as low-temperature steps indicating that the area was effected by a low-temperature thermal event in post-Late Triassic time (Appendix 7, Samples 88JIG-39-8-1, TL-90-2-4 and TL-90-2-2; *see* Archibald *et al.*, 1990, 1991a, for discussion of sample 88JIG-39-8-1). The two older Ar-Ar dates, with age spectra that do not record any later thermal event, provide the most reliable estimate of the age of blueschist-facies metamorphism, and suggest that it was a Middle Triassic or older event that ended by 230 Ma.

Biotite-Grade Schists

The Bridge River Complex in the southern Shulaps Range and contiguous Mission Ridge is in part represented by penetratively deformed greenschist to lower amphibolite facies phyllites and schists. These rocks were referred to as the Bridge River schists by Potter (1983, 1986) who suggested that they were deformed and metamorphosed during Mesozoic emplacement of a hot Shulaps ophiolite complex. They were also called Bridge River schists by Coleman (1990) and Coleman and Parrish (1991) who demonstrated that much of their deformation and metamorphism was Eocene in age, as was their exhumation by extensional faulting.

During the present study, biotite-bearing upper greenschist to lower amphibolite facies schists of the Bridge River Complex have been separated out and designated as Unit MJBRm on Figure 3. This unit is restricted to the area bounded by the Marshall Creek, Mission Ridge and Brett Creek faults. Also within this area are sub-biotite grade rocks of the Bridge River Complex, Cadwallader Group and Shulaps serpentinite mélange unit, as well as Eocene intrusive rocks of the Mission Ridge pluton and Rexmount porphyry. The rocks in this area, which range from prehnite-pumpellyite to lower amphibolite facies metamorphic grade, are collectively referred to as the Shulaps-Mission Ridge metamorphic belt. Following Coleman (1990), metamorphism and ductile deformation of the Bridge River schists is interpreted to be mainly Eocene in age. They are juxtaposed against other map units within and adjacent to the Shulaps-Mission Ridge metamorphic belt across a complex system of contractional, extensional and strike-slip faults that are thought to have formed during dextral strike-slip on the Yalakom-Marshall Creek-Relay Creek fault system (*see* Chapter 3).

Schists of Unit MJBRm are best exposed in the southern part of the Shulaps-Mission Ridge metamorphic belt, on both sides of the Bridge River canyon and northwestward to Jones Creek. There they are intruded by granodiorite of the Eocene Mission Ridge pluton and numerous syntectonic dikes and sills of similar composition (Photo 10). Biotite-grade schists also comprise a fault-bounded lens that extends from lower LaRochelle Creek to the head of Brett Creek, and occur in a belt that extends from the middle reaches of Brett Creek eastward to Holbrook and Shulaps creeks (Figure 3). The schists are strongly foliated and lineated, and recrystallized to the extent that primary textures and mineralogies are generally obscure. The most common lithology is grey quartzose schist comprising millimetre-scale quartz laminae separated by phyllosilicate-rich partings containing varying proportions of biotite, chlorite, muscovite and locally garnet. Other common lithologies are plagioclase-epidote-chlorite-actinolite schist and biotite-actinolite-quartz schist. Narrow lenses of marble

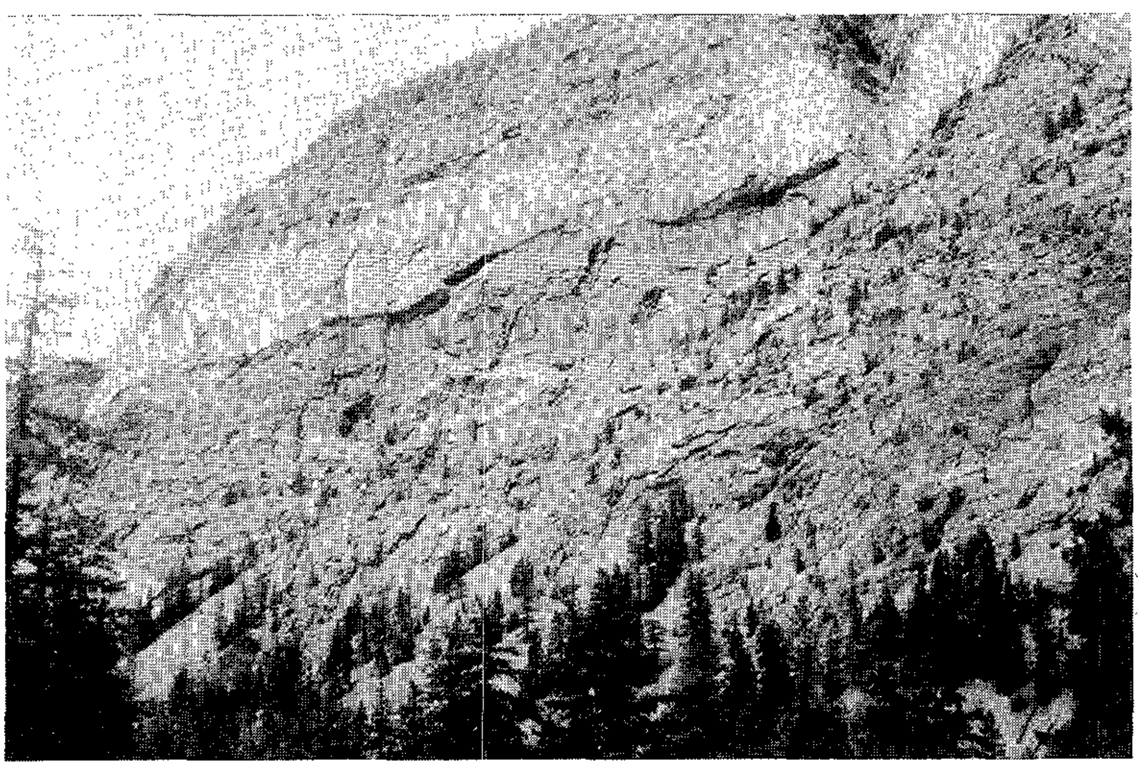

Photo 10. Bridge River schists intruded by syntectonic dikes, Bridge River canyon.

and talc-serpentine schist occur locally within the succession. Their composition suggests that the schists were derived from a protolith similar to the lower-grade portions of the Bridge River Complex exposed elsewhere in the map area. This conclusion is supported by relationships in the vicinity of Rex Peak and Holbrook Creek, where biotite-grade schists grade, presumably across a metamorphic isograd, into a succession of sub-biotite-grade phyllites, cherts and greenstones that are clearly a part of the Bridge River Complex. Their inclusion as part of the Bridge River Complex is also corroborated by conodonts of probable Carboniferous age that were extracted from a carbonate lens enclosed within biotite-grade phyllites near the headwaters of Bighorn Creek (Appendix 1, Sample 88BER-637).

INTERNAL AND EXTERNAL RELATIONSHIPS

The Bridge River Complex throughout the Taseko - Bridge River area is characterized by a monotonous repetition of mainly chert and greenstone pervaded by outcrop-scale brittle faults and folds. The combined effect of these and larger-scale structures is to produce a complex array of lenticular blocks which generally prohibits the tracing of individual lithologic units for more than a few hundred metres. Larger-scale units with recognizable lithologic attributes (*e.g.* units uTBRglc and TBRb) can locally be traced for several kilometres, but these constitute only a small proportion of the complex, and individual lithologic components within these units can rarely be traced beyond a few closely spaced outcrops. This fault-induced lenticularity contrasts markedly with the coherent stratigraphic successions found within coeval and younger rocks of Cadwallader and Methow terranes and the Tyaughton basin, and is attributed to accumulation of the Bridge River Complex as an accretion-subduction complex. This interpretation is corroborated by the wide age range documented for cherts within the complex (Cordey and Schiarizza, 1983) and in particular by the local presence of blueschist-facies rocks. Accumulation of the complex within a subduction-accretion setting was apparently a protracted event, extending from at least the late Middle Triassic (the age of Bridge River blueschists) to latest Middle Jurassic time (the age of the youngest known chert imbricated within the complex). The distribution of known ages within the Bridge River Complex (Figure 6) provides no clear indication of the polarity of accretion. The lack of a systematic age distribution may in part be attributed to post-accretionary deformation which involved several phases of mid to Late Cretaceous thrusting and folding as well as later translation along the major dextral strike-slip faults that transect the area.

The structural and stratigraphic relationships between the Bridge River Complex and other tectonostratigraphic assemblages within the map area are summarized in Figure 7. The oldest rocks inferred to rest stratigraphically above the Bridge River Complex are sandstones and shales of the Gun Lake unit, which occur locally in several fault-bounded domains near the west end of Carpenter Lake (*see* following section). The Gun Lake unit is not dated, but is inferred to correlate with the Jura-Cretaceous Cayoosh assemblage, which overlies the Bridge River Complex in thick well-documented sections to the south (Journeay and Mahoney,

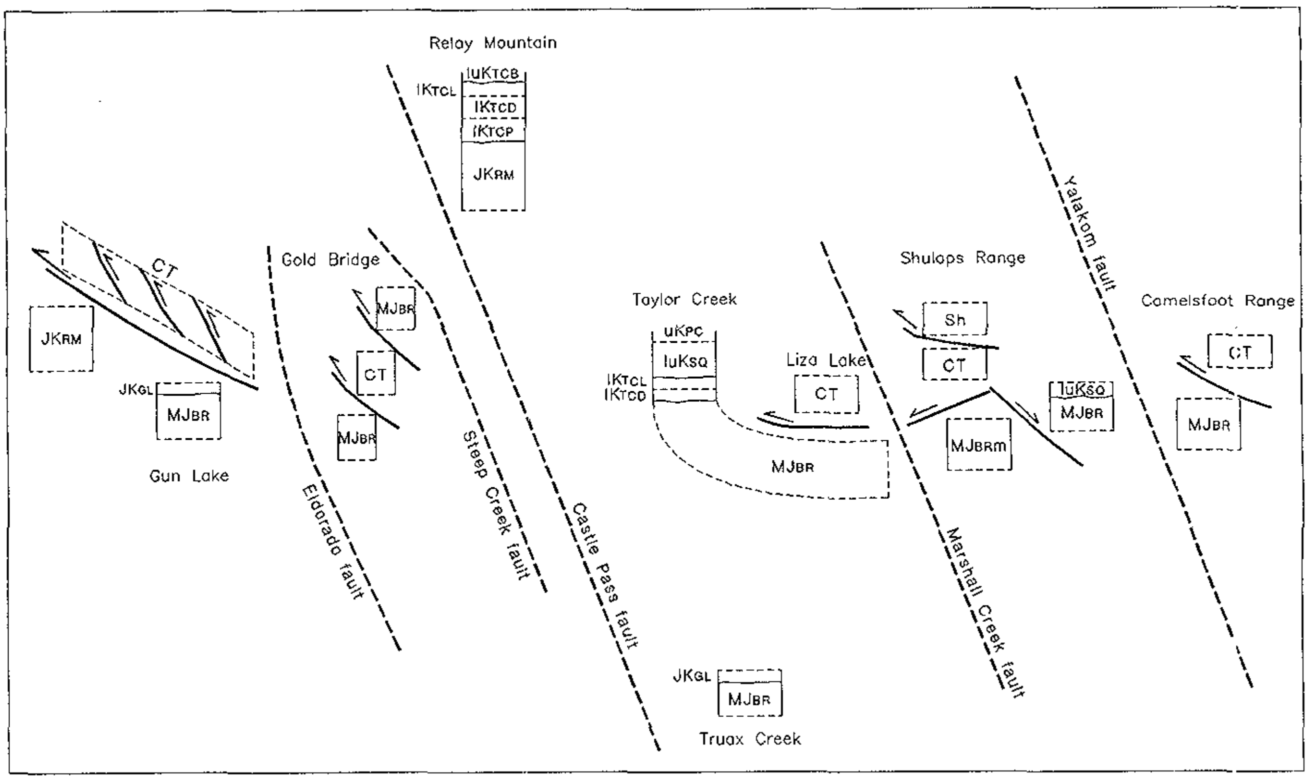

Figure 7. Summary of external structural and stratigraphic relationships of the Bridge River Complex. CT=imbricated Cadwallader Terrane and Bralorne-East Liza Complex. Sh=Shulaps Ultramafic Complex. Other map unit codes as in Figures 3 and 4.

1994). It may also correlate with the lower unit of the Relay Mountain Group, comprising the base of the Tyaughton basin to the north, although no unfaulted contacts between the Relay Mountain Group and Bridge River Complex are observed.

The Bridge River Complex is unconformably overlain by the Albian Taylor Creek Group in a belt that extends from the heads of Taylor and North Cinnabar creeks southeastward across Tyaughton Lake (Garver, 1989). It may also be stratigraphically overlain by the Taylor Creek Group north of Big Sheep Mountain, although the contact is not exposed in this area. The synorogenic Taylor Creek Group contains detritus derived from the Bridge River Complex, and provides the first record of uplift and erosion of the complex, which is interpreted to have resulted from west-vergent thrust tectonics (Garver, 1989). The Taylor Creek succession that overlies the Bridge River Complex in the Taylor Creek area passes northward into a thicker, more basinal succession that overlies the Relay Mountain Group in the vicinity of Relay Mountain (Figure 7). This relationship is consistent with the interpretation that the Relay Mountain Group was deposited above the Bridge River Complex and was locally removed by erosion before deposition of the Taylor Creek Group.

The Bridge River Complex is unconformably overlain by somewhat younger mid-Cretaceous rocks of the Silverquick conglomerate on Mission Ridge, and by Eocene sedimentary and volcanic rocks of the Jones Creek succession in the vicinity of Jones Creek. Contacts with other tectonostratigraphic assemblages within the map area are Cretaceous or Tertiary faults.

In the southeastern part of the map area the Bridge River Complex occurs structurally beneath imbricated slices of Cadwallader Terrane and Bralorne-East Liza Complex across thrust faults that are exposed in the Camelsfoot Range and to the west of Liza Lake (Figure 7). Other contacts are younger faults, most of which are related to the Yalakom-Marshall Creek fault system. The relatively low structural position of the Bridge River Complex within the Camelsfoot and Liza Lake thrust stacks (of presumed mid-Cretaceous age) is consistent with relationships in the intervening Shulaps-Mission Ridge metamorphic belt, where the Bridge River Complex is in part at a higher metamorphic grade than Cadwallader Terrane and the overlying Shulaps Complex, and at least in part occurs beneath these units across normal faults (*see* Chapter 3).

Structural relationships are more complex west of the Castle Pass fault, where the Bridge River Complex occurs both structurally beneath and structurally above imbricated slices of Cadwallader Terrane and Bralorne-East Liza Complex (Figure 7). This complexity is, at least in part, due to further imbrication of a previously assembled thrust stack by younger faults of the Late Cretaceous reverse-sinistral Eldorado fault system. West of the Eldorado fault, however, the Bridge River Complex and overlying Gun Lake clastic unit are structurally overlain by imbricated Bralorne-East Liza Complex and Cadwallader Terrane just as they are in the eastern part of the map area. Farther to the northwest, Cadwallader Terrane within this same hangingwall thrust sheet is structurally above the Relay Mountain Group, providing further corroboration of a stratigraphic relationship between the Relay Mountain Group and Bridge River Complex.

The structural and stratigraphic relationships described in the previous paragraphs suggest that the Bridge River Complex was depositionally overlain by clastic sedimentary rocks of the Tyaughton basin and Cayoosh assemblage in late Middle Jurassic to Late Jurassic time. Uplift and erosion of the complex occurred during mid-Cretaceous contractional deformation, at which time it was in part depositionally overlain by synorogenic clastic rocks of the Taylor Creek Group and structurally overlain by thrust slices of Cadwallader Terrane and associated ophiolitic rocks. In detail the present outcrop pattern is largely controlled by Late Cretaceous and Tertiary faults, but shows a general transition from Bridge River Complex in the southeast to younger clastic sequences of the Tyaughton basin to the northwest. This pattern probably reflects a northwestward plunge of the Bridge River Complex beneath the overlying sedimentary rocks of the Tyaughton basin, away from a structural culmination that developed during mid-Cretaceous contractional deformation.

CAYOOSH ASSEMBLAGE

Cayoosh assemblage is an informal name applied by M. Journeay and co-workers to a succession of Jura-Cretaceous(?) clastic metasedimentary rocks that is well exposed south of the project area, where it conformably overlies the Bridge River Complex (Journeay and Northcote, 1992; Journeay, 1993; Mahoney and Journeay, 1993; Journeay and Mahoney, 1994). Within the southern part of the Taseko - Bridge River area the Cayoosh assemblage is represented by sandstone, siltstone and argillite of the Gun Lake unit, which overlies the Bridge River Complex at several localities between Gun Lake and lower Tyaughton Creek. A narrow lens of Upper Jurassic conglomerate that occurs within the Bridge River Complex near Truax Creek may represent a stratigraphically higher unit within the assemblage. Predominantly fine grained clastic rocks that are in fault contact with the Bridge River Complex north of Downton Lake may also be part of the Cayoosh assemblage; alternatively, this unit may correlate with Lower to Middle Jurassic rocks of Cadwallader Terrane.

GUN LAKE UNIT (JKGL)

Rocks assigned to the Gun Lake unit are mapped in 5 separate areas in the southern part of the Taseko - Bridge River map area. None of the outcrop belts are extensive, but in each area the unit comprises a similar succession of sandstone, siltstone and argillite that is known or inferred to stratigraphically overlie the Bridge River Complex. These rocks are thought to represent the lower part of the Cayoosh assemblage based on their stratigraphic position directly above the Bridge River Complex, and their general lithologic similarity to the Cayoosh assemblage described by Mahoney and Journeay (1993) and Journeay and Mahoney (1994).

The Gun Lake unit consists of medium to dark grey argillite, slaty argillite and siltstone intercalated with generally lighter coloured grey to green fine to coarse-grained sandstone. Sandstone occurs variably as thin lenses enclosed by slaty argillite, as medium to thick normally graded beds, and locally as massive outcrops within which medium-scale bedding is defined only by discontinuous, wispy dark grey shale laminae. Sand grains are typically dominated by volcanic lithic fragments, quartz and feldspar. Quartz grains are commonly angular, and some preserve delicate embayments, suggesting derivation from a proximal volcanic source. Dark grey shale intraclasts are common locally, and chert grains are a major constituent of some sandstones.

The base of the Gun Lake unit is best exposed along the lower part of the Truax Creek road, where it passes eastward into a more heterogeneous assemblage comprising imbricated chert, argillite, sandstone, greenstone, limestone and serpentinite assigned to Unit JBRas of the Bridge River Complex. Both the Gun Lake unit and the Bridge River Complex are strongly sheared, with foliation, mesoscopic shears and bedding dipping moderately to the west or southwest. Graded bedding and crosslaminations from several localities within the Gun Lake unit indicate that it is overturned and faces to the east, away from the Bridge River Complex. Despite the shearing within both units, which is presumably related to their position in the footwall of the Late Cretaceous Truax Creek fault system (*see* Chapter 3), there does not appear to be a major structural break between the Bridge River Complex and the Gun Lake unit. The contact is therefore interpreted to be a stratigraphic contact (presently overturned) across which the Gun Lake unit was deposited above the Bridge River Complex.

Clastic rocks assigned to the Gun Lake unit also overlie Unit JBRas of the Bridge River Complex along lower Tyaughton Creek and in a belt that extends from the vicinity of Mount Zola northwestward across Gun Lake to near the lower reaches of Leckie Creek. Facing directions were not determined in the latter area, but these rocks are apparently disposed as a tight syncline, outlined in part by the underlying Bridge River rocks, in the footwall of the Eldorado and Sumner Creek faults. This belt of clastic rocks was mapped as Noel Formation by Cairnes (1937, 1943), who also mapped a separate outlier of Noel Formation two kilometres to the southwest; this latter belt was not examined during the present study, but is shown as the Gun Lake unit on Figure 3. A thin belt of well bedded sandstones and argillites mapped between two strands of the Castle Pass fault along Pearson Creek is also assigned to the Gun Lake unit. This unit is faulted against Bridge River serpentinite to the north, and is in structural or stratigraphic contact with an assemblage of Bridge River chert, greenstone and argillite to the south.

In general, the sandstones of the Gun Lake unit are quite similar to the volcanic-rich sandstones that are intercalated with chert and argillite within the underlying Bridge River Complex. These sandstones are most common within portions of the Bridge River Complex directly beneath the Gun Lake unit (specifically Unit JBRas), suggesting that the contact is in a general sense gradational. Since the Cayoosh assemblage does not display the tectonic disruption characteristic of the Bridge River Complex, this contact apparently reflects an increase in clastic input broadly coincident with the final stages of accretionary tectonics within this part of the Bridge River Complex. Although the Gun Lake unit is not dated, this transition is thought to have occurred in late Middle Jurassic time, as this is the age of the youngest dated chert imbricated within the Bridge River Complex as well as the age of the basal unit of the Relay Mountain Group, which may correlate with the Gun Lake unit.

DOWNTON LAKE UNIT (JDL)

Rocks assigned to the Downton Lake unit crop out on the north side of Downton Lake, where they are in fault contact with Bridge River Complex to the east and are intruded by Late Cretaceous granodiorite of the Dickson-McClure batholith to the west and north. The succession is dominated by rusty-weathering, dark grey to black siliceous argillite and siltstone that occur in thin to thick planar beds. Also present are thin to medium, locally graded beds of fine grained sandstone, medium beds of silty limestone, and thin lenses of black carbonaceous calcarenite and carbonaceous limestone. Beds of conglomerate occur locally, and contain pebbles of argillite, limestone and feldspathic volcanic rock within a calcareous matrix. No macrofossils were found in the succession, and calcareous samples processed for microfossils were barren of conodonts or radiolaria.

Rocks assigned to the Downton Lake unit were mapped as Noel Formation by Cairnes (1943). They comprise the north end of a belt that was traced south-southeast across Green Mountain to Noel Mountain by Roddick and Hutchison (1973) and Woodsworth (1977). These workers assigned most of the rocks within this belt to the Hurley Formation. Rusmore (1985) examined the rocks on Noel Mountain and provisionally accepted the Hurley correlation, while noting that, in comparison to the Hurley Formation of the Eldorado Creek area, the section contains less sandstone, the sandstones contain less quartz, and the composition of the conglomerates is more restricted. The rocks exposed north of Downton Lake do not resemble the Hurley Formation exposed elsewhere in the Taseko-Bridge River area, but are, in part, similar to the Lower to Middle Jurassic rocks of Cadwallader terrane, with which they were correlated by Schiarizza *et al.* (1993a). However, as much of this section also resembles the Gun Lake unit, we presently accept the more recent correlation of Journeay and Mahoney (1994), who suggest that this belt of rocks correlates with the lower to middle portion of the Cayoosh assemblage.

TRUAX CREEK CONGLOMERATE (JKT)

The Truax Creek conglomerate occurs as a narrow fault-bounded lens within the Bridge River Complex on the south side of Carpenter Lake, 11 kilometres northeast of Gold Bridge. These rocks were first recognized as a distinct unit by Church and MacLean (1987b), who mapped them as Relay Mountain Group on the basis of fossils they collected from a thin siltstone lens within the coarser rocks, which were identified by T. Poulton as *Buchia* sp. of possible Late Jurassic (Volgian?) age.

The Truax Creek unit consists almost exclusively of massive, unstratified, poorly sorted pebble to cobble conglomerate (Photo 11). Clasts are dominated by felsic to in-

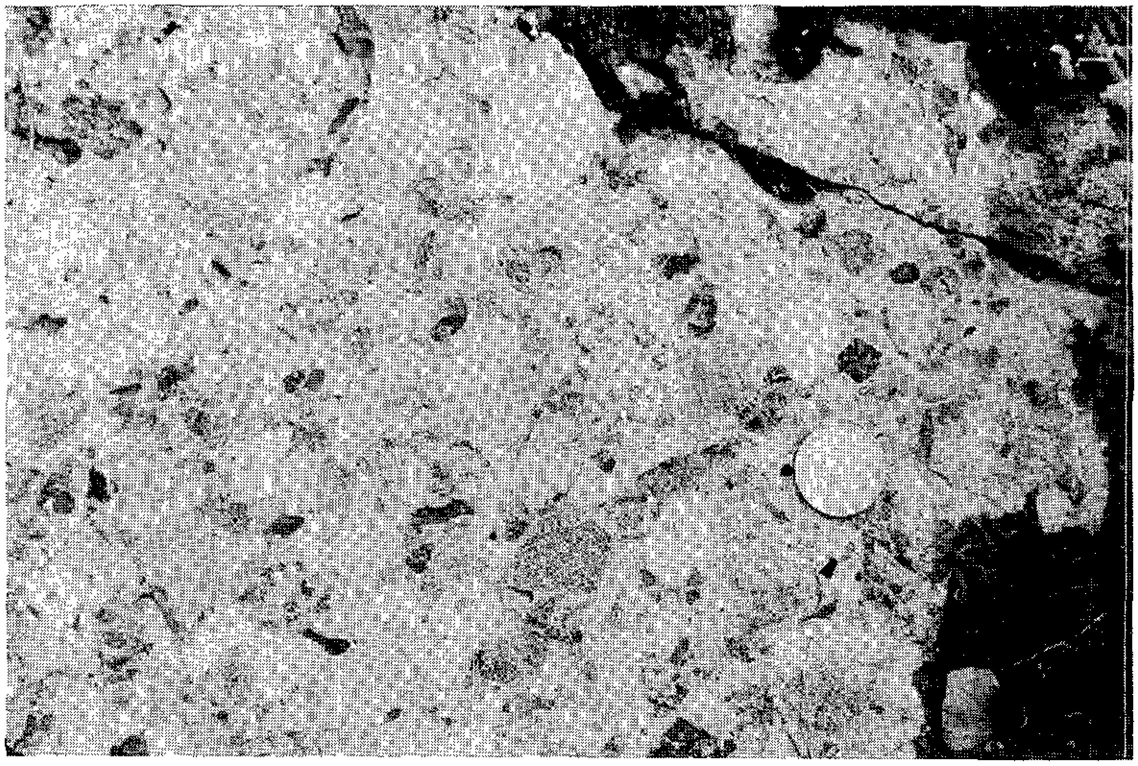

Photo 11. Truax Creek conglomerate.

termediate volcanic rocks, but also include significant proportions of mafic volcanic rocks, granitic to gabbroic plutonic rocks and shale. Clasts of chert, limestone, sandstone and granule to small pebble conglomerate, the latter probably of intraformational origin, also occur, but are not abundant. Volcanic and plutonic clasts vary from angular to moderately well rounded, with larger clasts tending to be better rounded. Shale clasts are rarely larger than pebble size and tend to be angular. Pebble conglomerates are commonly clast-supported, whereas the larger clasts in coarser varieties tend to be supported by a well indurated, siliceous, gritty to sandy matrix.

Massive, well indurated coarse grained sandstone and gritty sandstone occurs locally within the Truax Creek conglomerate, where it forms poorly defined beds or lenses that range from tens of centimetres to a few metres thick. Clastic grains are dominated by volcanic-lithic fragments, angular quartz, feldspar, chert and siliceous argillite, but also include hornblende, siltstone, polycrystalline quartz and quartz-feldspar aggregates, and quartz tectonites.

Stratigraphic relationships between the Truax Creek conglomerate and adjacent units are unknown, as it occurs as a narrow, southwest-dipping fault-bounded lens enclosed within the Bridge River Complex. Footwall Bridge River Complex to the northeast, however, passes eastward into overturned Gun Lake clastic unit comprising the base of the Cayoosh assemblage in this area. It is possible, therefore, that the Truax Creek conglomerate is a faulted repetition that has preserved a higher stratigraphic level of the Cayoosh assemblage, or an overlying unit.

CADWALLADER TERRANE

CADWALLADER GROUP

The Cadwallader Group comprises Upper Triassic volcanic and sedimentary rocks that outcrop in several fault-bounded panels in the southern part of the map area, extending from Eldorado Creek and Downton Lake eastward to the western slopes of the Camelsfoot Range, east of the Yalakom and Bridge rivers (Figure 8). Cairnes (1937, 1943) first used the designations Noel Formation, Pioneer Formation and Hurley Group for rocks in the Bralorne and Eldorado Mountain areas which had previously been included in the Cadwallader Series of Drysdale (1916, 1917) and McCann (1922). The Noel, Pioneer and Hurley were all assigned formational status by Roddick and Hutchison (1973), and included within the Cadwallader Group. Rusmore (1985, 1987) was the first to study the Cadwallader Group in detail. She concluded that the Noel Formation was not a coherent unit and should be abandoned. Her revised stratigraphy, based on sections west of Eldorado Mountain, comprised mafic volcanic rocks of the Pioneer Formation, and conformably overlying siltstone, sandstone and conglomerate of the Hurley Formation; neither the stratigraphic base nor the stratigraphic top of the section was recognized. Rusmore assigned the Cadwallader Group a Late Triassic

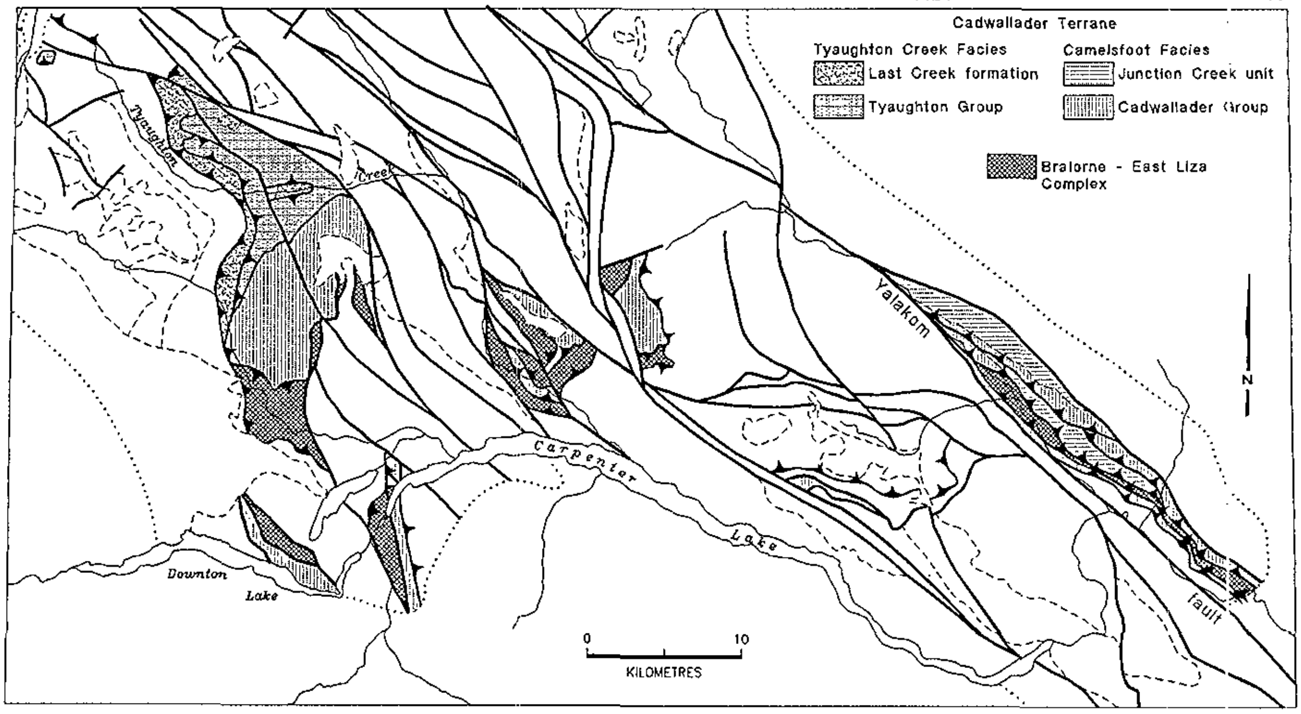

Figure 8. Simplified map showing distribution of the Cadwallader Terrane and Bralorne-East Liza Complex.

age on the basis of latest Carnian or earliest Norian to middle Norian conodonts collected from the Hurley Formation.

Church (1987) and Church *et al.* (1988a,b) retained Roddick and Hutchison's three-fold division of the Cadwallader Group. However, they assigned all mafic volcanic rocks in the Bralorne map area to the Pioneer Formation, including greenstone units that previous workers had assigned to the Bridge River Complex. They used the term Noel Formation for black argillite, siltstone and calcareous siltstone exposed in several areas in the Downton Lake - Bralorne - Gold Bridge area. This usage excluded some rocks originally assigned to the formation by Cairnes (included by Church *et al.*, in the Bridge River Complex), and locally included some rocks previously assigned to the Hurley Formation. Their assignment was apparently based on lithology, regardless of stratigraphic position, as they included some rocks that occur between their Pioneer and Hurley formations, whereas previous workers had assigned the Noel Formation a stratigraphic position beneath the Pioneer Formation.

Further confusion as to the status of the Cadwallader Group arose when Leitch (1989) obtained Early Permian U-Pb crystallization ages from diorite and soda granite of the Bralorne igneous complex. This conflicted with the Triassic age assigned to the Cadwallader Group by Rusmore (1985, 1987) because rocks traditionally included in the Pioneer Formation of the Cadwallader Group commonly display complex interfingering to gradational contacts with the Bralorne diorite, suggesting an intrusive and possibly comagmatic relationship (Cairnes, 1937, 1943; Leitch, 1989; Leitch *et al.*, 1991a).

Rocks assigned to the Cadwallader Group in the present study correspond to the Upper Triassic Cadwallader Group as redefined by Rusmore (1985, 1987). It comprises a lower volcanic unit together with overlying sedimentary rocks assigned to the Hurley Formation; the contact between the two main units is locally gradational and defined by an intervening transitional unit that is included in the Hurley Formation. Rocks assigned to the Noel Formation by Cairnes (1937, 1943) have in large part been included in the informal Gun Creek and Downton Lake units, which are correlated with the Jura-Cretaceous Cayoosh assemblage of Bridge River Terrane. The volcanic unit of the Cadwallader Group includes some rocks that have traditionally been assigned to the Pioneer Formation, but much of the Pioneer Formation as defined by Cairnes (1937, 1943) is here included in the Permian Bralorne-East Liza Complex. Because greenstones in the type area of the Pioneer Formation, at the Pioneer mine, apparently fall into the latter category, the name "Pioneer" is not used for the Cadwallader Group volcanic rocks. This two-fold division of rocks that had previously been included in the Pioneer Formation alleviates some of the confusion introduced with Leitch's (1989) Lower Permian dates for the Bralorne diorite. It is supported by available geochemical data (Macdonald, 1990a,b), as volcanic rocks assigned to the Cadwallader Group on the basis of observed stratigraphic contacts with the Hurley Formation display the chemistry of island arc tholeiites, whereas greenstones included within the Bralorne-East Liza Complex, which commonly interfinger with intrusive rocks of the complex, have the chemical characteristics of ocean floor basalts.

Much of the confusion over Cadwallader Group nomenclature, as well as continuing difficulties in distinguishing Cadwallader volcanics from Bralorne-East Liza volcanics, results from the close spatial relationship of the Cadwallader Group and the Bralorne-East Liza Complex (Figure 8). This spatial relationship may reflect an original stratigraphic relationship, with the Cadwallader Group having been deposited above an oceanic basement represented by the Bralorne-East Liza Complex. This has not been proven in the Taseko - Bridge River map area, however, as all observed contacts between the two units are faults.

VOLCANIC UNIT(uTCV)

The volcanic unit of the Cadwallader Group includes pillowed and fragmental mafic volcanic rocks that are lithologically similar to mafic volcanic units of both the Bralorne-East Liza Complex and the Bridge River Complex. The map units to which these mafic rocks have been assigned are based largely on the rocks with which they are associated, but this presents difficulties in separating Bralorne-East Liza volcanics from Cadwallader Group volcanics because the two map units are everywhere spatially associated. Consequently, rocks assigned to the volcanic unit of the Cadwallader Group include only those volcanic rocks observed or inferred to be in depositional contact with the Hurley Formation. They outcrop in only four widely separated localities, and are of limited aerial extent. Relationships are best displayed west of Eldorado Creek, where Rusmore (1985, 1987) describes stratigraphic contacts between the volcanic unit and overlying Hurley Formation that vary from abrupt to gradational; the gradational contacts are marked by a transitional unit comprising greenstone and bedded tuff intercalated with sedimentary rocks similar to those that characterize the overlying Hurley Formation (Figure 9). A similar gradational contact was observed between the Hurley Formation and underlying volcanic rocks along a northwest-trending ridge four kilometres northwest of Liza Lake. Volcanic rocks assigned to the Cadwallader Group also outcrop east and southeast of Gold Bridge, where they occupy a narrow fault-bounded belt between the Bralorne-East Liza Complex and the Bridge River Complex. These volcanics outline a tight syncline cored by the Hurley Formation, which at several localities was observed in conformable depositional contact with the volcanic rocks. The other area underlain by the Cadwallader Group volcanic unit is on the lower slopes northeast of the Yalakom river, between Ore and Junction creeks. There, volcanic breccia (Photo 12) is assigned to the Cadwallader Group because it also includes volcanic conglomerate that contains sparse clasts of limestone and green cherty tuff that are common as clasts in overlying conglomerate of the Hurley Formation.

The Cadwallader Group volcanic unit consists mainly of green, grey-green or purple, massive and pillowed basalt, together with pillow breccia and agglomerate. Massive and pillowed flows are commonly aphyric or plagioclase phyric, but locally include phenocrysts of both plagioclase and clinopyroxene. The aphanitic to fine-grained groundmass consists of intergrown plagioclase laths and clinopyroxene crystals together with opaque grains and low-grade metamorphic minerals that include chlorite, calcite, actinolite, epidote and pumpellyite. The flows are almost invariably

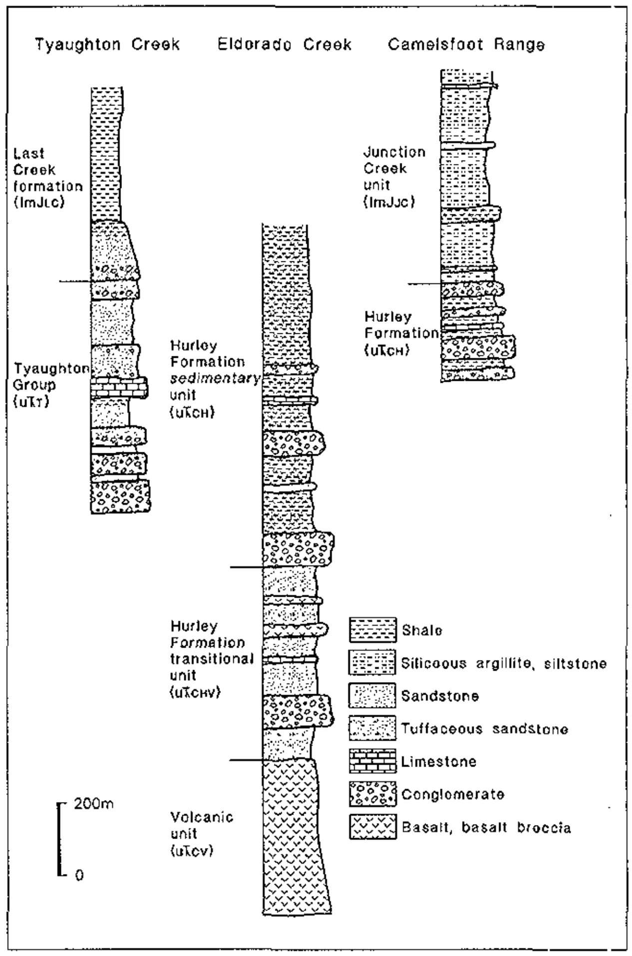

Figure 9. Schematic stratigraphic sections of Cadwallader Terrane. Tyaughton Creek section after Umhoefer (1989, 1990). Eldorado Creek section after Rusmore (1985, 1987).

amygdaloidal, with amygdules of calcite, calcite-chlorite, calcite-pumpellyite and quartz-epidote. Unstratified breccias comprised largely of pillow fragments are common, and crudely stratified mafic agglomerates occur rarely. Diabasic to gabbroic sills occur locally within the volcanic unit, and Rusmore (1985, 1987) reports a small body of quartz-phyric rhyolite in the unit near Eldorado Creek.

The volcanic unit of the Cadwallader Group has not been dated, but since basalt flows are intercalated with the transitional unit of the Hurley Formation, which contains early Norian conodonts, it is inferred to be of Late Triassic age.

Rusmore (1985, 1987) reports trace element compositions of ten basalt samples from the Cadwallader Group in the Eldorado Creek area (six from the volcanic unit and four from the overlying transitional unit of the Hurley Formation) and analyses them using various published trace-element discriminant diagrams. The samples fall mainly in the fields of island-arc tholeiites, although some overlap into ocean-floor basalt compositional fields. Rusmore concludes that the Cadwallader basalts probably erupted in or near an island arc. Trace element compositions of Cadwallader

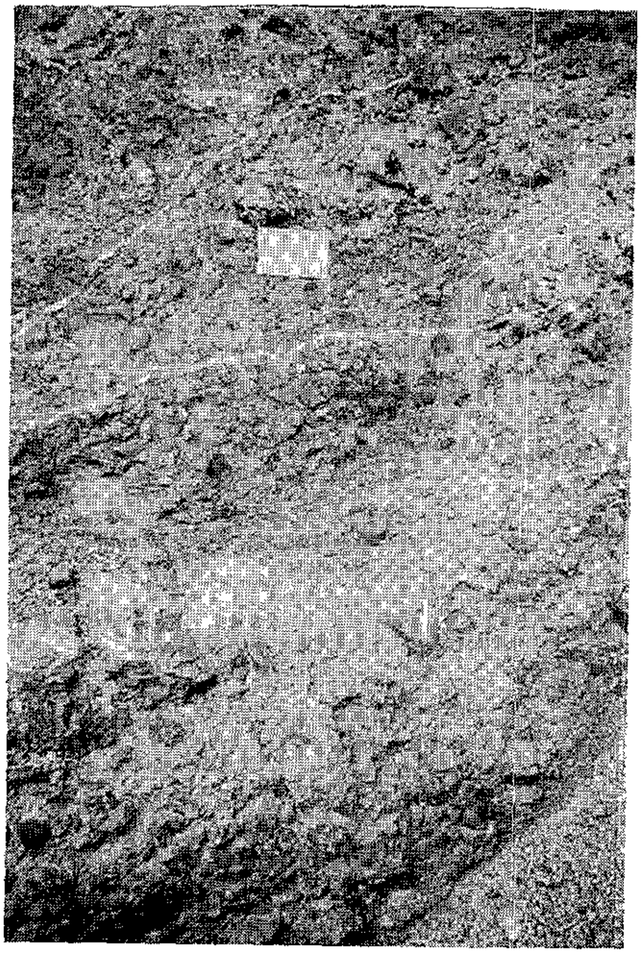

Photo 12. Volcanic breccia in the lower part of the Cadwallader Group, northeast side of the Yalakom River above the mouth of Shulaps Creek.

Group volcanic rocks from elsewhere in the map area support the conclusions of Rusmore as they also plot mainly in island-arc tholeiite compositional fields (Macdonald, 1990a,b).

HURLEY FORMATION

Transitional Unit (uTCHv)

The transitional unit of the Hurley Formation consists of basalt and bedded tuff intercalated with sandstone, conglomerate and minor amounts of micritic limestone. It occurs locally between the volcanic unit and overlying sedimentary rocks of the Hurley Formation. It is included in the Hurley Formation following Rusmore (1987), who took the stratigraphically lowest occurrence of clastic rocks to mark the base of the formation. The transitional unit is a mappable entity only in two separate fault slices in the Eldorado Creek area, where it was originally defined by Rusmore (1985, 1987). A similar transitional interval was noted at the contact between the volcanic unit and Hurley Formation on the ridge northwest of Liza Lake, but is not sufficiently well defined to constitute a mappable unit. Rare volcanic rocks observed elsewhere in the Hurley Formation likewise are not sufficiently extensive or well defined to be separated out as a mappable subdivision.

The transitional unit is described in detail by Rusmore (1985, 1987), and the following brief summary is mainly from her work. It includes pillowed and massive flows and pillow breccias that are very similar to those within the volcanic unit, as well as conglomerates, sandstones and rare micritic limestones that resemble rocks in the overlying sedimentary member (Photo 13). However, it also includes thick beds of felsic tuffaceous sandstone and thinner beds of crystal tuff that are common only in the transitional unit. The felsic tuffaceous sandstones dominate much of the unit, and generally occur as massive, dark green beds several me-

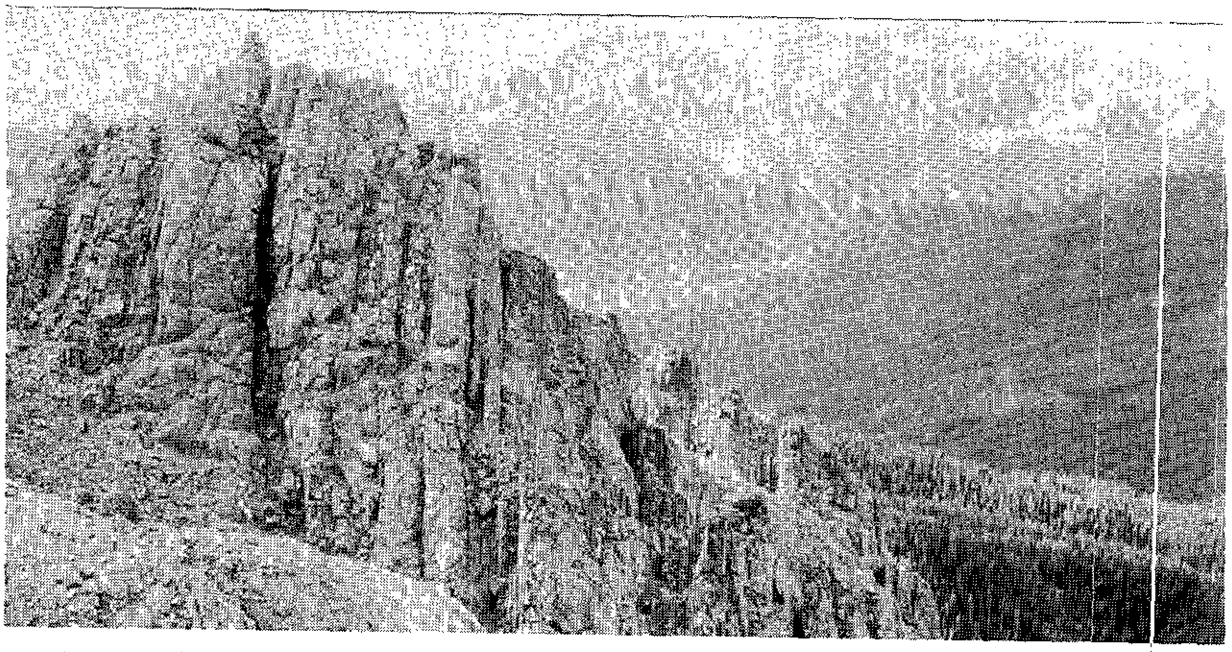

Photo 13. Well-bedded sandstone, tuffaceous sandstone and conglomerate in the transitional unit of the Hurley Formation, east of Spruce Lake.

tres thick. They contain fragments of basalt, pumice and devitrified glass, together with euhedral plagioclase and quartz crystals, within a chloritic tuffaceous matrix. Rusmore suggests that they are redeposited ash-fall tuffs or submarine pyroclastic deposits. Thin beds of bright blue-green crystal tuff that are intercalated with the tuffaceous sandstone beds also characterize the transitional unit. This tuff consists of a chloritic matrix containing scattered euhedral crystals of plagioclase, quartz and clinopyroxene, as well as relict glass shards replaced by calcite and chlorite.

Sedimentary Unit (u₸CH)

The sedimentary unit of the Hurley Formation constitutes most of the Cadwallader Group exposed within the map area. It comprises a sequence of generally well bedded sandstones, calcarenites and shales, locally punctuated by distinctive beds of polymict conglomerate. It locally includes limestone beds and lenses, and rarely contains chaotic deposits of limestone-basalt breccia associated with pebbly mudstone and conglomerate.

The sedimentary unit consists largely of thin beds of medium to coarse-grained, brownish weathered sandstone alternating with dark grey shale or siltstone. The sandstone beds commonly have sharp bases and graded tops. Scattered throughout the succession are intervals of finer grained siltstone-shale couplets, as well as beds of medium to thick-bedded sandstone and calcarenite. The thicker beds are mainly coarse to medium grained and are commonly graded. Rarely they include granules and small pebbles in their basal portions. Rip-up clasts of shale or siltstone are also present near the bases of some beds. The sandstones are mainly volcanic-lithic arenites and calcarenites containing variable proportions of mafic to felsic volcanic rock fragments, quartz and feldspar crystals, and carbonate clasts (including fossil fragments). Much of the detrital quartz is volcanic in origin as many crystals have embayed margins or a bipyramidal habit (Rusmore, 1985). Rare clasts of intergrown quartz and feldspar derived from a plutonic source are seen in some samples, and clasts of shale and siltstone may also be present.

Although distinctive pebble to boulder conglomerates are a subordinate component of the sedimentary member, they were observed in all outcrop belts of the Hurley Formation. Similar conglomerates are present within the transitional unit. The conglomerates commonly form single beds several metres thick, but locally occur in groups of beds, with or without intercalated sandstone, that may total several tens of metres in thickness. Most conglomerate beds are lenticular and unstratified, with strongly channeled bases; some relatively thin beds grade upward into planar sandstone caps. The conglomerates generally consist of poorly sorted pebbles and cobbles of limestone (commonly fossiliferous), felsic to mafic volcanic rocks and granitoid plutonic rocks, set in a sandy matrix that is commonly calcareous. Volcanic clasts are generally more abundant than plutonic clasts, but the proportion of igneous clasts versus limestone clasts varies considerably and is independent of stratigraphic position (Rusmore, 1985, 1987). Clasts are generally subangular to subrounded, although plutonic clasts are commonly rounded, and limestone clasts vary from markedly angular to well rounded. Distinctive clasts observed in most conglomerates include bright green tuff similar to the thin tuff beds found in the volcaniclastic member (Rusmore, 1985), and light green to grey rhyolite or dacite with large quartz and feldspar phenocrysts.

Rusmore (1985, 1987) describes tabular deposits of limestone-basalt breccia intercalated with conglomerates and pebbly mudstones within the sedimentary member west of Eldorado Creek, and suggests that they are submarine talus deposits that accumulated at the base of a steep slope or scarp. The breccias consist of unsorted, clast-supported blocks up to 4 metres across. Angular limestone blocks up to several metres across also occur within thick intervals of polymict conglomerate that occur in two separate thrust slices on the slopes southwest of Mount Bishop.

Thin to medium beds of micritic limestone or laminated to crosslaminated silty limestone occur locally within the Hurley Formation, where they are commonly associated with beds of calcareous siltstone or calcarenite. Thicker limestone bodies are not common, but a massive lens of light grey limestone west of upper Eldorado Creek is several tens of metres thick (Photo 14).

Rusmore (1985, 1987) assigned the Hurley Formation a late Carnian or early Norian to Middle Norian age, based on conodonts (identified by M.J. Orchard) extracted from both the transitional and sedimentary units. She also collected a poorly preserved ammonite from the transitional unit, which was assigned a Carnian or Norian age by E.T. Tozer of the Geological Survey of Canada. Rusmore noted that conodonts from clasts in conglomerate show a similar age range to those within limestone beds, indicating that deposition and erosion of the limestone source was contemporaneous with deposition of the clastic rocks of the formation. Limestone and calcarenite beds sampled during the present study, and by B.N. Church of this Ministry, have yielded several additional collections of Late Triassic conodonts and radiolarians (Appendix 1), but do not increase the age range reported by Rusmore. However, M.J. Orchard reports that one of Rusmore's samples previously assigned to the Middle Norian is probably of Late Norian age (Appendix 1, Sample 83-WV-R-5). This revised interpretation is significant, as it indicates that the Hurley Formation is in part the same age as the Tyaughton Group.

TYAUGHTON GROUP (u₸T)

The Tyaughton Group is a distinctive succession of Upper Triassic nonmarine to shallow marine sedimentary rocks that outcrops over a limited area extending from Bonanza Creek northwestward to the divide between Relay and Tyaughton creeks (Figure 8). The only exposure of the group known outside this belt is a small klippe resting on the Jura-Cretaceous Relay Mountain Group east of Lorna Lake. Cairnes (1943) originally defined the Tyaughton Group as consisting of these Upper Triassic rocks, but the definition was extended by Tipper (1978) and Glover *et al.* (1987) to also include overlying Lower to Middle Jurassic rocks. Umhoefer (1989, 1990) studied the succession in detail and restricted the Tyaughton Group to the Triassic rocks, as originally defined by Cairnes; he introduced the name

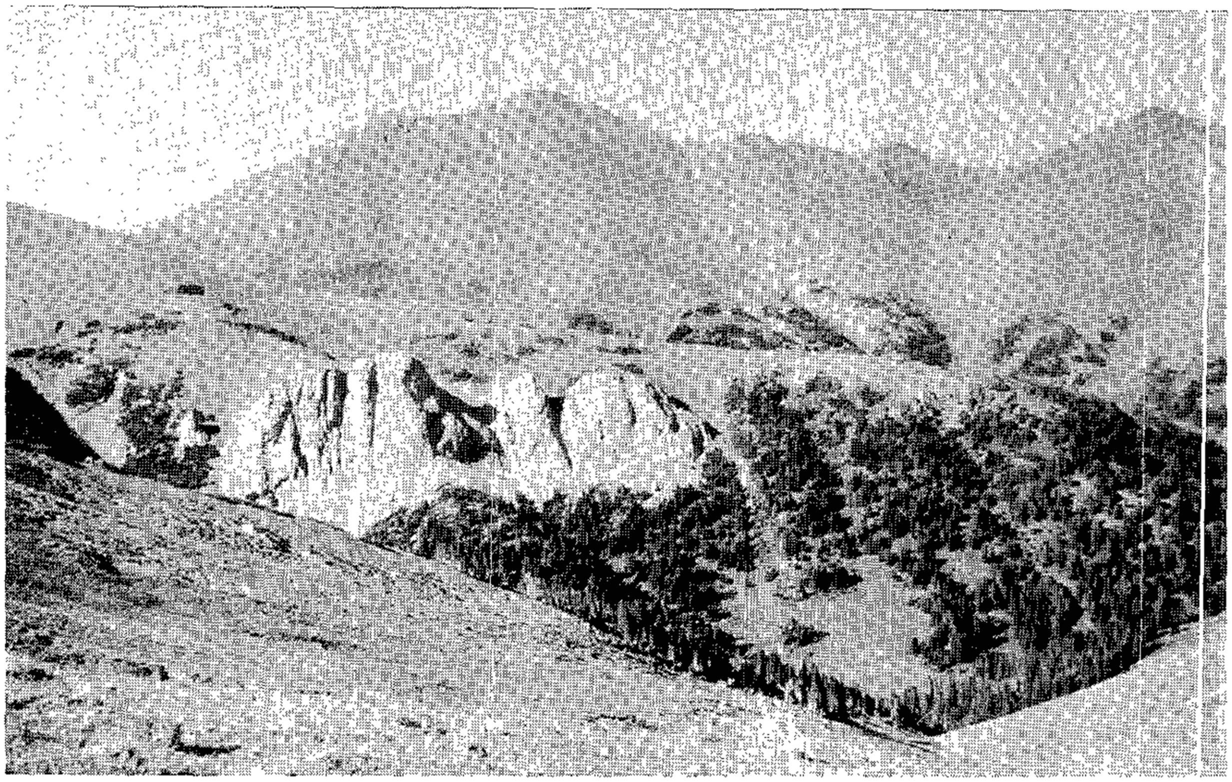

Photo 14. Limestone lens within the Hurley Formation, near Eldorado Creek.

Last Creek formation as an informal designation for the overlying Jurassic rocks.

The main belt of Tyaughton Group rocks is truncated by the Castle Pass fault to the northeast, across which it is juxtaposed against Jura-Cretaceous sedimentary rocks of the Tyaughton basin. The group is bounded by a thrust slice of Last Creek formation to the west, and by a different thrust fault to the southeast, across which it is structurally overlain by the Cadwallader Group. The Tyaughton Group within the belt is strongly deformed by both thrust and strike-slip faults, such that no single complete stratigraphic section is exposed. However, the distinctive stratigraphy of the group allowed Umhoefer (1990) to estimate a total thickness of about 600 metres, based on internal correlation of several individual sections. The base of the group is nowhere exposed, but the stratigraphic top is locally defined by a disconformity beneath overlying Jurassic rocks of the Last Creek formation.

Umhoefer (1989, 1990) subdivides the Tyaughton Group into five informal map units, following Tipper (unpublished 1965 mapping) and Tozer (1967): lower redbeds; the massive to thin-bedded limestone unit; a lower green clastic unit; the *Cassianella* beds; and an upper green clastic unit (Figure 9). The group is undivided on the 1:100 000 scale map of Figure 3, but the distribution of these units is shown on the 1:20 000 scale map of Umhoefer *et al.* (1988); a less detailed two-fold subdivision is presented by Umhoefer (1990) and Schiarizza *et al.* (1993a,c,d). The following summary of the group is based on the detailed descriptions of Umhoefer (1989, 1990).

The redbeds comprising the lowest exposed portion of the Tyaughton Group consist of nonmarine conglomerates and sandstones containing mainly felsic to mafic volcanic and limestone clasts, together with minor plutonic clasts. In general, the unit fines upward from cobble conglomerate to interbedded pebble conglomerate and sandstone, to fine-grained sandstone and siltstone. The lower part comprises amalgamated red to green pebble to cobble-conglomerate beds, typically 1 to 10 metres thick, with minor pebbly sandstone interbeds. The conglomerates are clast supported, poorly sorted and massive to poorly stratified (Photo 15). Overlying rocks are mainly interbedded red to grey-green pebble conglomerates and pebbly to medium-grained, medium to thick-bedded sandstones. Conglomerate is moderately sorted, tabular or trough crossbedded, and commonly grades into sandstone. Finer grained beds show parallel laminae or are massive to crudely stratified. The upper part of the unit is red, fine to medium-grained sandstone and sandy siltstone with thin, planar bedding and horizontal laminae.

The redbed unit is overlain by limestone (Photo 16) across a disconformity with no evidence of erosion. The limestone unit consists predominantly of bioclastic packstone to wackestone in medium to very thick, planar to wavy beds. It includes interbedded limestone and quartz-rich sandstone in beds 20 to 50 centimetres thick, and locally includes minor amounts of grey chert. The top of the unit

Photo 15. Conglomerate in the basal unit of the Tyaughton Group, northeast of Tyaughton Creek.

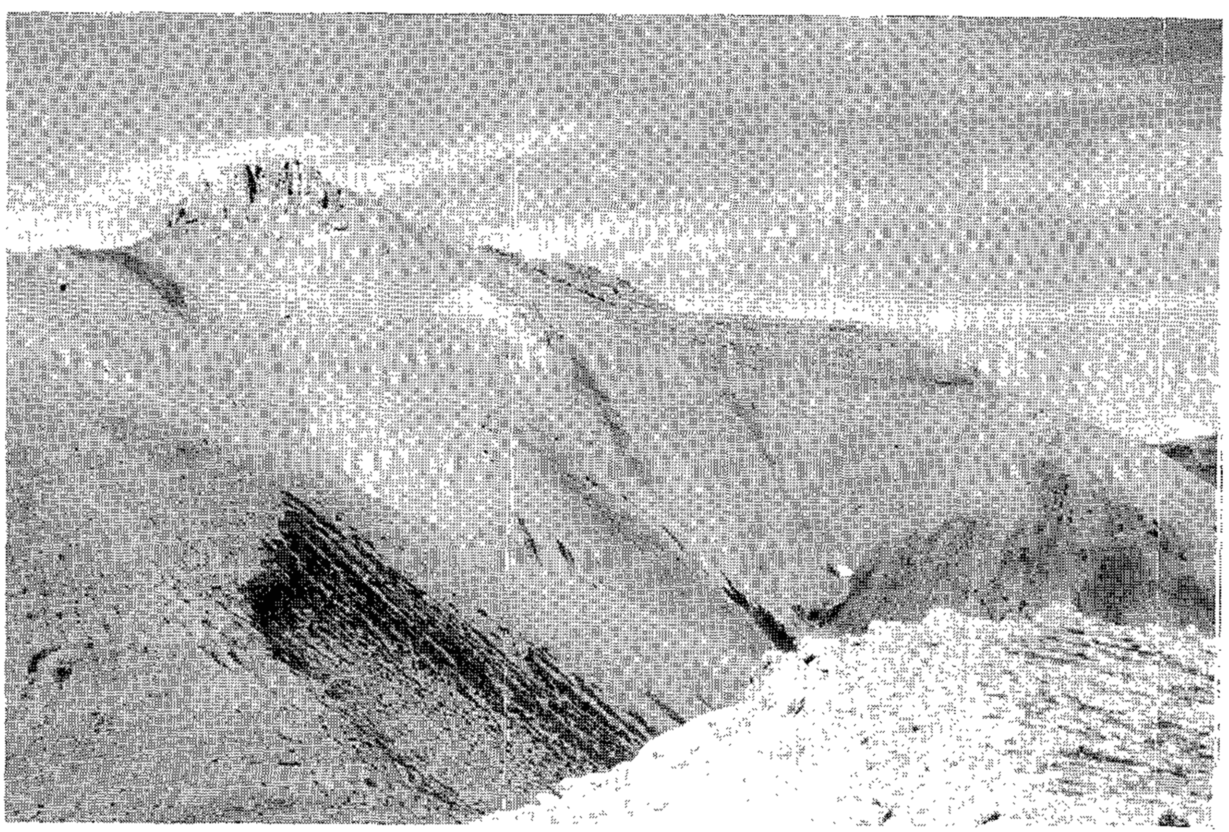

Photo 16. Limestone and overlying clastic rocks, including Cassianella beds, of the Tyaughton Group, west of Castle Peak.

commonly consists of yellow and grey, thin-bedded micrite. The lower part of the limestone unit contains the large fossil bivalve *Neomegalodus canadensis* (Shimer), as well as other bivalves, corals and bryozoa. The thin-bedded limestone that locally marks the top of the unit contains the early late Norian index bivalve *Monotis subcircularis* Gabb (Tozer, 1967).

The lower green clastic unit overlies the limestone unit across an erosional unconformity. Its base is locally marked by limestone-pebble-cobble conglomerate comprising closely packed, grey limestone clasts with minor quartz-granule matrix. The basal conglomerate beds grade upward into pebble conglomerate and then into red to orange-weathering quartz-granule conglomerate to coarse sandstone containing limestone pebbles. Overlying rocks are green, medium to coarse-grained lithic sandstones that commonly display tabular and trough crossbedding. These are intercalated with lenticular beds of sandy pebble conglomerate to pebbly sandstone containing subrounded clasts of felsic to intermediate volcanic rock, limestone and minor granitoid rock.

The overlying *Cassianella* beds comprise brown-weathering, poorly stratified, fine-grained calcareous sandstone interbedded with bivalve-rich sandy calcarenite to calcareous sandstone, dominated by the pelecypod *Cassianella lingulata*. The fossil-rich calcarenite beds are 10 to 40 centimetres thick and are laterally continuous for at least hundreds of metres. Tozer (1979) designated the *Cassianella* beds as the type locality of the Amoenum zone, the middle ammonite zone of the upper Norian, based on the index species *Cochloceras amoenum* (Mojsisovics).

The *Cassianella* beds grade upward into the uppermost unit of the Tyaughton Group, referred to as the upper green clastic unit, which consists of green to brown-green sandstone and small-pebble conglomerate. The sandstones are medium to coarse grained with low-angle tabular crossbedding, horizontal laminations, and thin pebble and bivalve-rich layers (Photo 17). The conglomerate beds are 10 to 100 centimetres thick, locally crossbedded, and locally grade upward into pebbly sandstone. Tozer (1979) denoted the upper green clastic unit as the type locality for the Crickmayi zone, the uppermost ammonite zone of the Triassic (latest Norian age); ammonites within the unit include the index fossil *Choristoceras crickmayi* Tozer.

The limestone and overlying clastic rocks of the Tyaughton Group span most of Late Norian time. Limestone clasts in the underlying redbeds have yielded late early to early middle Norian conodonts (M.J. Orchard *in* Umhoefer, 1990); the redbeds are therefore most likely middle Norian in age. Based on these constraints and the Carnian to middle Norian age range then known for the Hurley Formation (Cadwallader Group), Umhoefer (1990) inferred that the redbeds are either the nonmarine equivalent of the uppermost Cadwallader Group or were deposited over the Cadwallader after rapid uplift. However, the Hurley Formation is now thought to extend into the upper Norian (Appendix

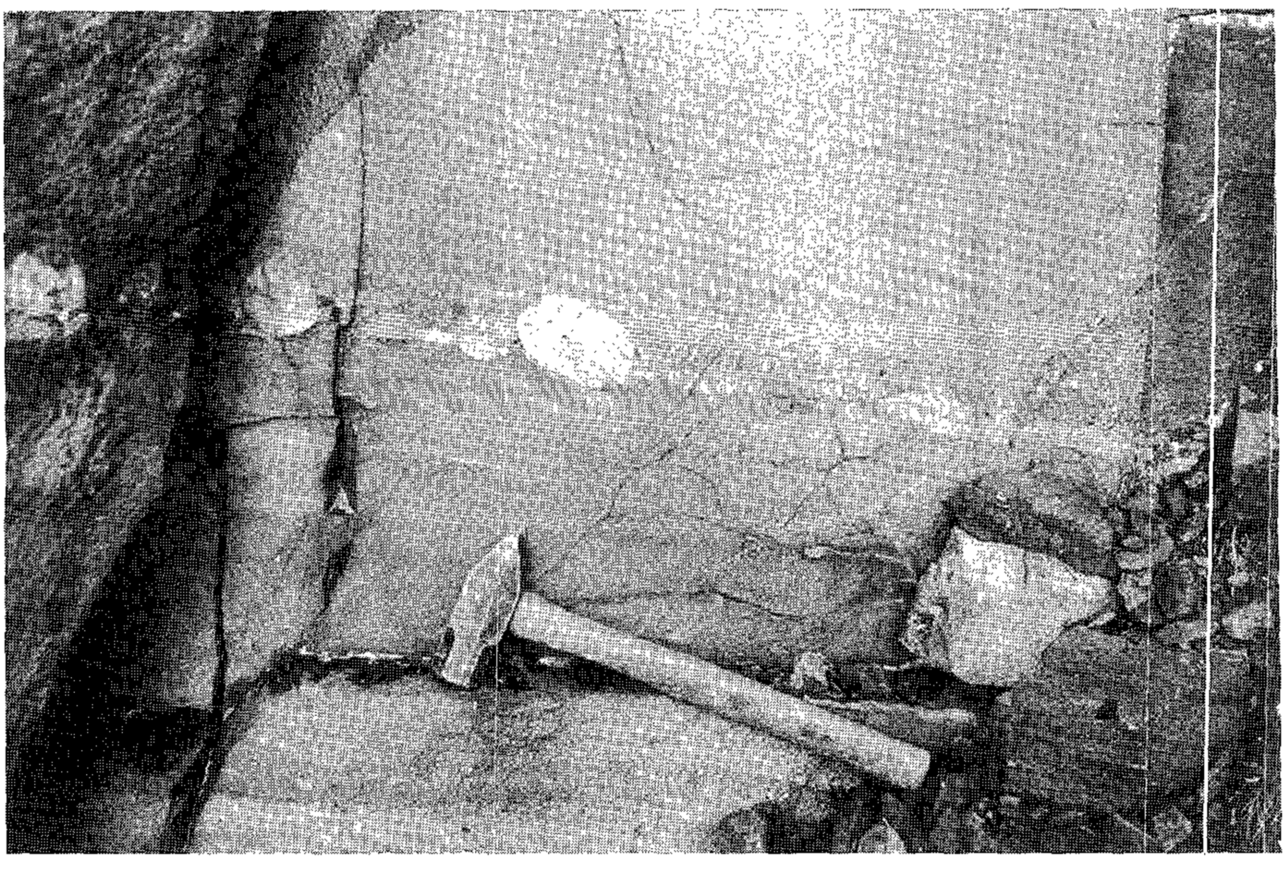

Photo 17. Sandstone and pebble conglomerate from the upper part of the Tyaughton Group, klippe east of the north end of Lorna Lake.

1), and is known to be directly overlain by Jurassic rocks (Junction Creek unit) that are broadly equivalent to the Last Creek formation. These new data suggest that the entire Tyaughton Group may be a nonmarine to shallow marine facies equivalent of the upper part of the Hurley Formation.

LAST CREEK FORMATION (lmJLC)

The informal name Last Creek formation was introduced by Umhoefer (1989, 1990) for Lower to Middle Jurassic clastic rocks that comprise the uppermost unit of Cadwallader Terrane in the Tyaughton Creek area. The most extensive exposures of the formation form a continuous belt that follows the southwest margin of the main belt of Tyaughton Group exposures (Figure 8). These rocks occur mainly as a northeast-dipping thrust slice imbricated between the Tyaughton Group and the Jura-Cretaceous Relay Mountain Group to the southwest. Less extensive exposures occur within the Tyaughton Group belt itself, where the Last Creek formation is in stratigraphic contact with the underlying Triassic rocks in the core of a syncline northwest of Castle Peak, and within a thrust window exposed to the southeast along Tyaughton Creek. The Last Creek formation also outcrops north of the Fortress Ridge fault, where it is apparently the offset extension of the main belt to the south, and locally forms thin fault-bounded slivers along the Fortress Ridge and Castle Pass faults (Figure 3).

No complete section of the Last Creek formation is known. It is, however, richly fossiliferous, and has yielded ammonites from all Lower and Middle Jurassic stages between the upper Hettangian and middle Bajocian (Umhoefer, 1990). Upper Hettangian rocks at the base of the unit comprise interbedded volcanic-pebble conglomerate and brown to green, coarse to medium-grained sandstone. These rocks rest stratigraphically above the Tyaughton Group across an erosional disconformity. Conglomerate beds are 20 to 400 centimetres thick and massive or graded. Sandstone beds are massive, parallel laminated, or low-angle crossbedded, and are commonly graded. Layers of reworked shells occur as thin discrete beds, or at the base of graded beds of conglomerate to pebbly sandstone. Sinemurian rocks change up-section from brown calcareous sandstone and sandy siltstone to siltstone and silty shale (Figure 9). The upper part of the Last Creek formation (upper Sinemurian to middle Bajocian) is generally poorly exposed, and consists of black calcareous shales, commonly with calcareous concretions, intercalated with thin to medium beds of tan-weathering calcareous siltstone (Photo 18). Beds of fine to coarse-grained sandstone occur locally, and thin, yellow to white, clay-rich layers that may be ash beds occur rarely (Umhoefer, 1989, 1990).

JUNCTION CREEK UNIT (lmJJC)

The Junction Creek Unit consists of Lower to Middle Jurassic siltstones and argillites, locally intercalated with beds of limestone and calcareous sandstone. These rocks outcrop in the western Camelsfoot Range, where they occupy several different thrust slices within the Camelsfoot thrust belt (*see* Chapter 3). They were included in the Upper Triassic Hurley Formation by Schiarizza *et al.*, (1990a b), but are now separated out as a separate unit because Fabrice

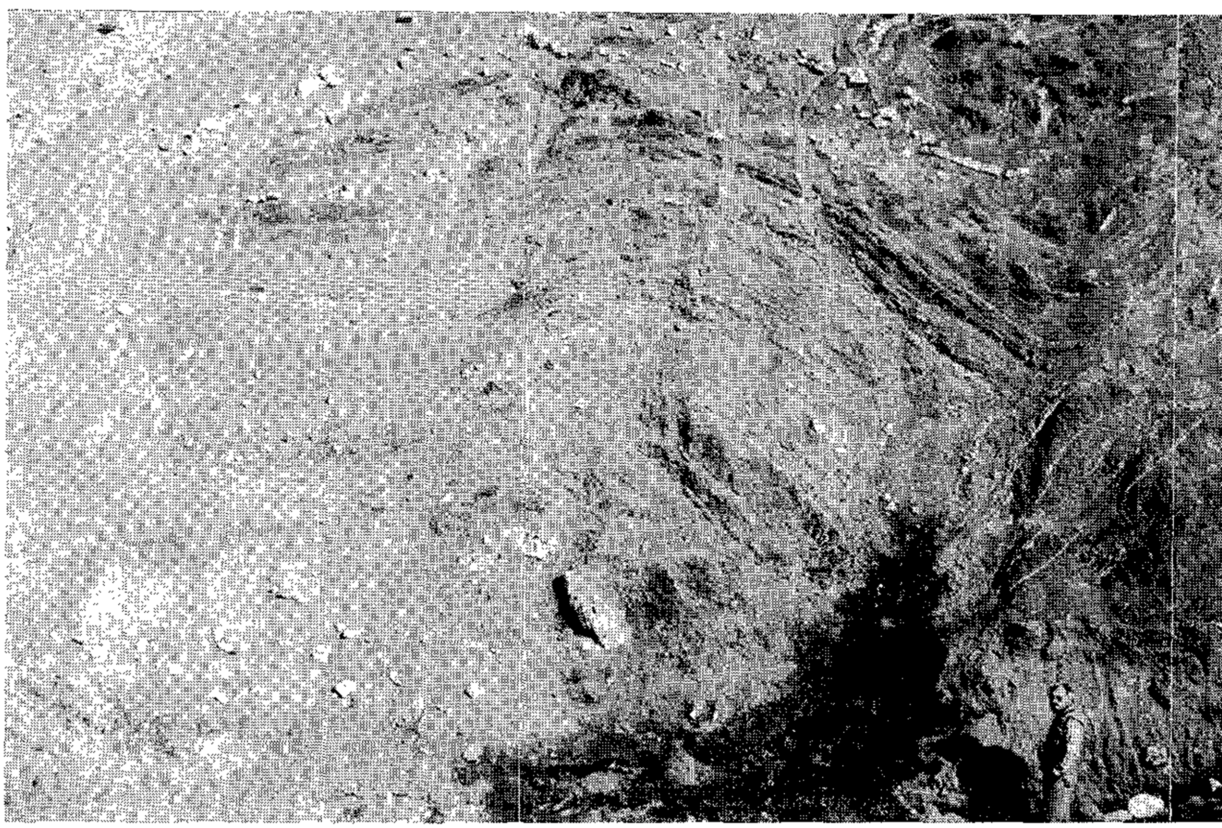

Photo 18. Contorted shales with calcareous siltstone interbeds, Last Creek formation, head of Paradise Creek.

Cordey identified Jurassic radiolarian fauna in two samples of the unit. One of these (Appendix 2, Sample 89APS-15-9-2) was assigned a Middle Jurassic, Aalenian to Bajocian age, and the other (Sample 89BGA-8-1c) an Early or Middle Jurassic, Hettangian to Bajocian age. These rocks therefore correlate with at least part of the Lower to Middle Jurassic Last Creek formation. They are generally similar to the fine-grained upper Sinemurian to middle Bajocian portion of the Last Creek formation in its type area, but differ in the apparent absence of the basal conglomerate - sandstone unit of the Last Creek formation. They also differ in their stratigraphic relationships, as they rest directly above the Hurley Formation, whereas the Last Creek formation was deposited above shallow-marine equivalents of the Tyaughton Group. The contact between the Hurley Formation and Junction Creek unit is not well defined, but is drawn to coincide with an abrupt decrease in the amount of sandstone and coarser rocks, which are characteristic of the rocks known to be Triassic in age but very uncommon higher in the section. There is no indication of an angular discordance between the Hurley Formation and Junction Creek unit, but the age control is not sufficient to preclude there being a significant disconformity between the Triassic and Jurassic rocks.

The Junction Creek Unit consists mainly of interbedded, dark grey, siliceous, well-indurated siltstone and argillite (Photo 19). Individual beds are mainly less than 15 centimetres thick; siltstone beds are commonly laminated and crosslaminated, and are locally graded. Medium to thick beds of limestone and calcareous sandstone are scattered sparsely throughout the section. Limestone beds are medium to dark grey, buff to brown weathering, commonly silty, and generally laminated to crosslaminated (Photo 20). Medium to coarse-grained calcareous sandstone beds are 40 to 70 centimetres thick, medium grey, brown-weathering, and locally graded. Some sandstone beds contain small limestone pebbles and volcanic rock fragments.

TYAUGHTON BASIN

RELAY MOUNTAIN GROUP

Middle Jurassic to Lower Cretaceous clastic sedimentary rocks now assigned to the Relay Mountain Group were included in the Eldorado Series by Dolmage (1929) and the Eldorado Group by Cairnes (1943) and Tipper (1963). This followed the work of Drysdale (1916) and McCann (1922), who introduced the term Eldorado Series for presumed Lower Cretaceous rocks exposed along Eldorado Creek and near Eldorado Mountain. Because rocks in the type area of the Eldorado Series were later found to be Triassic and late Early Cretaceous in age, Jeletzky and Tipper (1968) discontinued use of the term and proposed the name Relay Mountain Group for the uppermost Middle Jurassic to Lower Cretaceous (Neocomian) rocks of the Tyaughton basin. They chose the well-exposed sections on the northeastern and northwestern slopes of Teepee Mountain as the type area of the group (Sections 11 to 15 of Jeletzky and Tipper, 1968). Jeletzky and Tipper recognized 19 fossil zones within the Relay Mountain Group, but did not subdivide it into formal lithologic subdivisions because of its lithologic monotony, the lack of persistent markers, and the presence

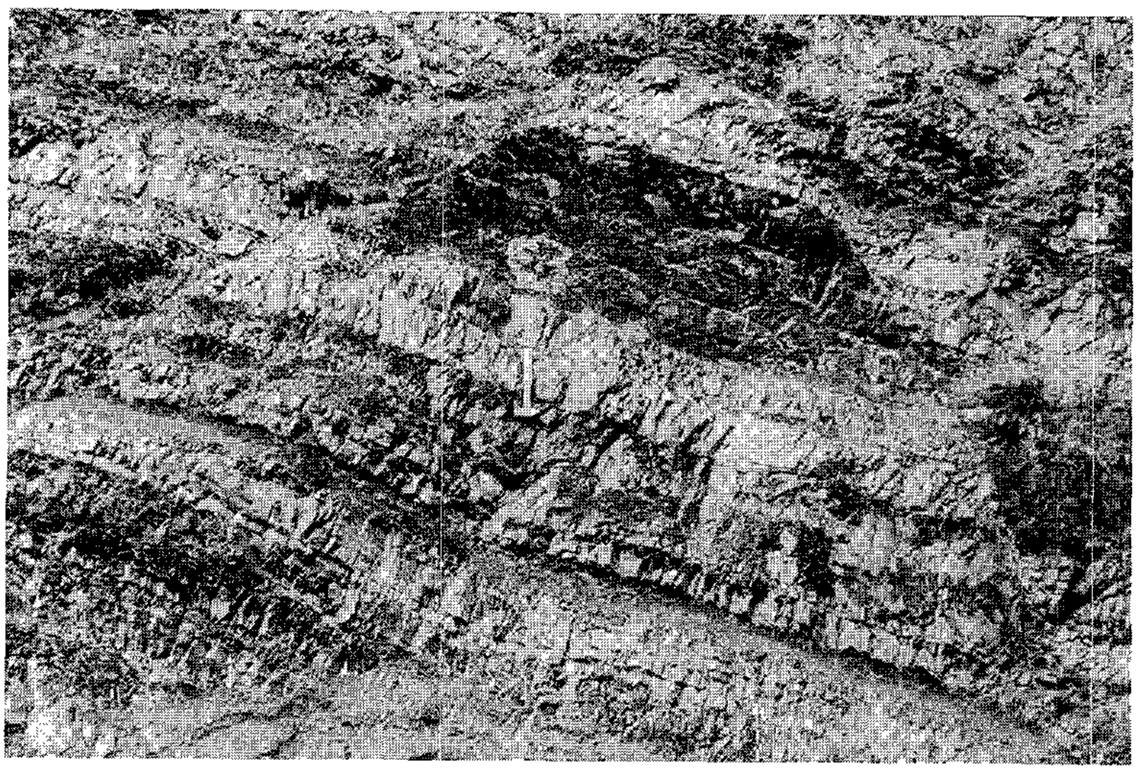

Photo 19. Well-bedded siltstone and argillite of the Junction Creek unit, south of Beaverdam Creek.

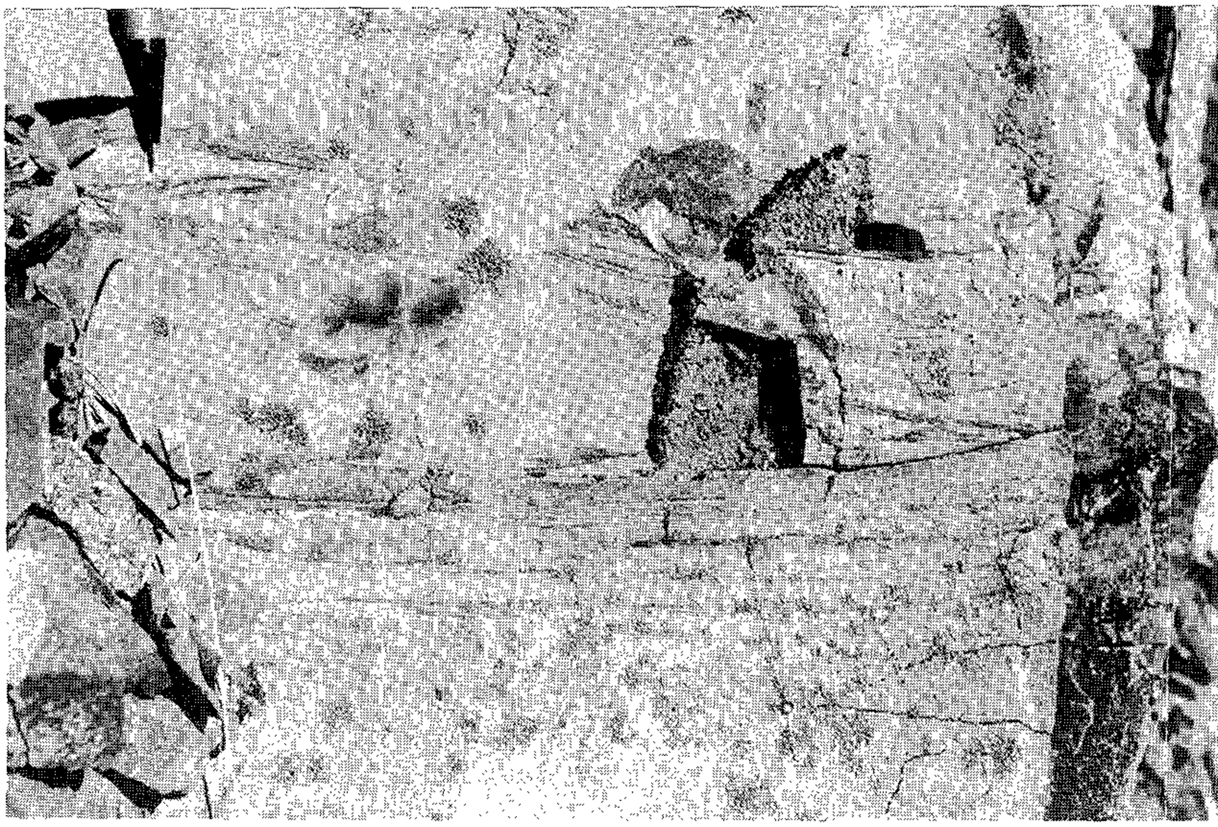

Photo 20. Crosslaminated silty limestone bed, Junction Creek unit, west of Applespring Creek.

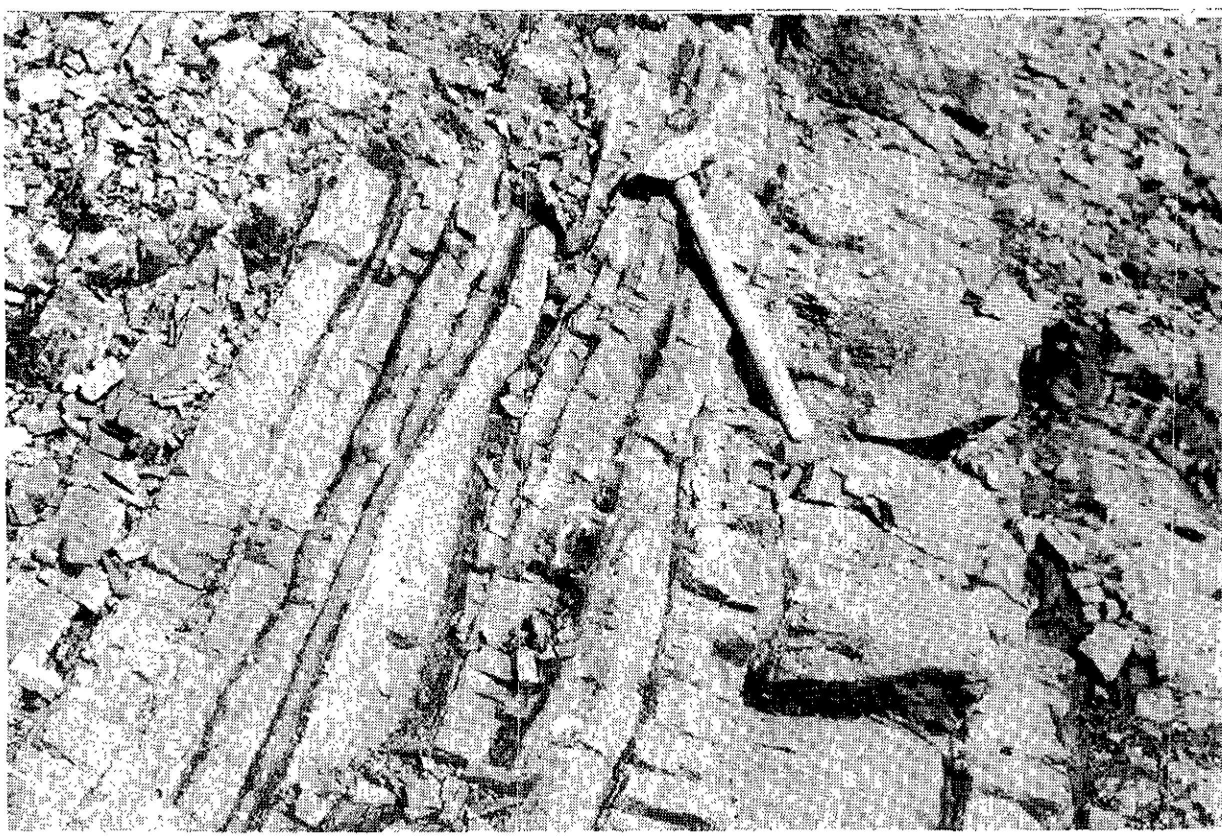

Photo 21. Thin-bedded siltstone and shale of the lower unit of the Relay Mountain Group, 2 kilometres east of Tyoax Pass.

of pronounced and irregular lateral facies changes. They only briefly described the basal unit of the group (their mid-Callovian(?) to lower Oxfordian shale unit), which is not well exposed in the type area of the group. This basal unit was expanded by Tipper (1978) to also include middle Callovian rocks which were described by Frebold and Tipper (1967). This usage is continued here, although this basal unit may include a significant hiatus separating middle Callovian from Oxfordian strata.

The Relay Mountain Group outcrops in several fault-bounded domains extending from near the confluence of Relay and Tyaughton creeks westward to the vicinity of Big Creek (Figure 5). The group is subdivided into three units (Figure 10) following Umhoefer (1989). The lower unit (muJRM1) is dominated by thin to medium-bedded shale, siltstone and sandstone which are commonly disrupted by faults and folds to a greater extent than younger components of the group. The base of this succession, which has yielded fossils of middle Callovian and early Oxfordian age, is not exposed. The middle Relay Mountain Group (JKRM2) consists of upper Oxfordian to Valanginian sandstones and siltstones that commonly contain the bivalve *Buchia* as a distinctive element. These rocks typically overlie the lower unit of the group across an abrupt conformable or disconformable contact. The upper unit (lKRM3) is a thick sequence of Hauterivian (and younger?) shale, siltstone and minor sandstone that commonly contains scattered fragments of *Inoceramus* shells. This unit generally displays an abrupt conformable to disconformable contact with the middle unit of the group, but locally rests directly above the lower unit across an angular unconformity.

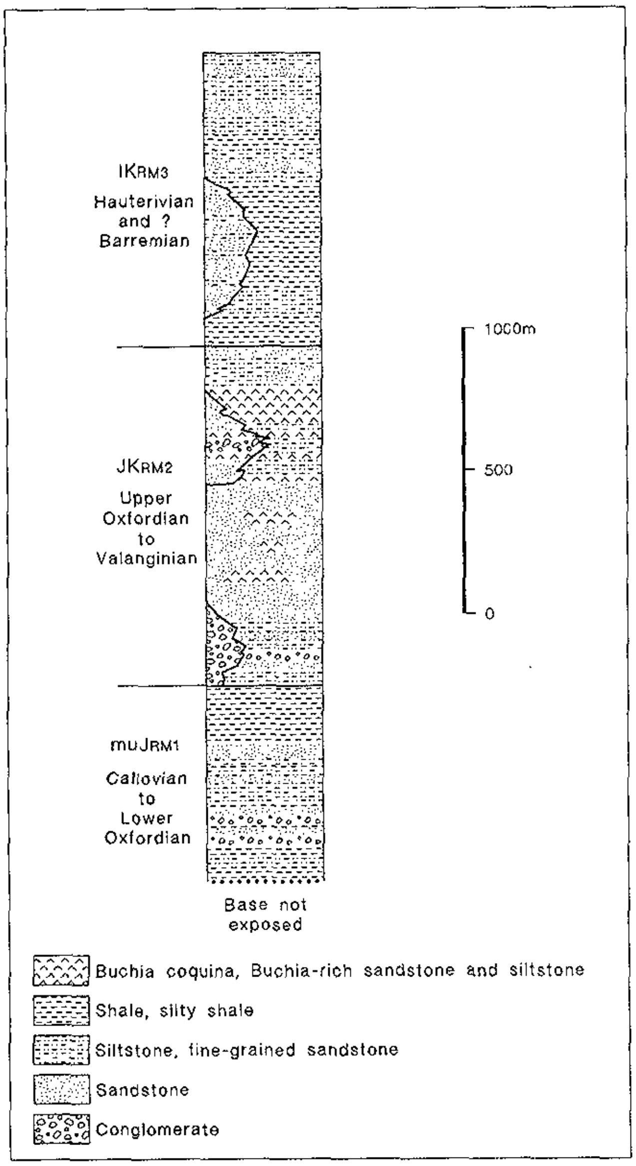

Figure 10. Composite stratigraphic section of the Relay Mountain Group, after Umhoefer (1989).

LOWER UNIT (muJRM1)

The lower unit of the Relay Mountain Group includes lower Oxfordian and(?) older rocks described by Jeletzky and Tipper (1968) as their mid-Callovian(?) to lower Oxfordian shale unit, as well as middle Callovian rocks briefly described by Frebold and Tipper (1967). The unit does not occur within Jeletzky and Tipper's type section of the group, although it may be partly represented by a fault-bounded sliver of shale and siltstone (too small to be shown on Figure 3) that bounds the base of the type section along the Relay Creek fault (Umhoefer *et al.*, 1988; Schiarizza *et al.*, 1993c). The unit is well exposed, however, in a belt that extends from Lizard Creek northwestward to Lorna Lake, and in an adjacent belt extending from near Elbow Mountain eastward to the head of Paradise Creek. It also outcrops as narrow slivers along the Relay Creek and Fortress Ridge faults, and in the core of an anticline exposed on the ridge between Leckie and Gun creeks (Figure 3).

Unit muJRM1 consists mainly of shale, siltstone and fine-grained sandstone, with local beds of coarser grained sandstone and granule to pebble conglomerate. Rare intervals of siliceous argillite are also present, as are metre-thick intervals of thin-bedded clastic limestone. The unit is characterized by rusty weathered, green to brown siltstone and fine-grained sandstone, which occur as thin beds rhythmically interbedded with dark grey shale (Photo 21). The beds are commonly graded and locally have ripple or contorted laminae in the upper parts. Thicker beds of medium-bedded, fine to coarse-grained sandstone, calcareous sandstone and calcarenite occur locally within the finer grained rocks. They are commonly graded, with massive bases and parallel-laminated tops. Wood fragments are present in some sandstone beds, and the top parts of some beds contain *Chondrites* trace fossils.

Granule to pebble conglomerate interbedded with medium to coarse-grained sandstone occurs locally as packages 10 to 25 metres thick within the lower Relay Mountain Group. Conglomerate beds are broadly lenticular at the base, graded, and poorly to moderately sorted. The conglomerates typically contain moderately well rounded clasts of felsic to intermediate volcanic rocks together with limestone clasts and belemnite fragments. Rounded clasts of sandstone, siltstone and chert(?) are common in some conglomerate units.

A distinctive lithofacies that is apparently restricted to the upper (lower Oxfordian) part of the lower Relay Mountain Group consists mainly of black siltstone and shale containing intervals with abundant rusty weathered siliceous concretions 1 to 3 centimetres in diameter. Interbedded with these rocks are thin beds of tan-weathering calcareous siltstone and, less commonly, medium to thick beds of brown-weathering medium to coarse-grained calcareous sandstone. The sandstone beds are pebbly, massive at the base and laminated at the top, and contain abundant mudstone rip-ups.

A single fossil locality discovered within Unit lmJRM1 during the present study contains ammonites of probable Callovian or Oxfordian age (Appendix 3, Samples 86PS-44-5-2 to 86PS-44-5-5). This is consistent with previous studies which have established that the unit contains fossils of middle Callovian and early Oxfordian age (Frebold and Tipper, 1967; Tipper and Jeletzky, 1968). It may extend into the lower Callovian, if an ammonite of probable early Callovian age collected from Tyaughton Creek, above the junction with Spruce Lake Creek (Appendix 4), also belongs to the unit. However, because no well-defined sections of the unit are known and the base is nowhere exposed, its full age range is not known. Furthermore, as no late Callovian ammonites have been found, it is not known whether the middle Callovian and lower Oxfordian rocks included in the unit are part of a continuous section, or are separated by an unconformity or disconformity.

MIDDLE UNIT (JKRM2)

The middle Relay Mountain Group (upper Oxfordian to Valanginian) is characterized by shallow marine sandstones and siltstones that are massive to thick-bedded and display few good sedimentary structures. *Buchia* pelecypods are common throughout the unit and allow detailed biostratigraphic correlation of different sections, many of which are described in detail by Jeletzky and Tipper (1968). A complete, unfaulted section of the unit occurs on the north flank of Teepee Mountain, where it occupies the north limb of the Teepee Mountain syncline (Figure 3). This section is part of the most extensive belt of exposures of the unit, which extends from Teepee, Relay and Cardtable mountains southeastward to the confluence of Relay and Tyaughton creeks. Parts of the unit are also well exposed to the west, near Elbow Mountain, but there it is extensively imbricated by mid-Cretaceous thrust faults of the Elbow Mountain thrust belt (*see* Chapter 3). An apparently complete section of the unit also occurs within a belt that extends from Lizard Creek southeastward to Leckie Creek. It is not well exposed within much of this belt, however, and has not been studied in detail. More limited exposures occur along Fortress Ridge (mainly Jurassic rocks), as narrow fault-bounded lenses along portions of the Relay Creek and northern Castle Pass fault systems, and as isolated inliers beneath the Tosh Creek succession and Miocene plateau basalts north of Tosh Creek.

The following general description of the middle Relay Mountain Group is based largely on the detailed biostratigraphic studies of Jeletzky and Tipper (1968) combined with the detailed mapping of Umhoefer (1989; Umhoefer *et al.*, 1988).

The lower (upper Oxfordian to lower Kimmeridgian) part of the middle Relay Mountain Group consists of siltstone, sandstone and conglomerate. The siltstone and sandstone are typically massive, possibly due to complete reworking of primary structures by bioturbation. Hummocky cross-stratification is locally present in sandstone, but is not common. Decimetre-scale beds of calcareous siltstone to fine-grained sandstone with ripple and planar laminae are interbedded with massive siltstone throughout much of the section. They display discrete burrows, but are not as thoroughly reworked by bioturbation as the enclosing rocks. These beds commonly contain wood debris and *Buchia*, and are interpreted to be storm-generated deposits (Umhoefer, 1989). Pebble conglomerates are a relatively minor component of this part of the section in the Relay Mountain and Elbow Mountain areas, where they form lenticular bodies, up to 50 centimetres thick, composed of moderately well rounded clasts of volcanic and plutonic rocks, commonly accompanied by belemnite fragments. On the ridge between Gun and Leckie creek's, however, conglomerate dominates a section about 200 metres thick within rocks of apparently the same age (Appendix 3, Sample 88APS-PUM-8-1-1) on the west limb of an anticline cored by Unit muJRM1. The conglomerates are massive to thick bedded, predominantly clast-supported, and consist of rounded cobbles and pebbles of mainly tonalitic to granodioritic plutonic rocks and felsic to intermediate volcanic rocks.

The middle Kimmeridgian to middle Tithonian part of the Relay Mountain Group consists of thick-bedded sandstones, locally intercalated with lesser amounts of siltstone. The sandstones are grey to brown and red-brown weathering. Where bedding is seen, it is a few decimetres thick and planar to broadly lenticular. Sedimentary structures are uncommon, but include trough and tabular crossbedding. Pebble stringers and sandy small-pebble conglomerates occur locally. Woody debris occurs throughout much of this part of the section; the largest fragment observed was a log more than 1 metre long and 15 centimetres in diameter. *Buchia* and belemnites are scattered sparsely throughout the interval.

Upper Tithonian to middle Berriasian rocks are mainly siltstones and shales containing calcareous concretions. Near Elbow Mountain, however, a contrasting facies of sandstones and pebble conglomerates is exposed. These rocks are similar to the underlying sandstone-rich unit, but commonly contain abundant *Buchia*-rich intervals.

The upper Berriasian to middle Valanginian part of the group contains distinctive beds of white-weathering *Buchia* coquina with siltstone matrix in the east, and *Buchia*-rich sandstone and siltstone to the west. The coquina beds (Photo 22) range from decimetre-scale units interbedded with sandstone or siltstone to a layer of coquina that is 45 metres thick in the type area. The *Buchia*-rich beds are locally lenticular, but may be continuous for tens or hundreds of metres.

The coquina beds of the middle Relay Mountain Group are generally overlain by upper Valanginian siltstone and sandstone containing local *Buchia*-rich beds. These in turn are abruptly overlain by Hauterivian shales of the upper Relay Mountain Group.

Photo 22. Valanginian Buchia coquina, middle unit of the Relay Mountain Group, north of Relay Mountain.

UPPER UNIT (lKRM3)

The upper unit of the Relay Mountain Group is dominated by black to dark brown shales, but locally includes coarser grained rocks on the southwestern side of the map area. Fragments of inoceramid bivalves are scattered throughout the unit, mainly in sandstone layers and calcareous concretions, and belemnites and wood fragments are also present. This unit is well exposed in the core of the Teepee Mountain syncline, where it comprises part of Jeletzky and Tipper's type section of the Relay Mountain Group, as well as in a narrow belt to the south which has been traced for 8 kilometres east of Relay and Cardtable mountains. It also outcrops within 3 separate fault-bounded belts between Elbow Mountain and Lorna Lake, and as part of the continuous belt of Relay Mountain Group rocks that extends from Lizard Creek southeastward to Leckie Creek, where it is truncated by the Late Cretaceous Dickson - McClure batholith (Figure 3).

In the Teepee Mountain and Cardtable Mountain areas, the upper Relay Mountain Group consists of lower and middle Hauterivian shales and siltstones, with only minor amounts of intercalated sandstone. Near Elbow Mountain the oldest dated rocks are middle Hauterivian shales and siltstones. These are overlain by an interval, locally more than 100 metres thick, consisting largely of fine to coarse-grained sandstone, gritty sandstone and pebble conglomerate dominated by clasts of siltstone and shale, which is in turn overlain by poorly dated shales and siltstones of possible upper Hauterivian to Barremian age (Jeletzky and Tipper, 1968). The unit is not well exposed in the belt that extends from Lizard Creek to Leckie Creek, but the outcrops present are also dominated by dark shales and siltstones. West of Spruce Lake, however, the basal 100 metres of the section is mainly massive, fine to medium-grained lithic sandstone (Jeletzky and Tipper, 1968).

PROVENANCE

This summary of the provenance of the Relay Mountain Group is based on data presented by Umhoefer (1989) who point-counted 43 sandstone thin sections and conducted 20 pebble counts on conglomerates.

Callovian sandstones from the lower unit of the group are dominated by subequal proportions of volcanic lithic grains and feldspar, generally accompanied by only minor proportion of volcanic quartz. The volcanic provenance indicated by the sandstones is confirmed by the compositions of Callovian conglomerates, which consist almost entirely of felsic to intermediate volcanic clasts with a minor component of limestone. In contrast, lower Oxfordian sandstones from the upper part of the lower unit are arkoses, dominated by plagioclase accompanied by significant proportions of polycrystalline plutonic lithic grains and plutonic quartz. This change in composition signifies an abrupt change from a volcanic to a dominantly plutonic source in Early Oxfordian time.

Sandstones throughout the entire overlying section, represented by the middle and upper units of the Relay Mountain Group, are of relatively uniform composition indicating derivation from a mixed volcanic - plutonic source. They are dominated by feldspar and volcanic lithic grains, but also include significant proportions of volcanic and plutonic quartz and polycrystalline plutonic grains; biotite, epidote and hornblende are commonly present in small quantities. The compositions of conglomerates from Oxfordian through Hauterivian rocks within the Relay Mountain succession reflects a similar mixed provenance. They are dominated by volcanic clasts, but also contain a significant percentage of granitoid plutonic clasts, and fewer sedimentary and metamorphic clasts.

When plotted on the Q-F-L and Qm-F-Lt diagrams of Dickinson *et al.* (1983), the Relay Mountain sandstones fall within the "magmatic arc" provenance terrane and span the entire range from undissected arc to dissected arc (Umhoefer, 1989). This spread of individual sample points is similar to patterns found in many forearc and backarc basins (Dickinson and Suzcek, 1979; Dickinson *et al.*, 1983). The one exception within the Relay Mountain suite are the Lower Oxfordian arkoses, which plot in the basement uplift field of the "continental block" provenance terrane.

INTERNAL AND EXTERNAL RELATIONSHIPS

The stratigraphic contact between the lower and middle units of the Relay Mountain Group is exposed or closely constrained at several places in the Elbow Mountain area as well as on both limbs of the anticline exposed between Gun and Leckie creeks. There is no indication of an angular discordance in any of these areas, although the contact is abrupt, and in the Elbow Mountain area is commonly defined by a pebble conglomerate unit containing abundant belemnite fragments. The turbidites and related deposits of the lower unit are interpreted by Umhoefer (1989) to represent a prograding delta, whereas the middle unit represents a subsequent period of relatively uniform shallow-marine deposition that persisted for about 30 million years. The contact between the middle and upper units of the group is exposed in the vicinity of Teepee, Relay and Cardtable mountains and on the slopes west of Spruce Lake. This contact is sharp but apparently conformable wherever it was observed, although Jeletzky and Tipper (1968) suggest that the top of the middle unit may have locally undergone some pre-Hauterivian erosion based on an abrupt thinning of the uppermost Valanginian faunal zone. Umhoefer (1989) suggests that the shales and siltstones of the upper unit are outer shelf to slope deposits that accumulated during a period of renewed subsidence and increased sedimentation rates following the long period of stable conditions represented by the middle unit.

In a small area east of Lorna Lake the middle unit of the Relay Mountain Group is missing and Hauterivian shales of the upper unit rest directly above the Callovian strata of the lower unit across an angular unconformity (Figure 3). The lower unit is strongly deformed by mesoscopic folds and faults in this entire belt, which extends from Lizard Creek northwestward to the west side of Lorna Lake. These relationships may reflect a pulse of pre-Hauterivian deformation that was concentrated in this relatively small area (*see* Chapter 3). However, it is worthy of note that parts of Unit muJRM1 also seem to be more strongly deformed than younger units of the group in its other major outcrop belt, east of Elbow Mountain, where it is stratigraphically overlain by unit JKRM2. This raises the possibility that at least some of the deformation within the basal unit of the group predates deposition of the middle unit. The apparently conformable or disconformable nature of the lower/middle contact does not support an angular unconformity at this boundary, but the apparent hiatus between middle Callovian and lower Oxfordian rocks of the lower unit suggests that and unconformity may actually occur <u>within</u> the lower unit of the group. The abrupt change of provenance recorded between the Callovian and Lower Oxfordian rocks of the lower unit lend some support to this speculated tectonic event.

The stratigraphic base of the Relay Mountain Group is nowhere exposed but, as will be discussed below, it is interpreted to have been deposited above the Bridge River Complex. The stratigraphic top of the group is most commonly defined by the base of the overlying Taylor Creek Group, which comprises the upper part of the Tyaughton basin. The westernmost exposures of middle unit of the Relay Mountain Group, however, are overlain by the Tosh Creek succession, which may be a volcaniclastic facies of the upper unit of the group, or may correlate with the lower part of the Taylor Creek Group.

Direct evidence that the upper part of the Tyaughton basin was deposited upon the Bridge River Complex comes from the southern margin of the basin, where the mid-Cretaceous Taylor Creek Group unconformably overlies the Bridge River Complex near the headwaters of Taylor and North Cinnabar creeks (Figure 3; Garver, 1989). The thin mid-Cretaceous section in this area passes northward into a thicker section that overlies the Relay Mountain Group. Evidence that this entire thick Jura-Cretaceous section (Relay Mountain Group + Taylor Creek Group) also overlies the Bridge River Complex comes from a local fault-bounded zone of uplift within the Tyaughton basin belt, along the Relay Creek fault system. There, a lens of Bridge River Complex is flanked by thin slivers of Jurassic Relay Mountain Group then extensive belts of mid-Cretaceous rocks to the northeast and southwest. Furthermore, these exposures of Tyaughton basin strata (mainly mid-Cretaceous rocks, but with local exposures of Relay Mountain Group) extend continuously along the southwest side of the Yalakom fault for 80 kilometres to Chilko Lake, where they are bounded to the north by a fault bounded panel of Bridge River Complex (Riddell *et al.*, 1993), suggesting that the Bridge River Complex underlies the full length of this Tyaughton basin belt. These relationships suggest that the present southern margin of the Tyaughton basin belt in the Taseko - Bridge River area corresponds to the mid-Cretaceous margin of the basin (*i.e.* the Taylor Creek basin), which was defined by a mid-Cretaceous zone of uplift that exhumed both the older part of the basin, represented by the Relay Mountain Group, and the underlying Bridge River Complex (Figure 11). The Relay Mountain Group was presumably removed by erosion along the mid-Cretaceous basin edge in the North Cinnabar Creek area, but is present in the more distal parts of the basin to the north. The Cayoosh assemblage, which overlies the Bridge River Complex farther south, may represent the

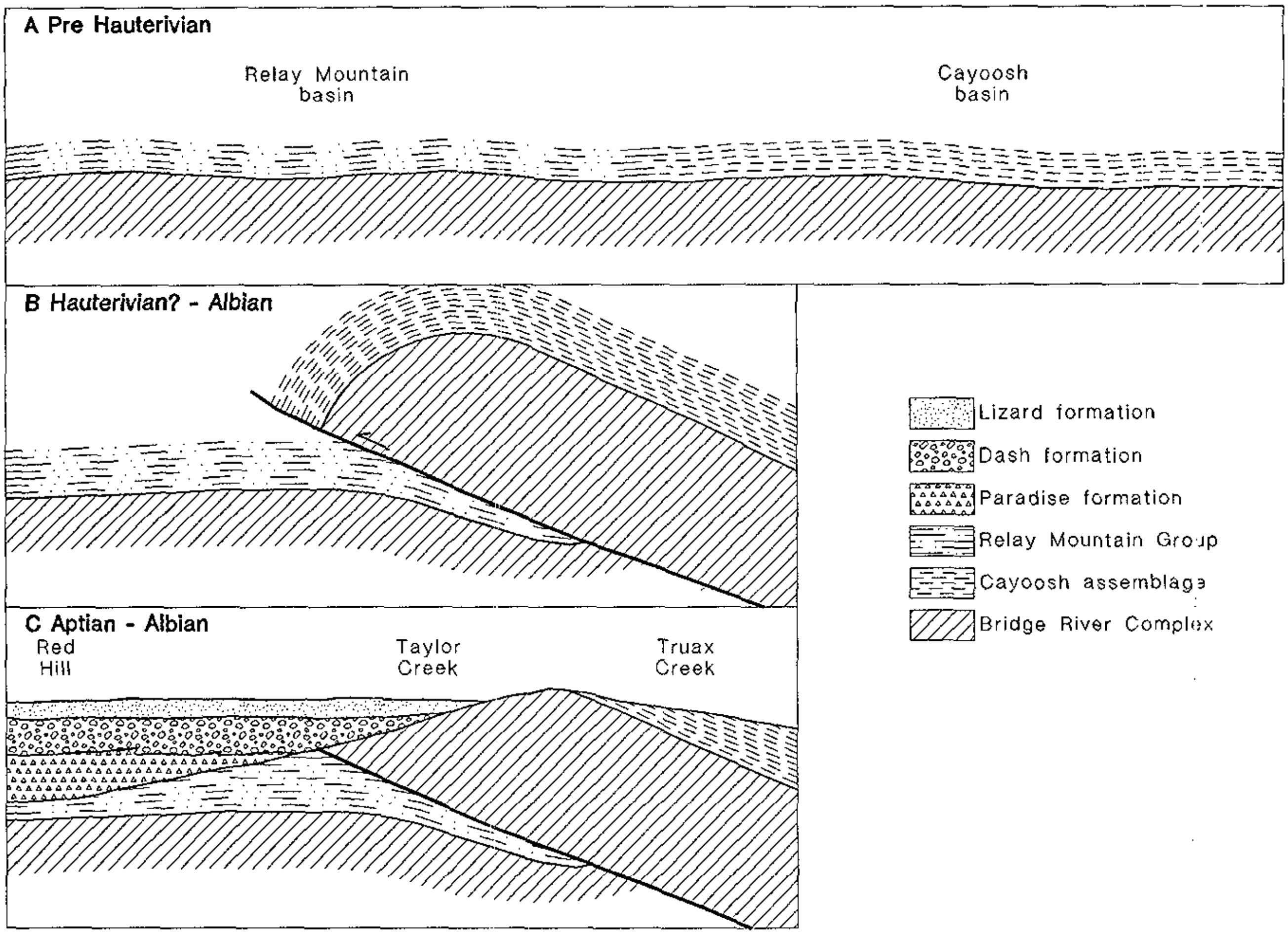

Figure 11. Schematic model for the evolution of the southern margin of the upper Tyaughton basin (Taylor Creek Group) east of the Castle Pass fault, showing inferred relationship between the older part of the basin (Relay Mountain Group) and the Cayoosh assemblage.

southern extension of the Relay Mountain basin (Figure 11). Within the southern part of theTaseko - Bridge River area, locally preserved remnants of this part of the basin are represented by the Gun Lake Unit, which may correlate with the lower unit of the Relay Mountain Group, and the Truax Creek conglomerate, which correlates with the middle unit of the Relay Mountain Group.

The interpretation that the Bridge River Complex forms the basement to the Relay Mountain Group is also supported by relationships along the northeastern margin of the Late Cretaceous Dickson - McClure batholith north of Downton Lake. There, clastic metasedimentary rocks of the Gun Lake Unit, which stratigraphically overlie the Bridge River Complex, pass northwestward into clastic sedimentary rocks that are clearly part of the Relay Mountain Group. The actual transition between the two clastic packages is obscured by a zone about 1.5 kilometres wide occupied by Quaternary alluvium and Late Cretaceous granodiorite near the mouth of Slim Creek (Figure 3). Although this covered interval makes other interpretations possible (Figure 12), the simplest and most likely interpretation is that the Gun Lake Unit and Relay Mountain Group are part of a single belt that stratigraphically overlies the Bridge River Complex (Figure 12a). This interpretation is consistent with the fact that the two clastic packages are structurally overlain by different parts of the same composite thrust slice of imbricated Cadwallader Terrane and Bralorne-East Liza Complex. Alternatively, however, the Bridge River Complex and overlying Gun Lake clastic unit might be separated from the the Relay Mountain Group by a thrust fault that has been obscured by the Dickson McClure batholith (Figure 12b). Such a thrust fault might be part of the system of faults that defined the southern margin of the Taylor Creek basin, as shown in Figure 11.

Farther to the north, the thrust panel of imbricated Cadwallader Terrane and Bralorne-East Liza Complex that overlies the Gun Lake Unit and Relay Mountain Group near Slim Creek includes the type areas of the Tyaughton Group and Last Creek formation. The well studied Late Triassic to Middle Jurassic successions there are in close proximity to well-studied sections of the Middle Jurassic to Lower Cretaceous Relay Mountain Group in and around its type area. This close spatial relationship has led to a common interpretation that the two packages are part of a single stratigraphic succession. The alternative interpretation presented here is based on data from a much broader area, where imbricated slices of Cadwallader Terrane and Bralorne-East Liza Complex are preserved in several different fault-bounded do-

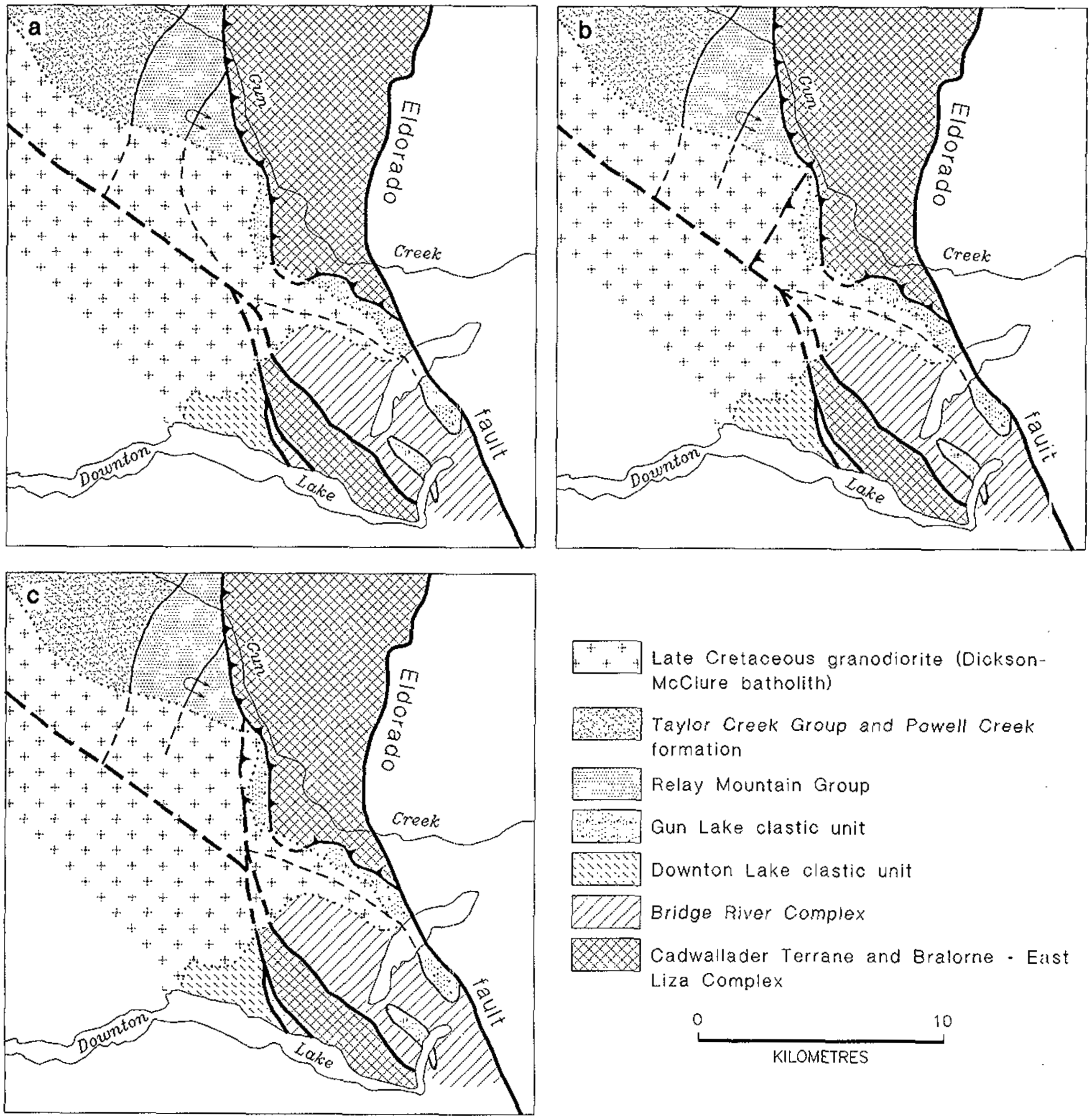

Figure 12. Three possible interpretations of the structural/stratigraphic relationships between Bridge River Terrane and the Relay Mountain Group west of the Eldorado fault. Solid lines show mapped structures and stratigraphic contacts; dashed lines show their possible extensions through the area now occupied by the Late Cretaceous Dickson - McClure batholith.

mains that typically form structurally high panels resting above the Bridge River Complex and/or Tyaughton basin strata. A stratigraphic relationship between these two footwall assemblages is reasonably inferred from the relationships described in the previous two paragraphs, whereas the various slices of Cadwallader Terrane are interpreted to be dismembered parts of a composite thrust stack that was emplaced above the Bridge River Complex and stratigraphically overlying Tyaughton basin during mid-Cretaceous contractional deformation (*see* Chapter 3). However, this does not preclude the possibility that the Relay Mountain Group represents just part of a much broader basin that also overlapped Cadwallader and Methow terranes.

TOSH CREEK SUCCESSION (lKTvs)

The Tosh Creek succession is an undated assemblage consisting mainly of conglomerates containing volcanic and sedimentary clasts, with lesser amounts of volcanic breccia, shale and sandstone. It is best exposed on the north side of Tosh Creek, directly east of Powell Pass. There, it apparently overlies a small inlier of *Buchia*-bearing sandstones and conglomerates of the Relay Mountain Group, although the contact is not exposed. It is in turn overlain by the volcanic unit of the Taylor Creek Group, but locally, as on the south side of Tosh Creek, it is unconformably overlain by the upper Cretaceous Powell Creek formation. Rocks included in the Tosh Creek succession also underlie the Taylor Creek volcanic unit at the southwest end of Cluckata Ridge, and form a narrow fault-bounded sliver between the Relay Mountain Group and Powell Creek formation above Tosh Creek on the south side of the Dil Dil Plateau.

The Tosh Creek succession consists mainly of pebble to boulder conglomerates containing poorly sorted, angular to subrounded clasts of volcanic and sedimentary rock within a sandy matrix (Photo 23). The conglomerates are generally poorly stratified, but locally contain discontinuous intervals of medium to thick-bedded granule to pebble conglomerate. Volcanic clasts predominate. These include green to grey aphyric varieties as well as feldspar porphyry, quartz feldspar porphyry and hornblende feldspar porphyry. Sedimentary clasts are usually present in subordinate quantities and include dark grey shale, siltstone and chert. The fault sliver on the south side of the Dil Dil Plateau locally includes conglomerate consisting mainly of sedimentary clasts, including shale, siltstone, sandstone and rare angular blocks of grey to buff-weathering silty limestone.

Volcanic-rich conglomerates of the Tosh Creek succession locally grade into volcanic breccias comprising angular fragments of volcanic rock in a matrix of volcanic lithic grains and crystals of feldspar and mafic minerals. Well-bedded, dark grey shale and siltstone are relatively minor components of the succession, and locally include thin to medium beds of sandstone and granule conglomerate with volcanic and sedimentary clasts.

The Tosh Creek succession has not yielded fossils, but is thought to be Hauterivian or younger because it appears to rest stratigraphically above the middle unit of the Relay Mountain Group. It may be a lateral equivalent of the upper unit of the Relay Mountain Group as it is lithologically similar to Hauterivian sedimentary and volcanic rocks which outcrop 30 kilometres to the west, between Taseko and Chilko lakes (Tipper, 1978; McLaren, 1990). Further similarity is provided by the stratigraphic position of the Hauterivian rocks to the west, which underlie volcanic and sedimentary rocks that are assigned to the Taylor Creek Group; these Taylor Creek rocks are lithologically similar to the volcanic unit and Beece Creek succession which overlie the Tosh Creek succession within the present study area. An alternative interpretation is that the Tosh Creek succession is Aptian or Albian in age and correlates with the Elbow Pass or Paradise formations of the Taylor Creek Group.

GROUSE CREEK UNIT (JKG)

The Grouse Creek unit comprises Jura-Cretaceous siltstone that crops out in a restricted area along the slopes

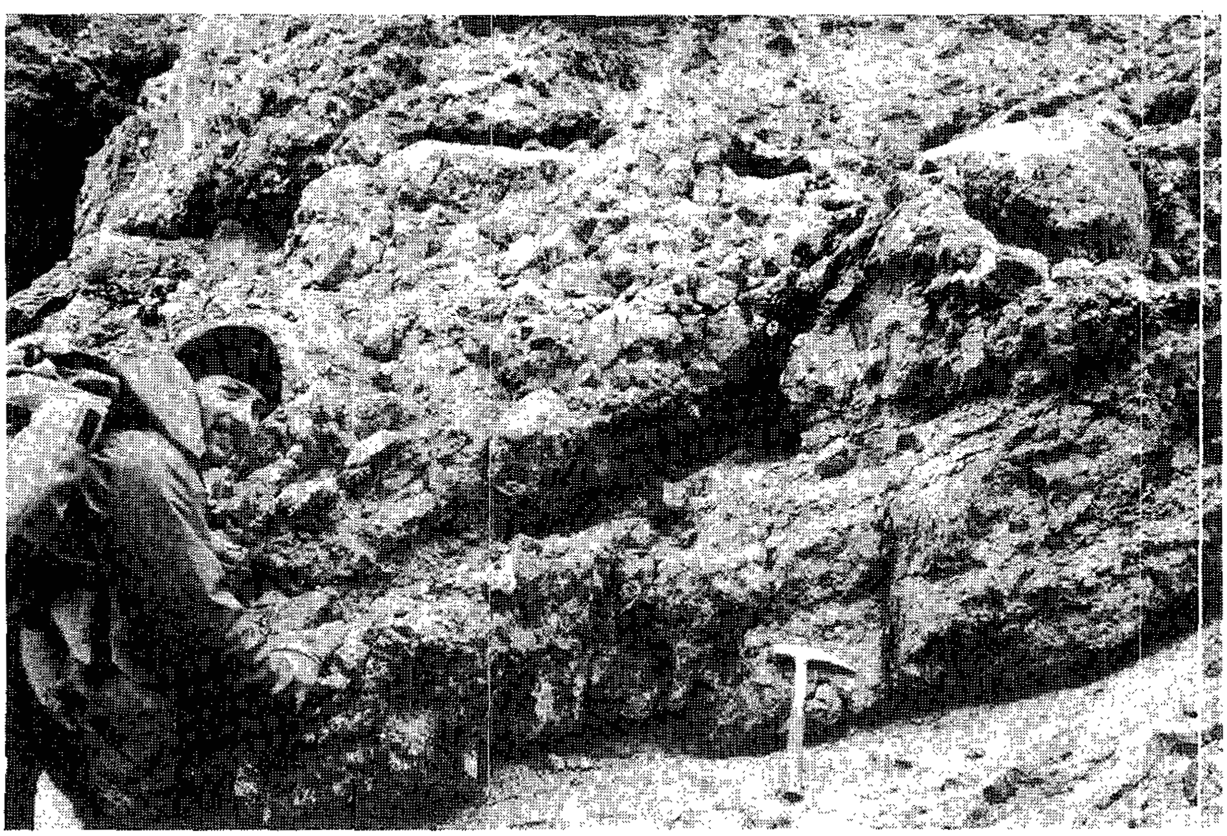

Photo 23. Volcanic conglomerate of the Tosh Creek unit, north of upper Tosh Creek.

northeast of the Yalakom River between Ore and Junction creeks. Lower Cretaceous (Valanginian) *Buchia* were first collected from this unit by Leech (1953). Jeletzky (1967) later measured a short section through unfossiliferous strata in the same general area (*see* Jeletzky and Tipper, 1968, section 18), but his descriptions suggest that he was in underlying rocks of the Hurley Formation and Junction Creek unit. During the present study *Buchia*-bearing siltstone was recognized only along a south-trending ridge due north of the mouth of Shulaps Creek. Coquina within light brown siltstone, apparently very close to Leech's Valanginian fossil locality, yielded *Buchia* of probable latest Jurassic (Tithonian), but possible earliest Cretaceous age (Appendix 3, Sample 89KGL-7-10). The *Buchia*-bearing unit comprises shale and siltstone that may be as much as 250 metres or as little as 100 metres thick. It is underlain, possibly stratigraphically, by siliceous mudstone assigned to the Junction Creek unit. To the northeast, it is structurally overlain, across a northeast-dipping fault, by greenstone of the Bralorne-East Liza Complex. The unit does not appear to extend for a great distance laterally, although it may be more extensive than presently shown on the geological map and be included in rocks assigned to the Junction Creek unit.

Unit JKG is the same age as the middle unit of the Relay Mountain Group, to which it was assigned by Jeletzky (1967) and Schiarizza *et al.* (1990a. b). However, because it occurs on the northeast side of the Yalakom fault, it has been displaced more than 100 kilometres southeastward relative to the exposures of Relay Mountain Group presently across the fault to the northwest. Furthermore, Unit JKG appears to sit stratigraphically above the Junction Creek unit of Cadwallader Terrane, whereas the Relay Mountain Group in inferred to have been deposited on Bridge River Terrane. The *Buchia*-bearing shales and siltstones between Ore and Junction creeks are therefore informally referred to as the Grouse Creek unit [named after the creek that enters the Yalakom River from the Camelsfoot Range almost directly opposite the mouth of Shulaps Creek (Leech, 1953, p. 21); this creek is not named on modern topographic maps]. This neither requires nor precludes their correlation with the Relay Mountain Group; such a correlation, if established, would demonstrate that the Jura-Cretaceous sedimentary rocks are an overlap assemblage above both Bridge River and Cadwallader terranes.

TAYLOR CREEK GROUP

The Taylor Creek Group consists of mid-Cretaceous clastic sedimentary rocks and local volcanic rocks that form the upper part of the Tyaughton basin. Cairnes (1943) introduced the name Taylor Group for these rocks where they outcrop in the vicinity of Taylor Creek and Tyaughton Lake. He did not find any diagnostic fossils within the succession, but suggested that they were probably Middle to Late Jurassic in age. Jeletzky and Tipper (1968) renamed the "Taylor Group" the "Taylor Creek Group" because of the similarity of the original name to the Taylor Marl in Texas. They suggested, on the basis of fossils, that most or all of the group was Albian in age. The map of Tipper (1978) showed the distribution of the Taylor Creek Group, as it was then understood, in the central and northwestern part of the Taseko Bridge River area.

Garver (1989) conducted a detailed study of the Taylor Creek Group between Big Creek and the Shulaps Range. He subdivided the group into 4 informal units, each with distinct compositional and sedimentological characteristics. These units encompass most of the Taylor Creek Group as mapped by Tipper (1978), but also include some rocks that Tipper included in the overlying Kingsvale Group (which is largely equivalent to the Powell Creek formation of this study). Garver also introduced the term Silverquick conglomerate for a distinctive assemblage of nonmarine conglomerates and associated finer grained clastic rocks that overlie the Taylor Creek Group across a slight angular unconformity in the Taylor Creek area. These rocks had been included in the Taylor Group of Cairnes, but had been assigned to the Kingsvale Group by Tipper (1978).

The subdivisions of the Taylor Creek Group and associated rocks of the Silverquick and Powell Creek formations adopted here are shown in Figure 13. The Taylor Creek Group includes the Paradise, Elbow Pass, Dash and Lizard formations of Garver (1989) as well as two other subdivisions, the volcanic unit and Beece Creek succession, which are exposed mainly west of Big Creek. The term Silverquick formation is retained for Garver's Silverquick conglomerate in its type area near Taylor and lower Tyaughton creeks, where it is excluded from the Taylor Creek group on the basis of its nonmarine nature, its unconformable contact with the underlying Lizard formation, and its gradational contact with the overlying Powell Creek formation. However, the Silverquick formation is very similar to the Beece Creek succession of the Taylor Creek Group in both composition and stratigraphic position. The Beece Creek succession is finer grained and distinctly more shale rich than the Silverquick formation, and also differs in that it is conformable with underlying Taylor Creek rocks and is separated from the overlying Powell Creek formation by an angular unconformity. Based on these criteria, rocks that rest gradationally above the Lizard formation in the core of the Red Hill syncline are here included in the Beece Creek succession (Figure 13), although they were mapped as Silverquick conglomerate by Garver (1989). Rocks that Garver assigned to the Silverquick conglomerate in the core of the Prentice Lake syncline (Panlos Creek section of Figure 13) are also included in the Beece Creek succession, as they appear to be part of a continuous belt that extends to the west side of Big Creek, where it is unconformably overlain by the Powell Creek formation (Riddell *et al.*, 1993a,b). These different interpretations are not of major significance, however, as the similarity in composition and stratigraphic position suggest that the Silverquick formation and Beece Creek succession are lateral equivalents that were deposited in different parts of the synorogenic upper Tyaughton basin.

PARADISE FORMATION (lKTCP)

The Paradise formation (Garver, 1989) is the basal unit of the Taylor Creek Group in the Relay Mountain area. (Red Hill section of Figure 13). It outcrops in a restricted area that extends from Cardtable Mountain northwestward to upper Relay Creek, where it occupies several northwest trending

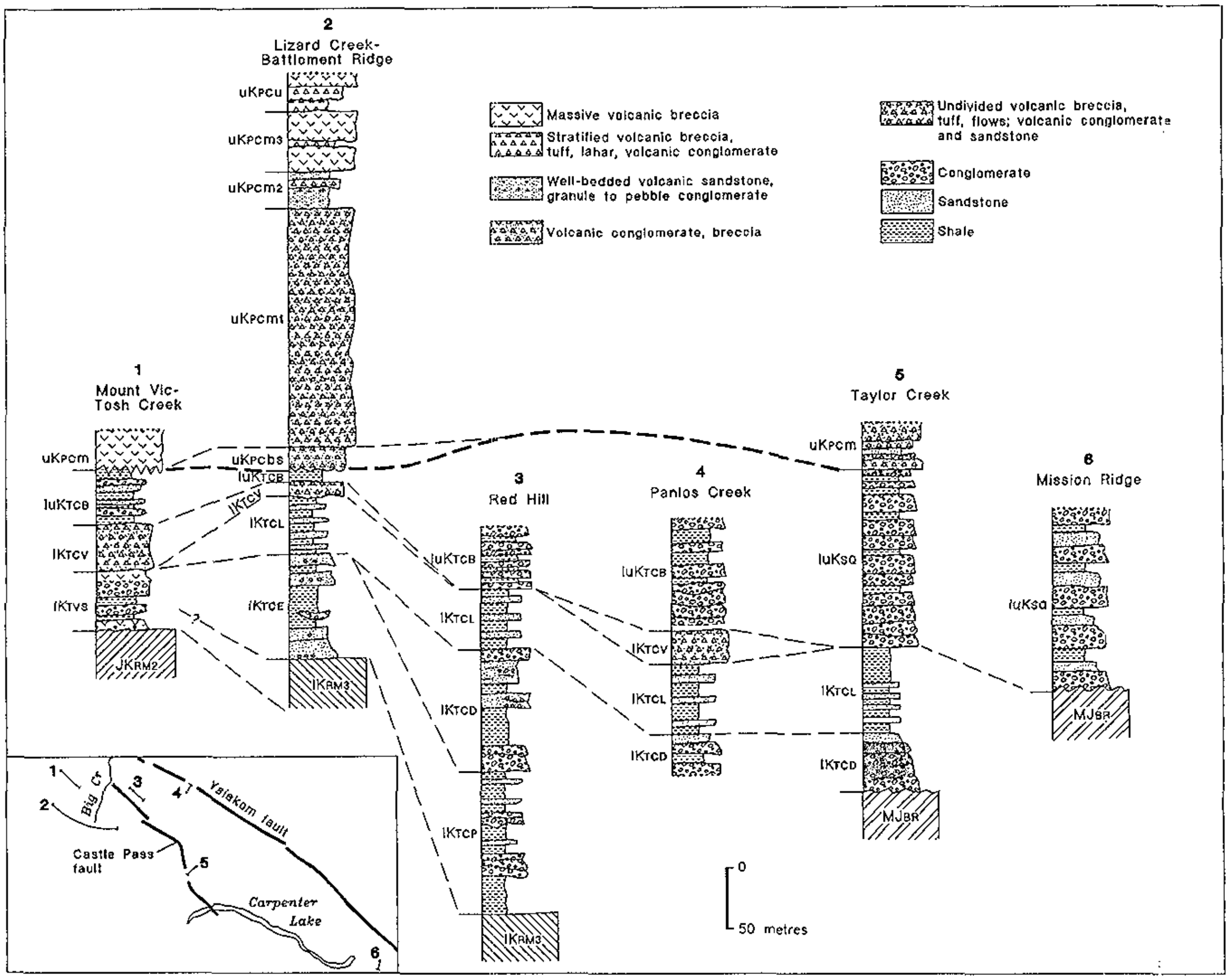

Figure 13. Generalized stratigraphic sections and relationships of the Taylor Creek Group, Silverquick formation and Powell Creek formation. Heavy line separates the Powell Creek formation from the underlying Taylor Creek Group and Silverquick formation. Sections 3, 4 and 5 are after Garver (1989, 1992). Map unit codes are the same as in Figure 3.

fault panels that cross the upper reaches of Paradise Creek. The type section is on the southern flanks of Relay Mountain, where over 900 metres of continuous section is exposed. The stratigraphic base of the Paradise formation is not exposed. It is inferred to have been deposited above the Relay Mountain Group because the two successions are presently interleaved across a series of high angle faults, and conglomerates of the Paradise formation locally contain fossiliferous clasts derived from the Relay Mountain Group (Appendix 3, Samples 86JG-12, 86JG-31, 86JG-87B and 86JG-317A).

The Paradise formation comprises about 80 per cent shale with interbedded sandstone, and about 20 per cent lenticular units of thick-bedded volcanic-pebble conglomerate (Photo 24). Fine-grained facies include friable, black to grey, laminated shale and interbedded thin-bedded sandstone (Photo 25). The sandstone beds have sharp bases and Tce Bouma sequences. A few medium to thick-bedded sandstone beds with complete Bouma sequences (Tabce) and convolute bedding are also present. Sections devoid of interbedded sandstone locally contain units characterized by tan-weathering concretions 15 to 35 centimetres long.

Conglomerate of the Paradise formation occurs in packages 50 to 200 metres thick that generally become finer grained and thinner bedded upwards. Conglomerates that are well exposed south of Relay Mountain appear to pinch out laterally over a distance of several kilometres, suggesting that they are lenticular on a large scale. Most individual conglomerate beds are 1 to 7 metres thick and lenticular over hundreds of metres. They are typically normally graded, clast supported, and contain moderately well rounded pebbles and cobbles. Also present are beds of inverse to normally graded, poorly-sorted, clast-supported cobble to boulder conglomerates 2 to 5 metres thick. A few beds 3 to 7 metres thick are very poorly sorted, matrix-supported, normally-graded cobble to boulder conglomerates that pass upward into matrix-supported pebble conglomerate. Interbedded with these various conglomerate facies are me-

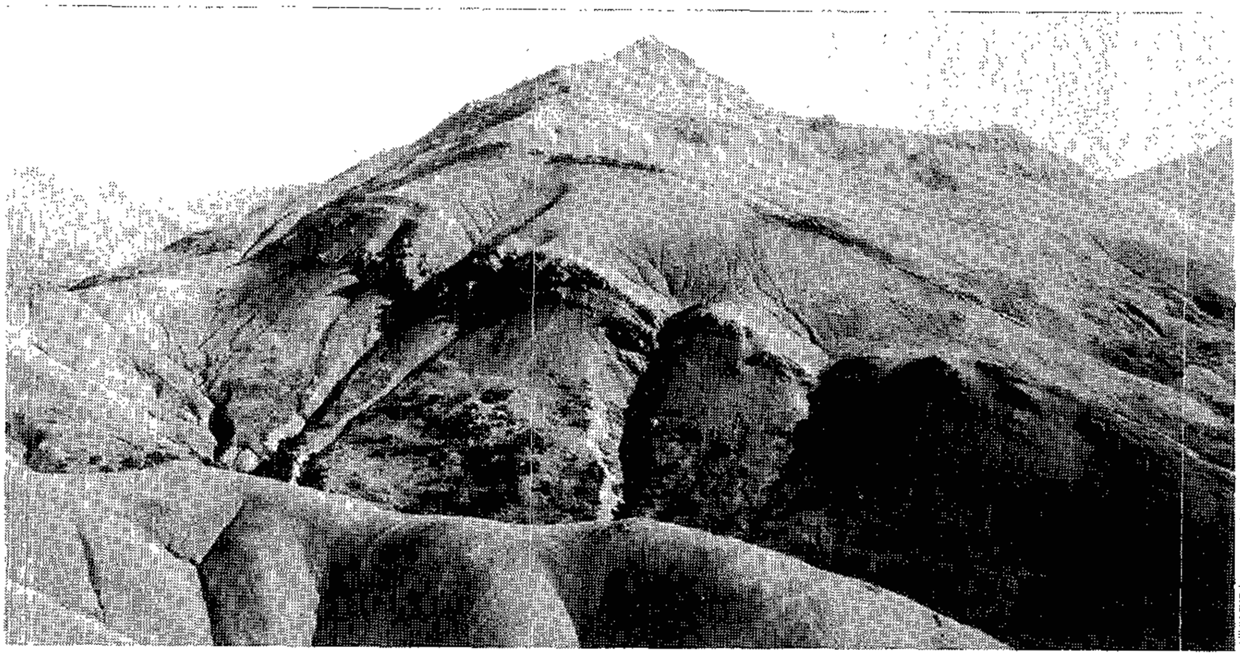

Photo 24. Resistant conglomerate ribs within recessive shales and sandstones of the Paradise formation, south flank of Relay Mountain. The mountain is capped by Neogene basalt flows of the Chilcotin Group.

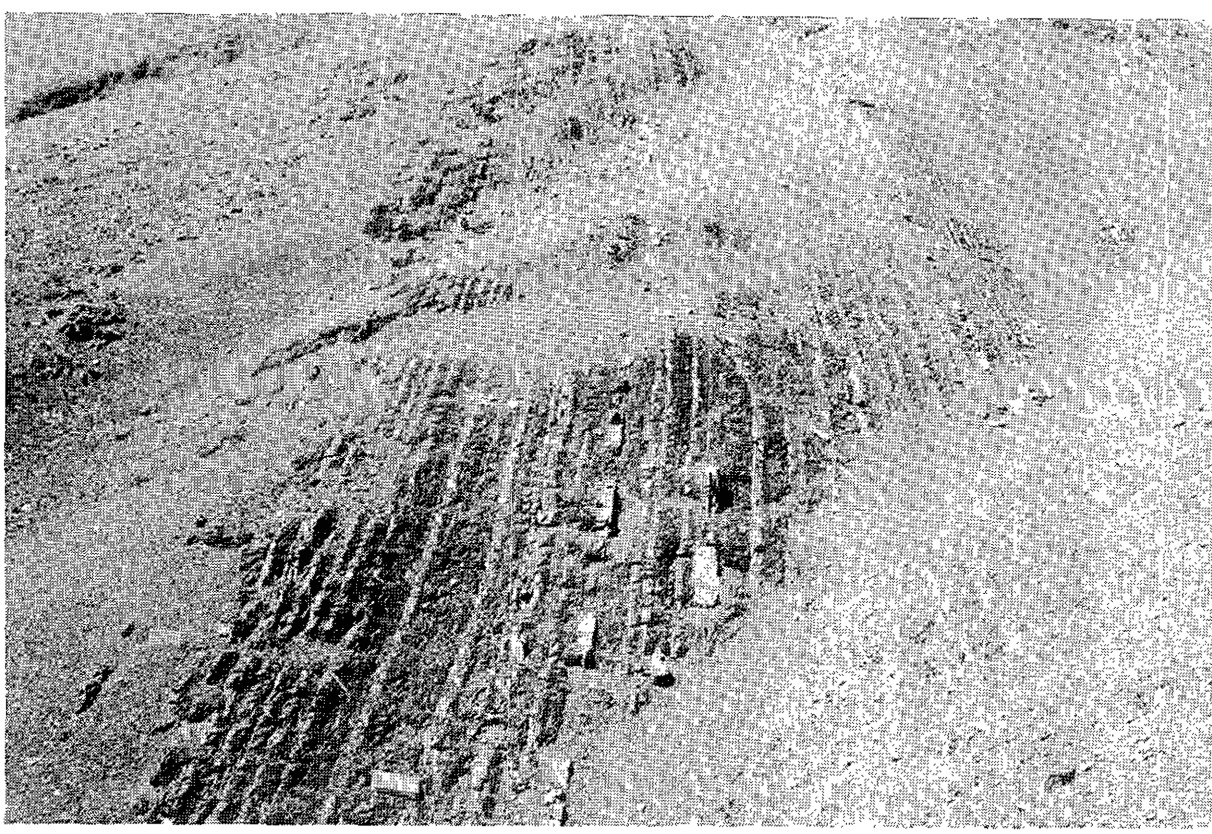

Photo 25. Thin-bedded shales and sandstones of the Paradise formation, south of Relay Mountain.

dium to thick-bedded, coarse-grained amalgamated sandstone beds (Taa and Tbe) which typically occur in thinning-upward sequences. Convolute laminations, mudstone rip-up clasts, and slump folds are common.

The sandstones within the Paradise formation are volcanic arkoses dominated by volcanic lithic grains and plagioclase. Conglomerates consist mainly of intermediate to felsic volcanic and metavolcanic clasts, but include clasts of sandstone, siltstone, argillite and limestone, as well as minor amounts of tonalitic to dioritic plutonic clasts. Paleocurrent indicators are sparse, but suggest that transport was to the east and southeast (Garver, 1989). Garver suggests that the formation was deposited as a submarine fan derived from a volcanic pile to the west, with sedimentary, plutonic and metamorphic rocks as a substrate to the volcanic centres.

The Paradise formation probably rests disconformably above the upper unit of the Relay Mountain Group, of Hauterivian to Barremian(?) age, and is in turn overlain gradationally by the middle Albian Dash formation. The Paradise formation itself is not well dated paleontologically, although an ammonite collected from its upper part northwest of Relay Mountain has been tentatively assigned an Albian age (Appendix 3, Sample 86-JG-16). The youngest fission-track peak date of 113±6.5 Ma from detrital zircon reported by Garver and Brandon (1994) suggests an Aptian to early Albian depositional age, which is consistent with the presently known stratigraphic and paleontologic constraints.

ELBOW PASS FORMATION (lKTCE)

The Elbow Pass formation (Garver, 1989) consists of interbedded sandstone, conglomerate and shale that is well exposed south of Elbow Pass, in the Elbow Mountain thrust belt, where it occupies a syncline beneath overthrust Relay Mountain Group. It also outcrops in a belt that extends from Lizard Creek southeastward to the east end of the Mount Sheba ridge system, but it is not sufficiently well-exposed there to be mapped separately, and so is included in the general map unit luKTC. The Elbow Pass formation is the basal unit of the Taylor Creek Group in both these areas, and apparently lies stratigraphically above Hauterivian shales of the upper Relay Mountain Group, although the contact is nowhere well exposed. The Elbow Pass formation is in turn overlain by the Lizard formation southeast of Lizard Creek (Figure 13, Section2).

Interbedded pebble conglomerate, shale and sandstone of the Elbow Pass formation typically occur in well-defined thinning and fining-upward units 10 to 30 metres thick (Garver, 1989). The conglomerates are poorly to moderately well sorted, graded, and commonly amalgamated. Channeling is common, especially in the coarser units, and many beds contain ripup clasts. Sandstone beds are generally medium bedded, amalgamated units with Taa, Tbb or Tab

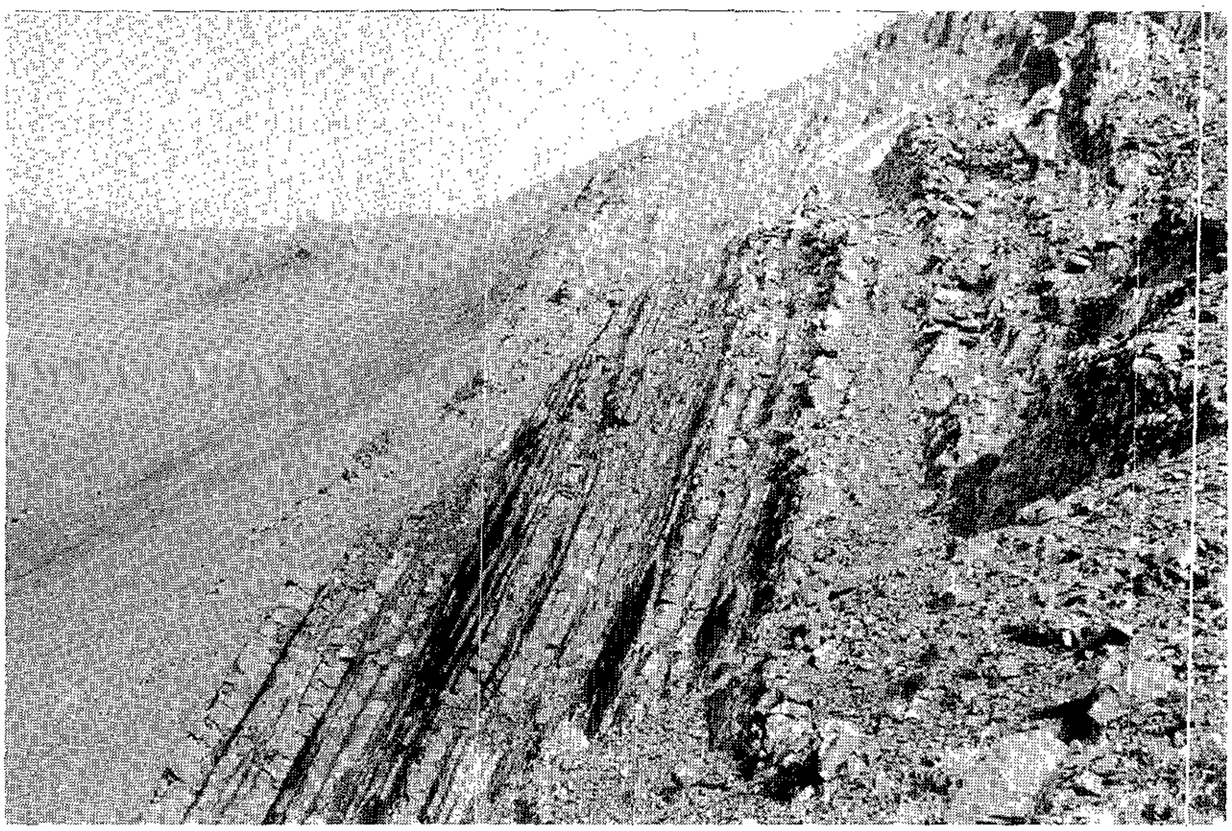

Photo 26. Medium to thin-bedded turbidites of the Elbow Pass formation, east of Big Creek. View is to the northeast.

Bouma sequences (Photo 26). Slumped bedding and convolutions occur locally, and are common in the overturned part of the succession directly west of Elbow Pass. Black, laminated shale is interbedded with the coarser grained rocks and locally contains brown-weathering concretions.

Sandstones within the Elbow Pass formation consist predominantly of volcanic lithic grains accompanied by lesser amounts of plagioclase and minor amounts of volcanic quartz (Garver, 1989). Conglomerates consist almost entirely of intermediate to mafic volcanic clasts. This restricted composition suggests that the formation was derived from an undissected juvenile volcanic terrain. The sedimentary structures suggest that the formation was deposited in the proximal part of a submarine fan, and relatively abundant flutes and grooves on the bottoms of conglomerate and sandstone beds indicate that paleotransport was from west to east (Garver, 1989).

No fossils were recovered from the Elbow Pass formation during the present study, but Jeletzky and Tipper (1968) report that an ammonite resembling *Brewericeras hulenense* Anderson was collected from the formation east of Elbow Pass. This tentative identification suggests that the Elbow Pass formation is, at least in part, late early Albian in age. This is consistent with the stratigraphic position of the formation in the Lizard Creek - Mount Sheba area, where it occurs beneath the middle to late Albian Lizard formation.

DASH FORMATION (lKTCD)

The Dash formation (Dash conglomerate of Garver, 1989) outcrops in several areas between Big Creek and the Shulaps Range, but is restricted to the northeast side of the Castle Pass fault (Figure 3). It is well exposed northwest of Relay Mountain, where it outlines the Red Hill syncline, as well as in a narrow belt that extends from Eldorado Mountain southeastward across Tyaughton Lake. It is also found in several fault-bounded lenses along the Relay Creek fault system, and in a series of fault lenses within the Quartz Mountain fault system between Big Sheep Mountain and Lone Valley Creek. The Dash formation rests unconformably above the Bridge River Complex in the south, and lies conformably above the Paradise formation to the northwest. It is everywhere stratigraphically overlain by the Lizard formation. The Dash formation is characterized by layers of distinctive orange-weathering chert-pebble conglomerate. These conglomerate layers are commonly intercalated with chert-quartz sandstones and dark-grey-weathering siltstones and shales.

The Dash Formation in the Eldorado Mountain - Tyaughton Lake area is a relatively thin (200 to 500 metres) basin margin assemblage that rests unconformably above the Bridge River Complex (Figure 13, Section 5). The basal unconformity is exposed for about three kilometres near the head of North Cinnabar Creek (Photo 27), where it rests on a variety of rock types in the Bridge River Complex, including blueschist, greenstone, chert, limestone and serpentinite. A boulder to pebble conglomerate at the base of the Dash formation contains clasts of all of these lithologies (Photo

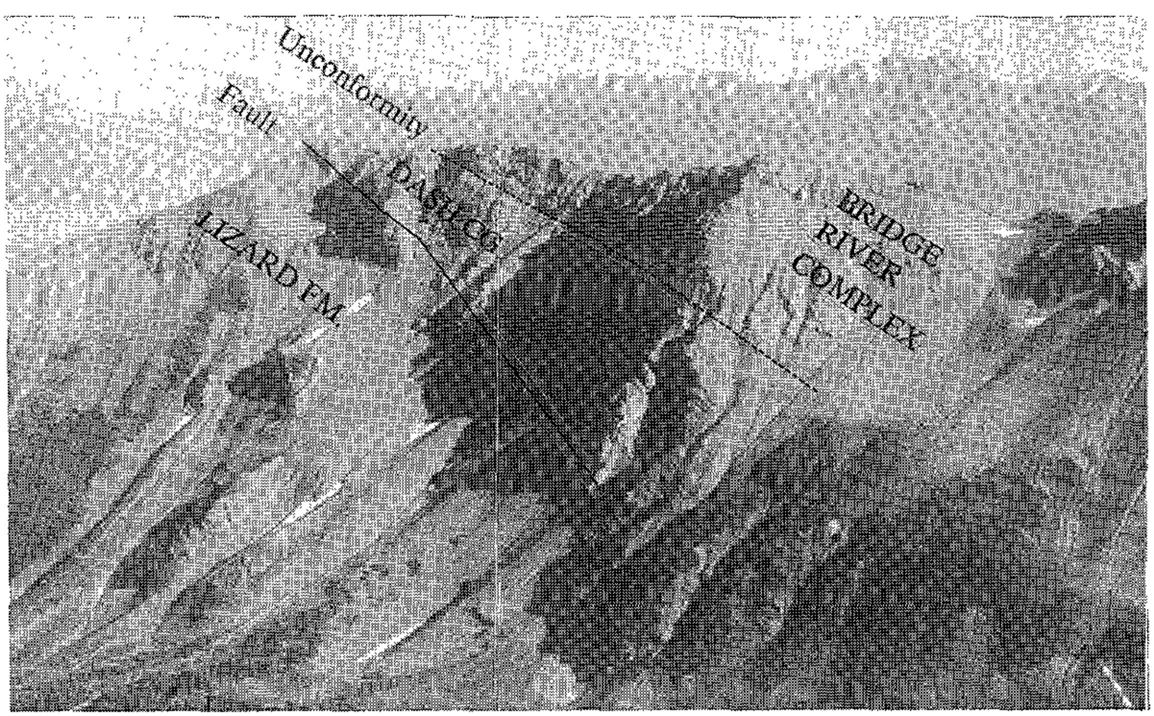

Photo 27. Overturned unconformity with the middle Albian Dash conglomerate depositionally overlying metachert and blueschist of the Bridge River Complex. View is to the southeast across the headwaters of North Cinnabar Creek.

Photo 28. The basal Dash conglomerate at North Cinnabar Creek. Angular pebbles include greenstone, chert, blueschist (under the coin and elsewhere) and greenschist.

28), and the immediate substrate is generally better represented than other rock types at any particular locality (Garver, 1989). The basal conglomerate passes up section into 30 metres of massive to cross-stratified pebble conglomerate and sandstone interbedded with mottled red and green siltstone that locally contains full-leaf fossils. Overlying rocks, comprising most of the section, consist of medium to thick-bedded pebble conglomerate intercalated with fine-grained sandstone. The conglomerate beds within this interval are both normal and inverse-graded and locally are crossbedded. The top of the formation in this area comprises several tens of metres of bioturbated sandstone and siltstone that contain pelecypods, ammonites and abundant plant hash and wood debris.

In the Red Hill area, northwest of Relay Mountain, the Dash Formation is more than 1000 metres thick (Figure 13, Section 3). There, it lies above the Paradise formation with a transitional conformable contact 20 to 30 metres thick in which chert-rich sandstone is intercalated with thin-bedded sandstone and shale typical of the underlying formation. This transitional interval is overlain by 500 to 600 metres of shale intercalated with thin-bedded, graded sandstone beds and medium to thick-bedded chert-pebble conglomerate. The conglomerate beds are typically stratified and graded, but locally are very-poorly sorted, disorganized and matrix-supported. This interval is overlain by 100 metres of concretionary shale with subordinate thin-bedded sandstone, which in turn is overlain by bioturbated siltstone containing intercalations of massive to trough-crossbedded sandstone and minor conglomerate. The top of the section consists mainly of massive to crossbedded chert pebble to cobble conglomerate in beds that are locally lenticular with scoured bases (Photo 29).

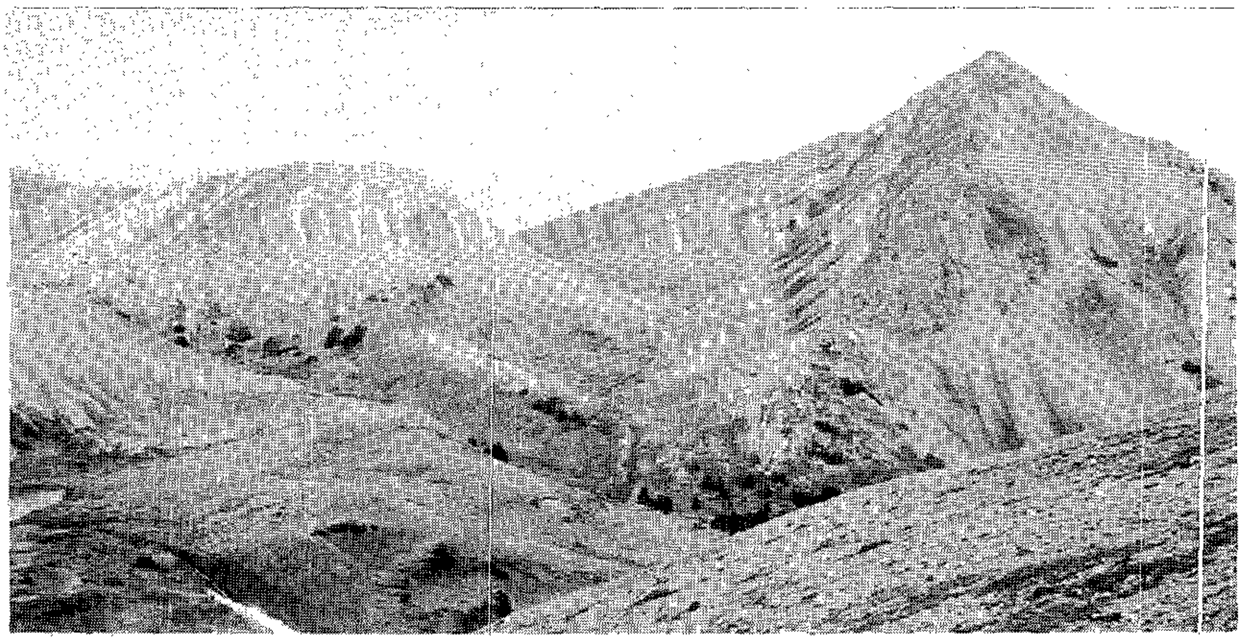

Photo 29. Resistant ridge of Dash chert-pebble conglomerate on the northeast limb of the Red Hill syncline. These are overlain by shales and sandstones of the Lizard formation within the recessive area to the left, which are in turn overlain by well stratified sandstones, shales and conglomerates of the Beece Creek succession.

Clasts within the basal Dash conglomerate in the North Cinnabar Creek area were clearly derived from the underlying Bridge River Complex. Conglomerates higher in the section in the North Cinnabar Creek area, and throughout the formation elsewhere in the map area, typically contain 70 to 90 per cent chert, which is also inferred to have been derived from the Bridge River Complex. This inference is supported by the ages of radiolarians extracted from chert pebbles at several localities within the area, which include Triassic and Mississippian forms (identifications by D.L. Jones, reported in Garver, 1989). In addition to chert, the conglomerates typically contain 10 to 20 per cent white to cream-weathering felsic volcanic rock fragments that locally contain quartz phenocrysts. Also present in relatively minor quantities are clasts of sandstone, argillite, greenstone and quartz, as well as rare clasts of hypabyssal intrusive rocks, commonly with hornblende-feldspar or quartz-feldspar phenocryst assemblages. Sandstones are dominated by chert grains, typically accompanied by a significant but subordinate percentage of monocrystalline quartz, as well as volcanic lithic, sedimentary lithic and plagioclase grains. Heavy mineral suites commonly include abundant chrome spinel that may have been derived from ultramafic rocks in the source area (Garver, 1989). Paleocurrent data from the Dash formation are abundant only in the Red Hill area, where they indicate an eastern source (Garver, 1989). These data, combined with its sedimentologic features and stratigraphic relationships, suggest that the Dash formation represents a fluvial-dominated deltaic complex that built westward into the basin away from an eastern source terrain dominated by uplifted Bridge River Complex (Garver, 1989).

Reports on 12 collections of macrofossils from the Dash formation at widely scattered localities are presented in Appendix 3. Many of these constrain the formation to a mid-Albian age, as is also suggested by its stratigraphic position beneath the middle to upper Albian Lizard formation and above the Aptian to early Albian Paradise formation.

LIZARD FORMATION (lKTCL)

The Lizard formation (Garver, 1989) is a distinctive sequence of mica-bearing quartzofeldspathic turbidites. The type area comprises a section of thin-bedded sandstones and shales that are well-exposed on the slopes south of upper Lizard Creek (Photo 30), where the formation is underlain by the Elbow Pass formation. It is more extensively exposed in several different outcrop belts to the north and east, on the northwest side of the Castle Pass fault, where it is underlain by the Dash formation. The largest of these exposure belts is situated between the Relay Creek and Yalakom faults, and extends for 40 kilometres between Big Sheep Mountain and Big Creek (Figure 3). The Lizard formation is also well exposed northwest of Relay Mountain in the Red Hill syncline, and in the belt of Taylor Creek rocks that overlies the Bridge River Complex between Eldorado Mountain and Tyaughton Lake. Where complete sections are exposed it is typically on the order of 500 metres thick.

The Lizard formation is composed primarily of black laminated shale with interbedded medium to thin-bedded, light brown to grey-weathering sandstone. In shale-domi-

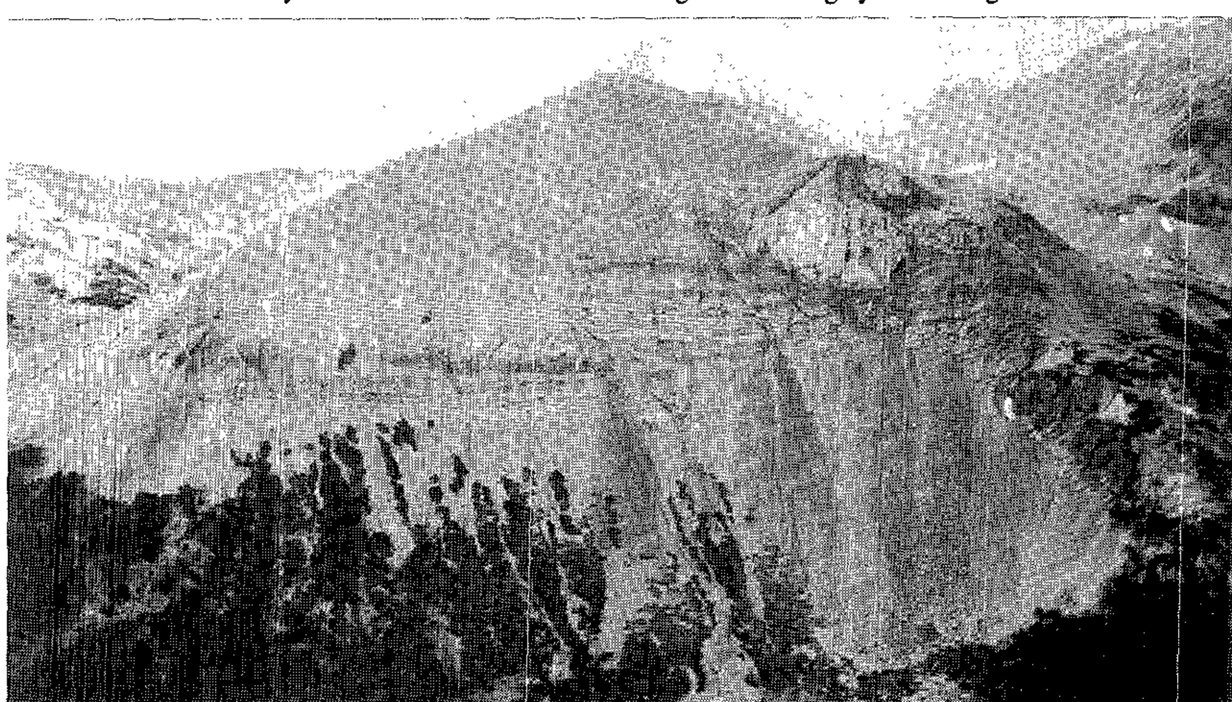

Photo 30. Taylor Creek Group exposed on the south side of Lizard Creek. Lower part of the slope is underlain by well-bedded sandstones and shales of the Lizard formation. These are overlain by an interval of slumped volcanic conglomerate included in the Taylor Creek volcanic unit, which is in turn overlain by a shale-dominated interval tentatively included in the Beece Creek succession. More massive unit at the very top of the section comprises conglomerates at the base of the Powell Creek formation, which are separated from the underlying rocks by an angular unconformity.

nated sections sandstone beds are generally thin bedded and display Tae, Tbc and Tce Bouma sequences. The sandstone beds are thicker (medium to locally thick bedded) in sandstone-dominated intervals, where they typically display Tbc, Tab and Taa Bouma sequences. Flutes and grooves are common on the bottoms of sandstone beds and fine-grained, disseminated plant hash occurs locally along laminae at the tops of sandstone beds. Slump structures and convoluted bedding are also common.

The sandstones of the Lizard formation are fine to coarse-grained quartzofeldspathic litharenites (Garver, 1989). They consist of subequal proportions of quartz, feldspar and lithic grains, and are characterized by abundant detrital mica (muscovite±biotite). Feldspar grains are mainly plagioclase, although potassium feldspar is present in minor quantities. The characteristics of the quartz grains suggest that they were derived from plutonic, volcanic and metamorphic source rocks (Garver, 1989). Most of the lithic grains were derived from volcanic rocks, although metamorphic detritus, including quartz-mica tectonites and foliated quartz aggregates, is also present. Flutes and grooves define a paleotransport direction to the north-northeast, and Garver (1989) suggests that the Lizard formation was deposited within a very large submarine fan system that transported sediment longitudinally along the axis of the mid-Cretaceous Tyaughton basin. The source terrain was probably underlain by plutonic rocks with associated metamorphic and volcanic rocks. The provenance studies, including fission-track dating of detrital zircons, of Garver (1989, 1992) and Garver and Brandon (1994) indicate that this was the same source terrain that supplied detritus to the much thicker sequence of arkosic deposits that characterized the mid-Cretaceous portion of the Methow basin to the east.

The Lizard formation apparently overlies the Elbow Pass formation south of Lizard Creek (Figure 13, Section 2), although the contact is not exposed. Elsewhere in the area it lies above the Dash formation (Figure 13, Sections 3, 4 and 5). In the Red Hill and North Cinnabar Creek areas the base of the Lizard formation is marked by 10 to 30 metres of laminated black shale containing a few thin beds of micaceous quartzofeldspathic sandstone. The contact is abrupt, but in the North Cinnabar Creek area rare thick beds of coarse-grained chert-lithic sandstone, similar to that of the Dash Formation, are intercalated with typical Lizard sandstones and shales higher in the section. Paleocurrent data from these beds of chert-lithic detritus indicate east-west transport, similar to those in the underlying Dash formation, suggesting that they represent minor sediment influx from the same source (Garver, 1989). Farther to the east, in exposures extending from Big Sheep Mountain north and northwest to beyond Mud Creek, the base of the Lizard formation is marked by an interval of intercalated conglomerates and sandstones (Unit lKTCLc on Figure 3). Most of the conglomerates within this unit contain angular to rounded pebbles of greenstone, chert, gabbro, diabase and locally serpentinite, that were probably derived from the Bridge River Complex. Some conglomerates, however, contain mainly intermediate volcanic and volcaniclastic clasts along with minor amounts of chert, gabbro and rare medium grained quartz dioritic pebbles. The conglomerates of unit lKTCLc are intercalated with green lithic sandstones and gritty sandstones, which dominate some portions of the unit. These sandstones consist of altered mafic to intermediate volcanic grains, with lesser amounts of plagioclase and a relatively small proportion of angular quartz grains. Mica-bearing quartzofeldspathic sandstones similar to those throughout the rest of the Lizard formation are also present within this unit, and become more prominent westward.

An *Inoceramus* fossil collected from the central part of the Lizard formation in the Red Hill syncline is of probable middle to late Albian age (Appendix 3, Sample 87JG-238B), as is an *Inoceramus* fossil from one of the fault-bounded panels of the formation that crosses Mud Creek (Appendix 3, Sample 88JKG-18-2-1). Plant fossils collected from the contact zone between the Lizard formation and Beece Creek succession in the Red Hill syncline have been assigned an Albian to Cenomanian age (Appendix 5, Sample 86JG-178). These sparse paleontologic data are consistent with the stratigraphic relationships of the Lizard formation, which is underlain by the mid-Albian Dash formation and overlain by the Albian to Cenomanian Beece Creek succession and Silverquick formation.

VOLCANIC ROCKS (lKTCv)

The volcanic unit of the Taylor Creek Group outcrops in several areas west of Big Creek, where it is locally underlain by the Tosh Creek succession and is stratigraphically overlain by the Beece Creek succession. It is exposed north and east of Dorrie Peak, at the southwest end of Cluckata Ridge, on the ridges south of Vic Lake, and on the ridges dividing Beece Creek from Chita and Powell creeks. Strongly-altered volcanic and sedimentary rocks that underlie the Powell Creek formation south of the Tchaikazan fault are also included in this unit. The Taylor Creek volcanics also occur locally to the east of Big Creek, where they are best represented by volcanic and volcaniclastic rocks that outline the Prentice Lake syncline between Mud Creek and the headwaters of Dash Creek. These rocks occupy a stratigraphic position between the Lizard formation and the Beece Creek succession. An interval of channel conglomerates containing cobbles and boulders of felsic and intermediate volcanic rocks that is exposed on the south side of Lizard Creek is also included in the Taylor Creek volcanic unit (Photo 30). This interval, which is 100 to 150 metres thick, was interpreted by Garver (1989) as a lens within the Lizard formation, but is here interpreted to mark the contact between the Lizard formation and overlying shales and siltstones of the Beece Creek succession.

West of Big Creek, the Taylor Creek volcanics consist mainly of intermediate to felsic flows and fragmental rocks, locally intercalated with minor amounts of dark grey shale and sandstone. Volcanic rocks are generally light grey to light green, and commonly weather to somewhat darker shades of brownish grey to green; locally the rocks contain up to 1 per cent disseminated pyrite and weather rusty. Volcanic flows are generally massive, and consist of an aphanitic to very fine grained feldspar-rich groundmass containing small feldspar or feldspar and hornblende phenocrysts. Rarely, narrow zones of flow banding define flow contacts, and in one such case the flow grades from sparsely porphyritic margins into an interior containing more and larger phenocrysts. Fragmental rocks are mainly crystal-lithic tuffs and lapilli tuffs composed of feldspar and hornblende crystals together with fragments of intermediate to felsic volcanic rock. The angular to subrounded lithic fragments rarely exceed several centimetres in size (Photo 31). The fragmental rocks are generally only poorly stratified, but locally form distinct medium-thick beds. Sedimentary intervals of sandstone and shale occur mainly near the contact with the overlying Beece Creek succession; sandstones are compositionally similar to those within the Beece Creek succession.

Rocks assigned to unit lKTCv between the Tchaikazan fault and Dickson-McClure batholith comprise a poorly exposed succession of altered volcanic and volcaniclastic rocks intercalated with sandstones rich in quartz and chert. This succession is apparently continuous with a belt of Taylor Creek volcanic and sedimentary rocks that outcrops south of the Tchaikazan fault to the west (McLaren and Rouse, 1989a,b; McLaren, 1990). Altered volcanic rocks higher in the section appear to form a relatively gently-dipping cap that is inferred to represent unconformably overlying Powell Creek formation.

Photo 31. Volcanic breccia of the Taylor Creek volcanic unit, west of Vic Lake. Clasts are in part accentuated by epidote alteration.

The volcanic and volcaniclastic rocks that outcrop between Mud Creek and upper Dash Creek were assigned to the Kingsvale and Taylor Creek groups by Tipper (1978) and to the Powell Creek formation by Glover *et al.* (1988a,b). Although unfaulted external contacts were not observed, the distribution of the unit, which outlines the Prentice Lake syncline, indicates that it occupies a stratigraphic position above the Lizard formation and below the Beece Creek succession (Figure 13, Section 4). It is therefore included in the Taylor Creek volcanic unit, although lithologically much of it is more similar to the Powell Creek formation than to the Taylor Creek volcanics west of Big Creek. The volcanics in the Prentice Lake syncline consist largely of green, grey and purple volcanic breccias, comprising poorly sorted angular to subrounded clasts in a matrix of smaller lithic clasts and feldspar and hornblende crystals. Clasts commonly range from less than 1 centimetre to 10 centimetres across, and consist mainly of intermediate porphyritic and aphyric volcanic rocks; porphyritic varieties generally dominate and contain the phenocryst assemblages hornblende-plagioclase, plagioclase, and clinopyroxene-plagioclase. Green, rusty brown weathering flows occur locally within the breccias, and contain the same phenocryst assemblages. Dark green to grey, brownish weathering, crudely to moderately well stratified volcanic conglomerates and laharic breccias, locally intercalated with beds of volcanic sandstone, are also present, mainly in the upper part of the unit. The coarser grained rocks consist mainly of poorly sorted, angular to rounded clasts floating in a friable, silty to sandy matrix. Clasts locally range up to 1 metre in diameter, and consist mainly of intermediate porphyritic and aphyric volcanics as well as hornblende-feldspar-bearing tuffs and volcanic breccias.

The volcanic rocks included in the Taylor Creek Group all occur at a similar stratigraphic level, directly beneath the Beece Creek succession. They overlie the Lizard formation east of Big Creek and the undated Tosh Creek succession west of the Creek. Volcanic rocks are generally absent from this stratigraphic level in the Red Hill syncline northwest of Relay Mountain, although the volcanic unit may be represented by a hornblende-phyric andesite flow or sill, about 5 metres thick, that was seen near the Lizard - Beece Creek contact at one locality near the core of the syncline. The volcanic unit is also absent from this stratigraphic level in the Eldorado Mountain - Tyaughton Lake area, although there the Lizard formation is overlain by the Silverquick formation across a slight angular unconformity.

The Taylor Creek volcanic unit is not dated, but is presumed to be late Albian (and/or Cenomanian) in age based on its stratigraphic position above the middle to late Albian Lizard formation and beneath the Albian to Cenomanian Beece Creek succession. Hornblende separated from a small plug of hornblende-feldspar porphyry that intrudes the volcanic unit near upper Relay Creek yields an Ar-Ar plateau date of 104.5±16.6 Ma (Appendix 7, Sample TL-87-14). Despite the large analytical uncertainty, this date is similar to the stratigraphically inferred age of the host volcanics, and suggests that the intrusive suite may be comagmatic with the volcanics. Geological relationships in the area permit this interpretation, because although porphyries intrude the volcanics and underlying Lizard formation, they were not observed cutting the overlying Beece Creek succession (Figure 3).

BEECE CREEK SUCCESSION (luKTCB)

The Beece Creek succession consists of sandstones, shales and conglomerates that comprise the uppermost unit of the Taylor Creek Group. These rocks overlie the volcanic unit in most areas, but locally, where the volcanic unit is absent, they are directly above the Lizard formation. Where the upper contact of the succession is exposed, mainly to the west of Big Creek, it is overlain by the Powell Creek formation across an angular unconformity. West of Big Creek, the Beece Creek succession outcrops mainly within a belt that extends from the head of Tosh Creek to the northwestern corner of the map area. There are smaller exposures on the ridge between Big and Grant creeks, on the slopes south of Nadila Creek, and adjacent to the creek that flows northward from Mount Vic. The succession also occurs on the east side of Big Creek, where it comprises rocks that were assigned to the Silverquick formation by Garver (1989) in the cores of the Prentice Lake and Red Hill synclines. Shales that occur in the uppermost part of the Taylor Creek Group on the south side of Lizard Creek are also assigned to the Beece Creek succession, as these rocks occur above volcanic conglomerates assigned to Unit lKTCv and unconformably beneath the Powell Creek formation.

The Beece Creek succession consists of shale and siltstone together with about equal amounts of coarser clastic rocks, although either fine or coarse-grained rocks generally dominate any given section. Fine-grained intervals consist of medium to dark grey shale with thin beds of somewhat lighter grey siltstone and scattered thin to medium beds of fine to medium-grained sandstone. The sandstone beds are massive to graded, locally with scoured bases. Laminated limestone and marly mudstone occur locally within the unit near the core of the Prentice Lake syncline, where they are associated with red-weathering siltstone containing minor intercalations of sandstone and pebble conglomerate. Coarser grained intervals within the Beece Creek succession are dominated by medium to dark grey, light grey weathering, fine to coarse-grained sandstone. It may be poorly stratified or form well-defined thin to medium beds that display Tab and Tce Bouma sequences. Poorly to moderately well sorted granule to pebble conglomerate is common in sandstone-dominated intervals, where it occurs as thin to very thick beds, commonly with channeled bases and rip-up clasts. Locally pebble to cobble conglomerate occurs as massive, unstratified, predominantly matrix-supported units up 10 metres or more in thickness.

Conglomerates within the Beece Creek succession are dominated by clasts of chert, siltstone, sandstone and intermediate to felsic volcanic rock; clasts of vein quartz and granitic rock occur locally. Clasts are generally angular to subrounded, although chert clasts are locally well rounded. Sandstones contain a similar lithic component, accompanied by abundant quartz and feldspar. They also contain clasts of massive to foliated quartzite, foliated granitic rock, and quartz-mica schist, as well as scattered grains of muscovite, epidote and biotite. Sandstone grains are typically angular, and a few quartz grains have delicate embayed margins suggesting, in part, a local volcanic source.

The Beece Creek succession in the Red Hill syncline overlies the Lizard formation across a gradational contact defined by the intercalation of chert-rich conglomerates with Lizard-like arkosic sandstones. West of Big Creek it overlies the Taylor Creek volcanic unit across a contact that is also gradational, at least in part, because sandstones typical of the Beece Creek succession are locally intercalated with fragmental volcanic rocks in the upper part of the volcanic succession. The Beece Creek succession in these areas is interpreted to be primarily marine because of its gradational contact with the marine Lizard formation and its deposition as turbidite deposits. The Beece Creek succession in the core of the Prentice Lake syncline has a somewhat higher percentage of conglomerates than elsewhere in the area, and includes substantial sections of redbeds that may indicate nonmarine deposition. The basal contact of the succession is apparently abrupt in this area, although no unfaulted contacts between it and the underlying Taylor Creek volcanics were observed. This succession was mapped as Silverquick conglomerate by Garver (1989) who noted that it contains a much higher percentage of fine-grained material than the type Silverquick area in the Taylor Creek and North Cinnabar Creek drainage basins. He suggested that it was deposited in a fluvial system more distal than the Taylor Creek section, perhaps in a broad fluvial plain. Although the rocks in the core of the Prentice Lake syncline are here included in the Beece Creek succession, they are thought to represent a transitional facies between the Silverquick formation in its type area and the Beece Creek succession elsewhere in the area.

The Beece Creek succession is probably late Albian to Cenomanian in age because it overlies the middle to late Albian Lizard formation and is itself unconformably overlain by the Cenomanian (and younger?) Powell Creek formation. It has not yielded any diagnostic fossils, although plant fossils collected from the contact zone between the Lizard Creek formation and Beece Creek succession in the Red Hill syncline have been assigned a general Albian to Cenomanian age (Appendix 5, Sample 86JG-178).

SILVERQUICK FORMATION (luKSQ)

The Silverquick formation (Silverquick conglomerate of Garver, 1989) consists of nonmarine conglomerates and associated finer grained clastic rocks that form the upper part of the Tyaughton basin near its southeastern margin. These rocks are well exposed in several adjacent fault panels that outcrop in the drainage basins of Taylor and North Cinnabar creeks and the adjacent portions of Tyaughton creek. The type section is on the overturned limb of a northeast-verging syncline that occurs between the Castle Pass fault and a splay of the Fortress Ridge fault to the east. This belt includes the past-producing Silverquick mine, which produced mercury from mineralized shears related to the Fortress Ridge fault. The Silverquick formation in this area overlies the Lizard formation across an abrupt contact marked by an angular discordance of 10 to 20 degrees (Garver, 1989). The underlying Lizard formation forms the upper part of a condensed section of Taylor Creek strata that unconformably overlies the Bridge River Complex (Figure 13, Section 5). Rocks included in the Silverquick formation also outcrop on Mission Ridge, 50 kilometres to the southeast, where they rest directly above the Bridge River Complex (Figure 13, Section 6). The upper stratigraphic boundary of the Silverquick formation is exposed in several places in and near its type section, where it is a gradational contact with overlying volcanic rocks of the Powell Creek formation. This contact is marked by the intercalation of chert-rich conglomerates typical of the Silverquick formation with volcanic-rich conglomerates containing clasts typical of the Powell Creek formation (Garver, 1989).

TAYLOR CREEK AREA

The Silverquick formation is about 1500 metres thick where it is well exposed on the ridges north and south of the middle reaches of Taylor Creek. It consists of about 80 per cent rusty-brown to grey-weathering conglomerate and 20 per cent grey to greenish-grey sandstone to siltstone. These lithologic units are arranged in numerous fining-upwards sequences ranging from a few metres to more than 10 metres thick (Photo 32). The lowest and thickest part of individual fining-upwards sequences is dominated by massive, poorly

Photo 32. Silverquick conglomerate south of Taylor Creek. Eroded shale interval (occuppied by geologist and dog) provides a view of the same unit on the adjacent ridge, where the well-defined coarse stratification of the unit is apparent.

sorted cobble conglomerate locally showing low-angle basal scour and internal, low-angle cross-stratification. This lower unit passes upward into horizontally stratified to cross-stratified conglomerate and locally graded conglomerate. Metre-scale channeling is common in the conglomerates in this part of the sequence. The conglomerate units are capped by an interval of fine-grained sediments composed of structureless sandstone to siltstone containing graded interbeds of medium to coarse-grained sandstone with lenses of conglomerate. These fine-grained intervals commonly contain stick and leaf fossils. Locally, they are red to maroon weathering and contain root traces and mud cracks.

Fault panels of Silverquick formation exposed farther east, along Tyaughton Creek, show a similar arrangement of coarse and fine-grained intervals, but are commonly red, maroon, or mottled red-green-weathering. The fine-grained intervals within these redbeds are generally thicker than those within the Taylor Creek exposures, and typically contain a higher proportion of siltstone relative to sandstone.

Conglomerates within the Silverquick formation typically contain about 50 per cent chert clasts, 20 to 30 per cent sedimentary rock fragments and 15 to 25 per cent intermediate volcanic clasts. They also contain clasts of greenstone, quartz and dioritic plutonic rocks, as well as minor amounts of serpentinite, limestone and blueschist. The sedimentary rock fragments include abundant clasts of calcarenitic sandstone and muscovite-bearing quartzofeldspathic sandstone that may have been derived from the Hurley Formation and Lizard formation, respectively. Sandstones within the Silverquick formation consist largely of chert grains, which are accompanied by quartz, feldspar, and volcanic and sedimentary lithic grains. Detrital mica (muscovite and biotite) is invariably present in minor quantities (less than 1 per cent).

The upper part of the Silverquick formation in its type area includes beds of volcanic conglomerate intercalated with the typical chert-rich conglomerates and finer grained sediments. The beds of volcanic conglomerate are typically 1 to 3 metes thick and occur over several hundred metres of section (Garver *et al.*, 1989b). They are predominantly matrix supported and contain poorly-sorted pebbles and cobbles of plagioclase, hornblende and pyroxene-phyric volcanics. These conglomerates are the first indication of contemporaneous volcanism in this part of the Tyaughton basin, which culminates in the deposition of volcanic breccias and flows of the overlying Powell Creek formation.

The Silverquick formation is interpreted to have been deposited primarily in a braided fluvial system (Garver, 1989). Flutes and grooves on the bottoms of conglomerate and sandstone beds in the Taylor Creek area indicate that paleotransport was dominantly from east to west (Garver, 1989). Detritus within the Silverquick formation was derived largely from the Bridge River Complex, presumably from the same source area that supplied chert-rich detritus to the older Dash formation. The Silverquick has a more varied provenance, however, and also includes sandstone clasts that were probably derived from the Hurley Formation; these provide the first record of eroded Cadwallader Terrane supplying detritus to the upper part of the Tyaughton basin. The Silverquick conglomerates also conboth sides of upper Lizard Creek, where it is 150 to 200 metres thick (Figure 14); from there it was traced 4 kilometres to the southeast, beyond which the base of the formation is missing due to faulting. A thin interval of conglomerate assigned to the basal unit is also exposed on the slopes north of Gun Creek, 1.5 kilometres northeast of Hummingbird Lake (Figure 3). The contact between unit uKPCbs and the underlying Taylor Creek Group was observed at both the Lizard Creek and Hummingbird Lake localities; at both places the contact is abrupt and marked by an angular discordance of 20 to 30 degrees.

Unit uKPCbs consists mainly of poorly-bedded cobble-boulder conglomerate containing angular to rounded clasts of mainly sandstone, siltstone and intermediate to felsic volcanic rocks; sandstone and siltstone clasts are commonly laminated or cross-laminated and locally contain *Buchia* fossils (Appendix 3, Sample 86KG-36-2-2). Subordinate clast types include chert, siliceous mudstone, limestone, granitoid rocks and serpentinite. Interbedded with the coarse conglomerates are intervals of well-bedded pebble conglomerate, as well as thin beds of sandstone and siltstone. Light grey, medium to thick-bedded tuffaceous sandstone and granule conglomerate is also present, and contains clasts of plagioclase, volcanic quartz, sanidine and biotite. On the west side of Lizard Creek two ash flow tuff units occur within the upper part of the unit; the upper one is about 20 metres thick and passes upward into lapilli tuff at the base of unit uKPCm. The ash flow tuffs were not recognized east of Lizard Creek, where the top of unit uKPCbs is marked by a transition from bedded conglomerate containing mainly sedimentary clasts upwards into massive, poorly sorted volcanic clast conglomerate, which in turn grades upward into volcanic breccia of Unit uKPCm.

MIDDLE UNIT (uKPCm)

The middle unit of the Powell Creek formation underlies most of the Battlement Ridge belt, where it has been subdivided into three subunits: a lower division of tuffs, breccias and flows (uKPCm1); a middle division of volcanic sandstones and bedded tuffs (uKPCm2); and an upper division of massive volcanic breccias (uKPCm3).

Division uKPCm1 outcrops in the southern half of the Battlement Ridge belt, where it is well exposed on the high ridges and peaks around Lizard Lake and Warner Pass northwestward to Denain Spur (Photo 33). Cross sections constructed from the base of the division, near Lizard Lake, to Mount Warner, and from there to the top of the division north of Feo Spur, suggest that it is about 2500 metres thick. It consists mainly of moderately to poorly stratified lapilli and ash tuffs containing andesitic lithic fragments and crys-

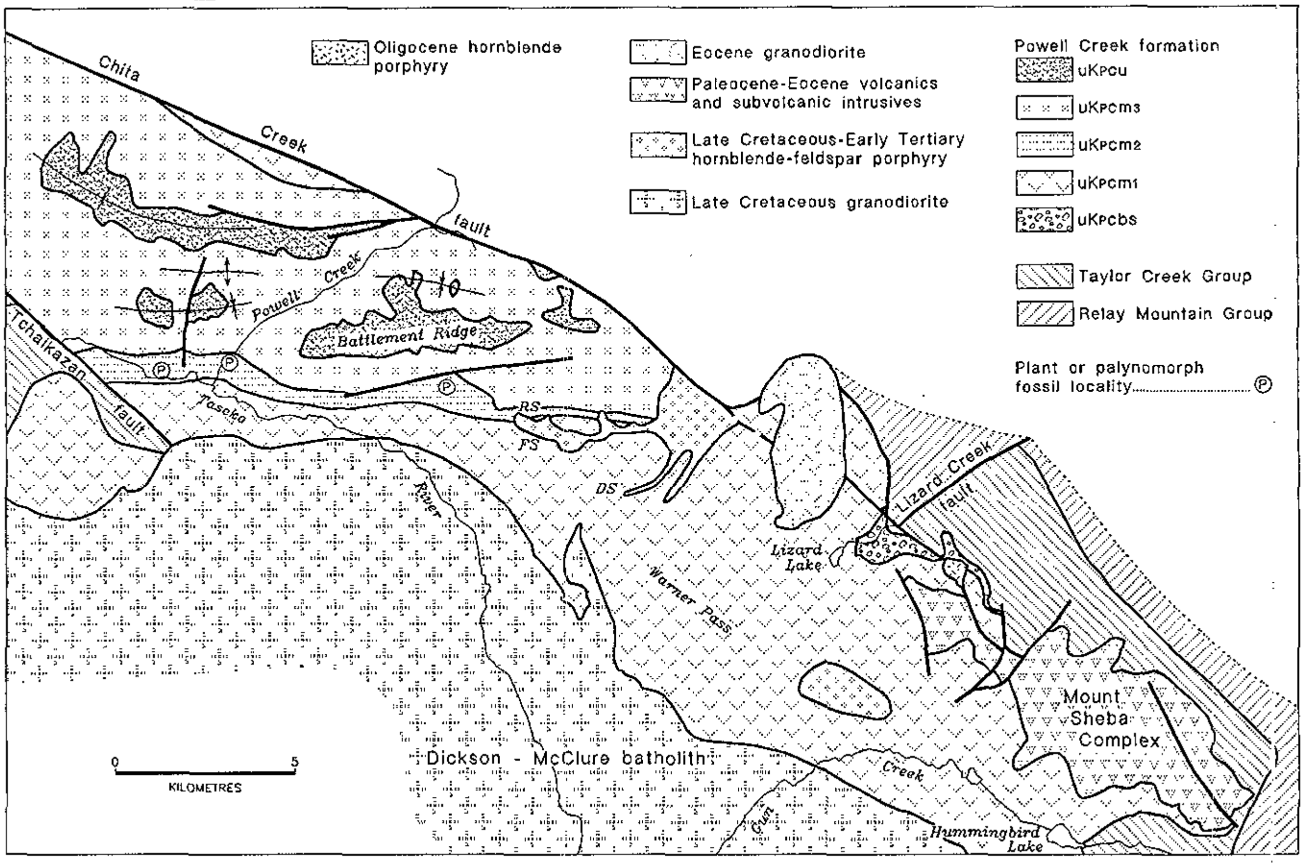

Figure 14. Simplified map of the Powell Creek formation in the Battlement Ridge belt. RS=Rae Spur; FS=Feo Spur; DS=Denain Spur.

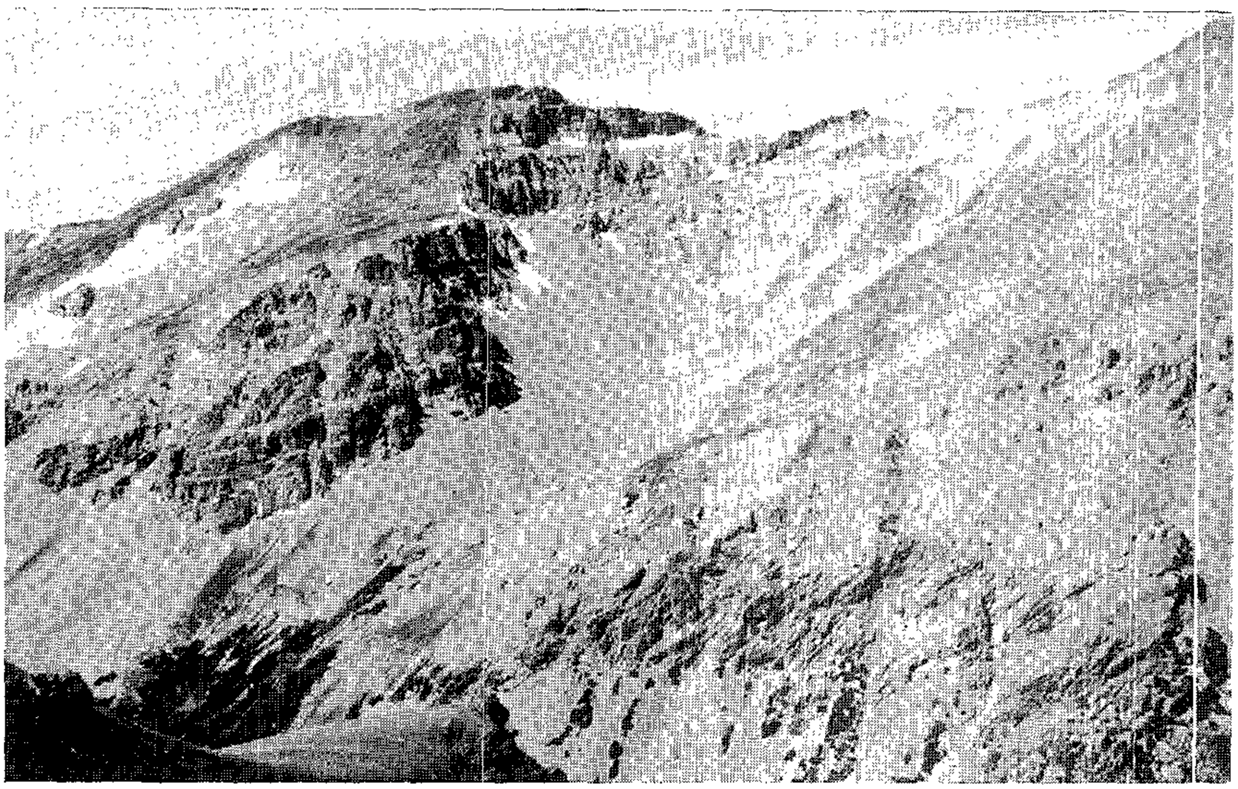

Photo 33. Resistant section in the left part of the view comprises gently-dipping volcanic breccias, tuffs and rare flows of the lower part of the Powell Creek formation, north of Lizard Lake. The upper part of the basal sedimentary unit occurs at the base of the section. Less resistant rocks to the right (north) consist of highly deformed shales and sandstones of the lower unit of the Relay Mountain Group, which are separated from the Powell Creek formation by a normal fault related to the Chita Creek system.

tals of mainly feldspar and hornblende. Coarser intervals of compositionally similar volcanic breccia and volcanic cobble conglomerate occur locally, as do thin intervals of well-bedded volcanic sandstone. The latter units are rarely more than a few metres thick, although a 250 metre-thick section of well-bedded volcanic sandstone and conglomerate (uKPCm1s) is exposed 2.5 kilometres west of Mount Sheba. Volcanic flows occur mainly in the lower part of the division, and include light to medium grey hornblende-feldspar-phyric andesites as well as more mafic pyroxene-phyric varieties. The latter include distinctive rusty brown-weathering clinopyroxene-feldspar-phyric basalt flows that were noted at several places along the ridge system that extends from Lizard Lake southeastward to Mount Sheba.

Division uKPCm2 comprises a distinctive succession of volcanic sandstones, conglomerates, tuffs and shales that forms an east-striking belt extending from the Taseko River to Rae Spur (Figure 14). It is well exposed along lower Powell Creek, where it is about 300 metres thick, and directly east of Battlement Creek where it is locally folded through an anticline/syncline pair. This division is dominated by well-bedded sandstone, tuffaceous sandstone, and ash to fine lapilli tuff, in medium to dark shades of grey, purplish grey and green (Photo 34). Clasts include feldspar and hornblende crystals together with grey and purple intermediate volcanic-lithic fragments. Dark grey carbonaceous shale is intercalated with the coarser clastic rocks and it, together with adjacent sandstone, commonly contains plant fragments. Pebble to boulder conglomerate occurs locally and contains mainly intermediate volcanic clasts, along with rare clasts of chert and fine-grained clastic sediments. A hornblende-feldspar porphyry sill occurs within the division along Powell Creek, and a similar sill or flow outcrops within it east of Battlement Creek at Palisade Bluff. Sandstone and tuff within the division are locally silicified near Powell Creek, and lapilli tuffs are in part strongly silicified near Palisade Bluff. Eastward from there, the division is tentatively mapped as a narrow belt of silicified tuffs that has been traced to the Dorrie Peak stock at the north end of Warner Ridge.

Division uKPCm2 is overlain by division uKPCm3 in a belt that extends from Iron Pass to the western boundary of the map area, and is bounded to the north by the Chita Creek fault (Figure 14). The rocks of this belt are broadly warped by a number of east-trending folds, and have an overall synformal aspect such that the upper unit of the Powell Creek formation caps the high ridges in the central part of it. This synformal aspect is also reflected in the preservation of flows and tuffs that probably correlate with division uKPCm1 along the northern boundary of the belt, adjacent to the Chita Creek fault on the ridge south of the headwaters of Beece Creek.

Division uKPCm3 is characterized by generally unbedded, massive, unsorted breccias comprising angular to subrounded fragments within a finer matrix of lithic and crystal grains. The clasts are mainly feldspar and hornblende-feld-

Photo 34. Well-bedded tuffaceous sandstone of the Powell Creek formation (Unit uKPCm2), lower Powell Creek.

spar-phyric andesitic volcanics in shades of grey, green and purple. They commonly range up to 10 centimetres across, and locally are as large as 60 centimetres. A well-exposed section on the west side of lower Powell Creek is about 500 metres thick and, with the exception of a 30 metre interval of thick-bedded laharic breccias in the centre, consists almost entirely of these massive breccias. Elsewhere, the massive breccias are locally punctuated by intervals up to several tens of metres thick of well bedded volcanic pebble conglomerate, sandstone and siltstone. Hornblende-feldspar-phyric flows and sills also occur locally within this division, but are not common. The base of division uKPCm3 was observed along Powell Creek, where a five-metre-thick layer of massive breccia is interbedded with volcanic sandstone in the upper part of underlying division uKPCm2, suggesting a gradational contact. The top of the division is defined by an abrupt contact with the distinctly stratified tuffs of Unit uKPCu.

UPPER UNIT (uKPCu)

The upper unit of the Powell Creek formation consists mainly of lapilli tuff and volcanic breccia. It is exposed only along the upper parts of Battlement Ridge and the unnamed ridge to the west, where it sits above division uKPCm3 of the middle unit (Photo 35). The top of the upper unit is nowhere seen; the maximum exposed thickness is estimated to be on the order of 300 to 400 metres. The following description is based mainly on a section that was measured on the west side of lower Powell Creek.

The base of the upper unit is marked by about 100 metres of recessive, distinctly stratified lapilli and ash tuffs that contrast markedly with the underlying resistant massive breccias (Photo 35). The tuffs are predominantly purple in colour, but range to maroon, brick red, and light grey to green. They are friable, thin to thick bedded, and composed mainly of feldspar and hornblende crystals together with angular volcanic rock fragments that commonly contain these same minerals as phenocryst assemblages. Clinopyroxene and clinopyroxene-phyric volcanic clasts are usually present in subordinate amounts, while volcanic quartz crystals and quartz-phyric volcanics are abundant in some beds, but absent from others. Accretionary lapilli are locally evident but not common. Clast-supported volcanic breccia, containing angular to subrounded andesitic rock fragments up to 15 centimetres across, is a relatively minor component of this lower interval but locally forms resistant ribs from 2 to 10 metres thick.

The recessive interval at the base of the upper unit is overlain by a somewhat more resistant interval of massive to vaguely stratified volcanic breccias a little less than 100 metres thick. It consists of angular, hornblende-feldspar-phyric, feldspar phyric and aphyric volcanic rock fragments floating within a matrix that includes abundant feldspar and hornblende crystals.

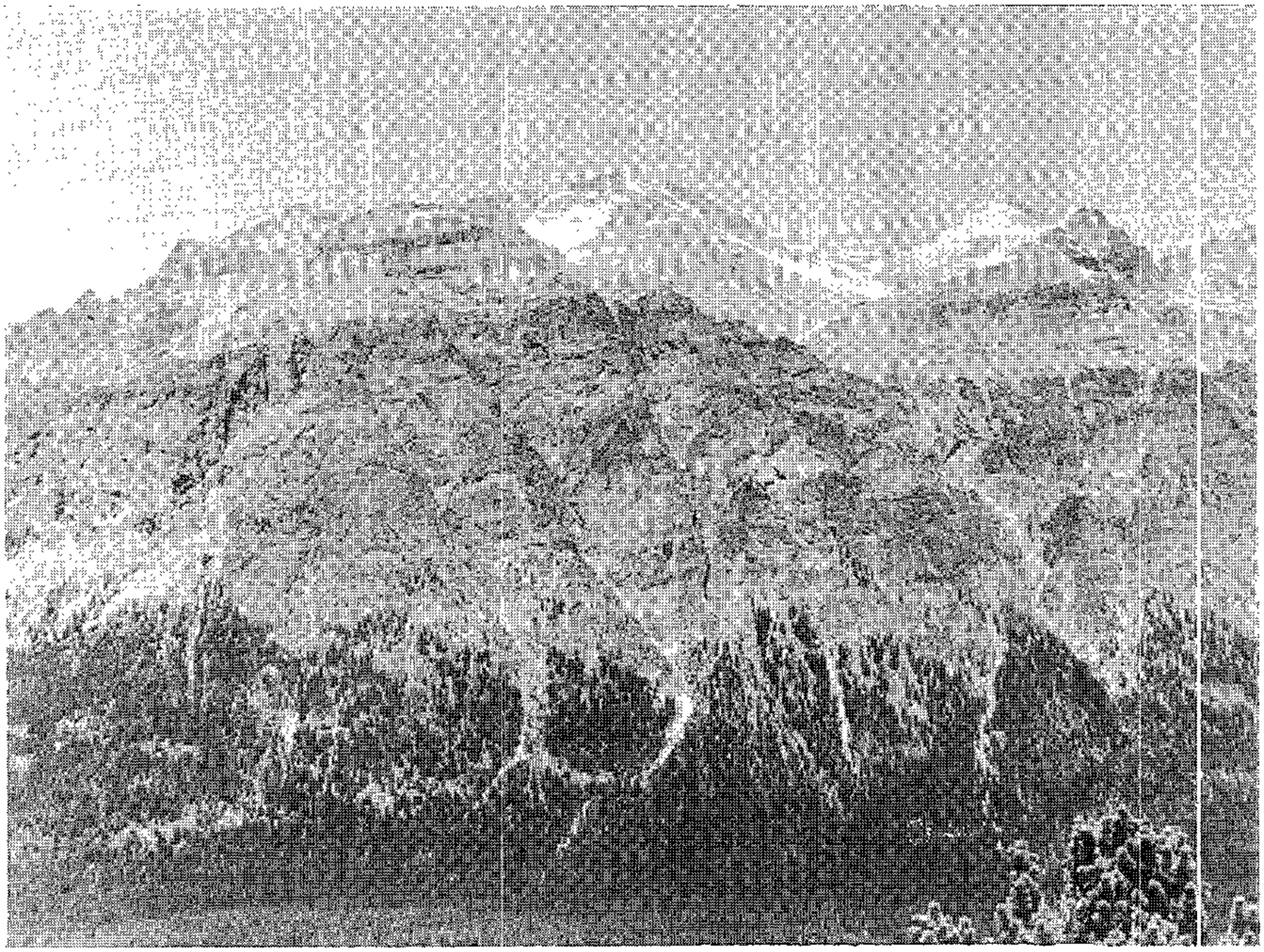

Photo 35. View to the north, across the Taseko River, showing Powell Creek formation on the unamed ridge west of Powell Creek. Massive rocks making up the lower part of the section are mainly volcanic breccias of Unit uKPCm3 and overlying well-stratified breccias belong to Unit uKPCu.

The resistant, uppermost part of the upper Powell Creek unit comprises more than 100 metres of mainly massive, unstratified volcanic breccia that is compositionally and texturally similar to the underlying interval, but locally contains clasts more than 1 metre in size. The base of this interval, however, consists of about 30 metres of well-stratified, thick-bedded, matrix-supported laharic(?) breccia that includes a significant proportion of rounded clasts (Photo 36).

TASEKO MOUNTAIN BELT

The second major belt of Powell Creek exposures occurs in the northwestern corner of the map area, north of the Chita Creek fault and west of Big Creek. In this area the formation typically caps the higher ridges and plateaus, while the underlying Taylor Creek Group outcrops on lower ground (Figure 3). The main areas of Powell Creek exposure are, from west to east, the high peaks and ridges around Taseko Mountain, the ridge system extending north from Mount Vic, the mountains west of the Dil Dil Plateau, and the ridges south of Tosh and Grant creeks. The basal contact of the Powell Creek formation was observed at several places within this belt, and is a pronounced angular unconformity (Photo 37). It most commonly rests above the Beece Creek succession of the Taylor Creek Group, but locally overlies the Taylor Creek volcanics, the Elbow Pass formation, and the Tosh Creek succession.

The Powell Creek formation of the Taseko Mountain belt correlates with the middle unit of the formation exposed in the Battlement Ridge belt; the basal sedimentary unit is clearly absent, and the high stratigraphic levels at which the upper unit would be expected are apparently not attained beneath the present erosion surface. It consists mainly of lapilli and ash tuffs (Photo 38), together with hornblende-feldspar and clinopyroxene-feldspar porphyry flows, and relatively minor amounts of well-bedded volcanic sandstone and conglomerate. These rocks closely resemble those of division uKPCm1 of the Battlement Ridge belt. The section at Mount Vic, however, consists of massive breccias that are most similar to those of division uKPCm3.

McCLURE CREEK AREA

Rocks assigned to the Powell Creek formation along the western boundary of the map area near McClure and

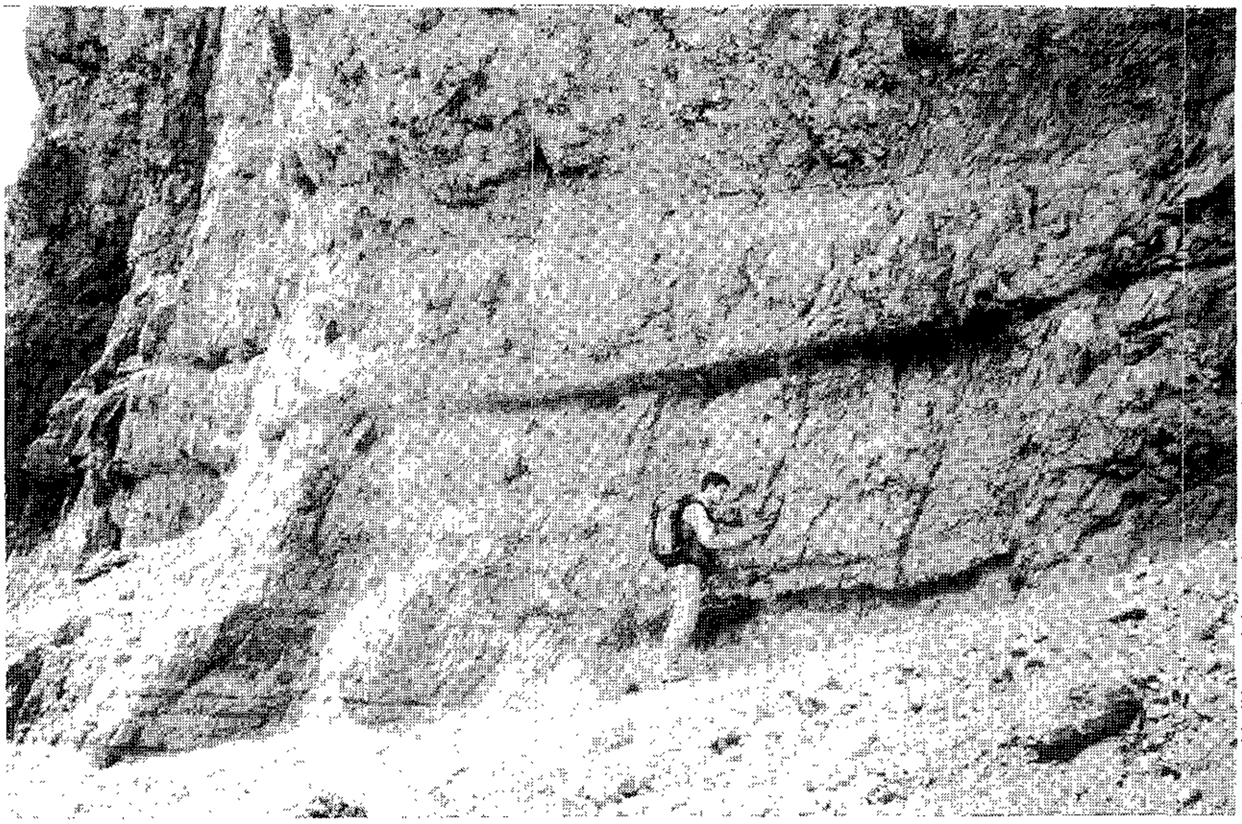

Photo 36. Coarse volcanic breccias of Unit uKPCu, west of Powell Creek.

Honduras creeks consist of crystal lithic tuffs, breccias, flows and epiclastic sedimentary rocks that are similar to those of Unit uKPCm1 of the Battlement Ridge belt. These rocks are bounded to the south by Late Cretaceous granodiorite of the Dickson - McClure batholith, and are within an extensive zone of advanced argillic alteration that affects rocks on the northern margin of this part of the batholith (Figure 3). They dip gently and are underlain, at lower elevations to the north, by an assemblage of altered volcanic and volcaniclastic rocks that appears to dip more steeply and contains intercalations of chert-quartz sandstone. This succession is tentatively assigned to unit lKTCv of the Taylor Creek Group, and is inferred to lie unconformably beneath the Powell Creek formation, although this relationship is not well exposed in this area. The Taylor Creek assemblage is truncated by the Tchaikazan fault to the north, which separates it from extensive exposures of Powell Creek formation forming the western end of the Battlement Ridge belt.

TYAUGHTON CREEK AREA

Exposures of Powell Creek formation in the south-central part of the map area are restricted to small areas on either side of Tyaughton Creek, north of Tyaughton Lake. In this area the formation rests stratigraphically above the Silverquick formation across a gradational contact defined by the intercalation of chert-rich conglomerate characteristic of the underlying formation with volcanic conglomerate and breccia typical of the Powell Creek formation (Garver, 1989). This transitional contact is exposed along Taylor Creek and the ridge systems north and south of the creek. As mapped here (Figure 3), the transitional interval is included in the Silverquick formation, and the Powell Creek formation comprises overlying andesitic breccias, bedded tuffs and pyroxene-phyric flows. As thus defined, the Powell Creek formation outcrops in two areas along the south-central splay of the Fortress Ridge fault, and as two narrow slivers in the thrust-faulted core of the North Cinnabar syncline.

AGE OF THE POWELL CREEK FORMATION

The Powell Creek formation unconformably overlies the late Albian or younger Beece Creek succession in the western part of the map area, and rests gradationally above the Cenomanian or younger Silverquick formation to the east. It is in turn unconformably overlain by volcanics of probable Paleogene age at Mount Sheba, on Cluckata Ridge and in the mountains west of the Dil Dil Plateau, and is intruded by several Late Cretaceous and Tertiary plutons. The oldest pluton to intrude the formation is the Dickson-McClure batholith, which cuts Unit uKPCm1 along the southern margin of the Battlement Ridge belt and has yielded a 92.4±0.3 Ma U-Pb zircon age from Mount Dickson (Parrish, 1992). This constraint, combined with that of underlying rocks, indicates that the lower part of the Powell Creek formation is probably Cenomanian in age. This is

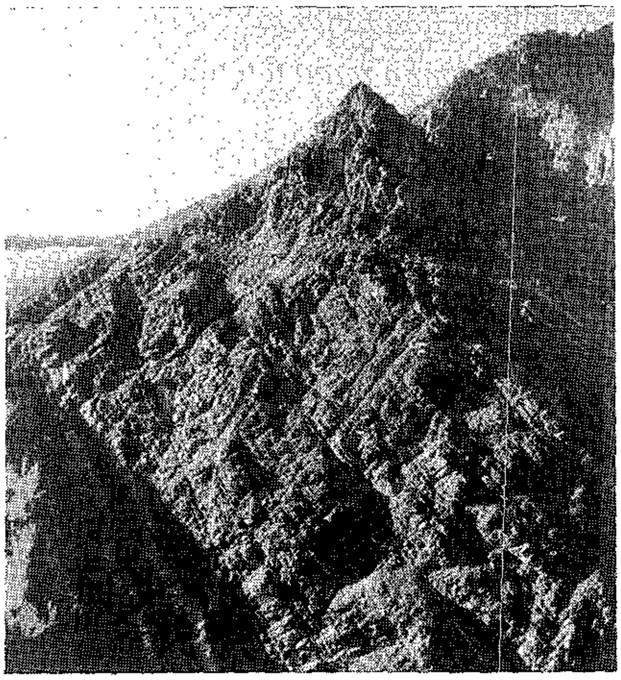

Photo 37. Angular unconformity between massive volcanic breccias of the Powell Creek formation and underlying well-bedded sandstones and shales of the Taylor Creek Group (Beece Creek succession), 2.5 km northeast of Mount Vic.

consistent with the Albian to Cenomanian age assigned to plant fossils collected from unit uKPCm2 slightly higher in the section (Appendix 5, Samples 86KG-18-2 and 86KG-22-3). Price (1986) reports that plant fossils collected from this same unit, along and east of Battlement Creek, were assigned a Late Cretaceous age by Stanley A. J. Pocock of Esso Resources Canada Limited; this suggests that a Cenomanian age is most likely for Unit uKPCm2.

Paleomagnetic data obtained from Unit uKPCm by P.J. Wynne of the Pacific Geoscience Centre have normal magnetizations, consistent with the mid-Cretaceous age inferred from other lines of evidence. However, reverse magnetizations were obtained from Unit uKPCu in the upper part of the formation, suggesting that this unit is younger than 83 Ma (P.J. Wynne, personal communication, 1990). A Campanian or younger age is therefore suspected for Unit uKPCu, and because it is not overlain by any other rock unit a very Late Cretaceous or early Tertiary age cannot be ruled out. Together, the paleomagnetic data for Unit uKPCu and fossil data for Unit uKPCm2 suggest that the intervening Unit uKPCm3 was either deposited over a time interval of 10 million years or longer, or the abrupt contact at the base of Unit uKPCu is a significant disconformity. In either case, the data suggests that rocks included within the Powell Creek formation were deposited both before and after intrusion of the Dickson-McClure batholith.

These data are consistent with Ar-Ar dating of the Powell Creek formation in the Mount Tatlow area to the west, where J.A. Maxson has obtained a date of 92±1.3 Ma

Photo 38. Lapilli tuff of the Powell Creek formation, south of Tosh Creek.

(Cenomanian) from near the base of the formation and a date of 79±4.1 Ma (Campanian)from the highest levels of the formation exposed in the core of the Mount Tatlow syncline (Wynne *et al.*, 1995).

OPHIOLITIC ASSEMBLAGES

SHULAPS ULTRAMAFIC COMPLEX

The Shulaps Ultramafic Complex outcrops in the Shulaps Range, which occupies the east-central part of the map area. It is bounded by the Yalakom fault to the northeast, and by a complex network of thrust, normal and strike-slip faults on the north, west, south and southeast, where it is juxtaposed against the Bridge River Complex, Cadwallader Group and Bralorne-East Liza Complex.

The ultramafic rocks of the Shulaps Complex were named the Shulops volcanics by Drysdale (1916, 1917), who included them within the Jura-Triassic(?) Cadwallader Series. McCann (1922) also referred to them as the Shulaps (new spelling) volcanics, but suggested that they were extruded unconformably above the Pennsylvanian-Permian Bridge River Series prior to deposition of the Upper Triassic Cadwallader Series. The complex was first studied in detail by Leech (1953), who concluded that it was an intrusive body, emplaced in the Late Triassic or Early Jurassic, and later redistributed, possibly by solid flow, along fault zones to the west and northwest. Later workers (Monger, 1977; Nagel, 1979; Wright *et al.*, 1982; Potter, 1983, 1986) suggested that the Shulaps and Bridge River complexes together constitute a dismembered ophiolite. The present study, and in particular the detailed mapping by Calon *et al.*

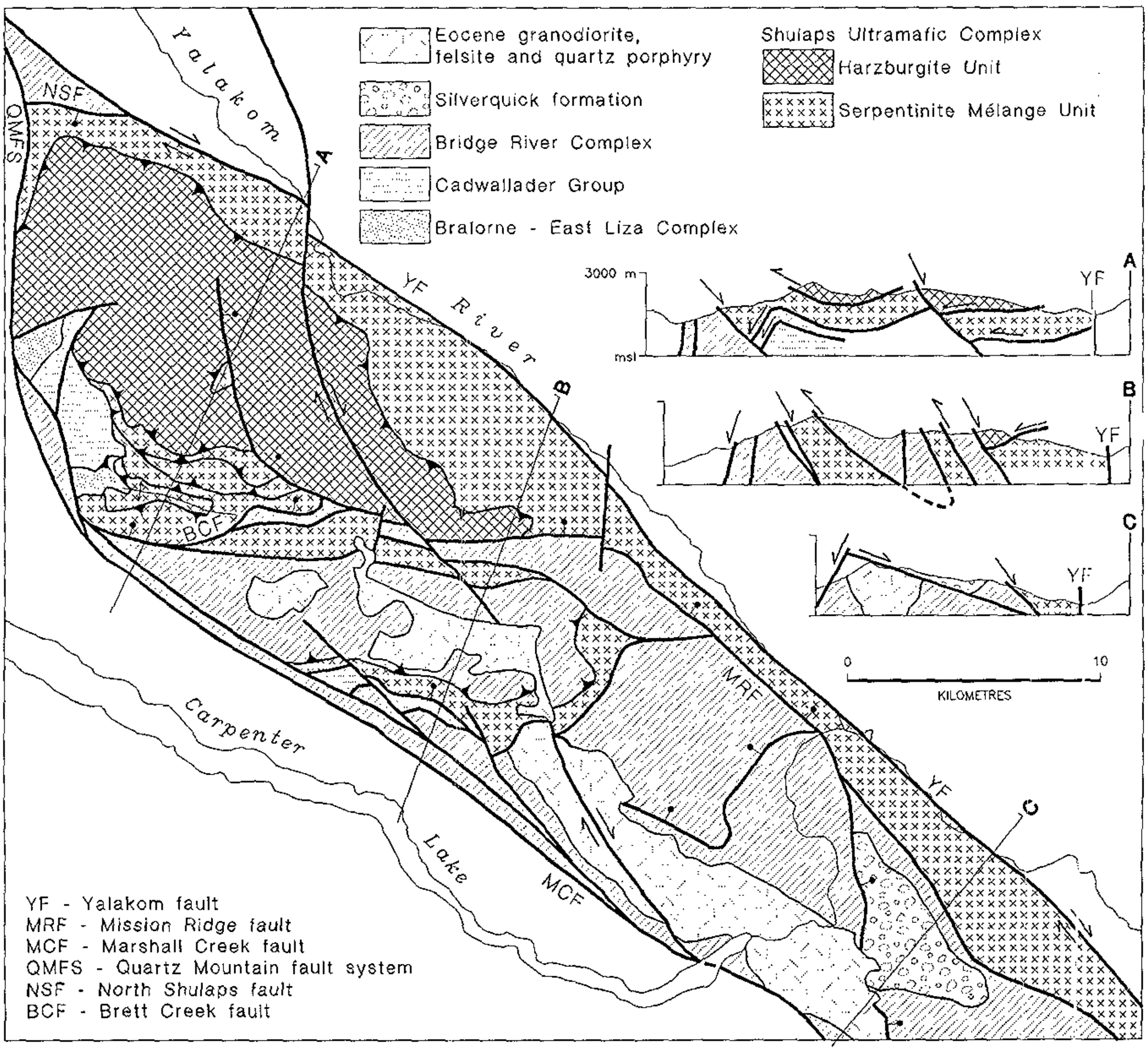

Figure 15. Simplified map of the Shulaps Range showing internal and external relationships of the Shulaps Ultramafic Complex.

(1990) along the southwestern margin of the complex, has confirmed that the Shulaps Complex is part of a dismembered ophiolite. Structural relationships within the area suggest, however, that the Shulaps and Bridge River complexes originated on opposite sides of Cadwallader Terrane, and are not, therefore, derived from a single ophiolite succession.

The Shulaps Complex is here subdivided into two mappable components (Figure 15). The structurally and topographically highest part of the complex consists of harzburgite and dunite with a mantle tectonite fabric (Unit PSH). The harzburgite unit is structurally underlain by serpentinite mélange (Unit PSM) that is well exposed along the southwestern edge of the complex, and also outcrops along its northeast and southeast margins. The serpentinite mélange comprises sheared serpentinite, derived from an ultramafic cumulate protolith, with knockers of ultramafic cumulates, layered to isotropic gabbros, amphibolitic dike fragments, and volcanic and sedimentary rocks. The Shulaps Complex is therefore regarded as a dismembered ophiolite in which the original igneous stratigraphy has been inverted during structural telescoping. The internal deformation was apparently coincident with thrust emplacement of the Shulaps Complex above the Bralorne-East Liza Complex and Cadwallader Group across a southwest-vergent thrust system that is exposed in the upper reaches of East Liza Creek. Elsewhere, the Shulaps Complex is juxtaposed against rocks of Methow Terrane across the Yalakom fault, or is in contact with the Bridge River Complex across a network of normal and oblique-slip faults related to the Marshall Creek - Yalakom - Mission Ridge system.

HARZBURGITE UNIT (PSH)

The rugged core of the Shulaps Range, from the headwaters of Burkholder Creek northwestward to Big Dog Mountain, is underlain by Unit PSH, comprising variably serpentinized harzburgite with lesser dunite and orthopyroxenite. The harzburgite weathers to a rusty-brown or orange-brown colour and is characterized by a warty texture resulting from resistant orthopyroxene grains weathering in relief against the more abundant but less resistant grains of olivine and serpentinized olivine. Individual mineral grains are typically anhedral and commonly range from 0.5 to 5 millimetres in size. The harzburgite is locally layered, (Photo 39), with layering defined by centimetre-wide bands of orthopyroxenite and rarely by wider bands of dunite, orthopyroxenite and harzburgite. Chromite is generally evident in accessory quantities, and locally defines (together with orthopyroxene) a penetrative mineral foliation and lineation that is typically parallel, or at a low angle to, compositional layering. This foliation is commonly at a high angle to faults and fabrics related to mid-Cretaceous thrust emplacement of the Shulaps Complex, and is interpreted by Calon *et al.* (1990) to be a mantle tectonite fabric.

Dunite is distinguished from harzburgite by its tan-weathering colour and smooth-textured surface. It consists

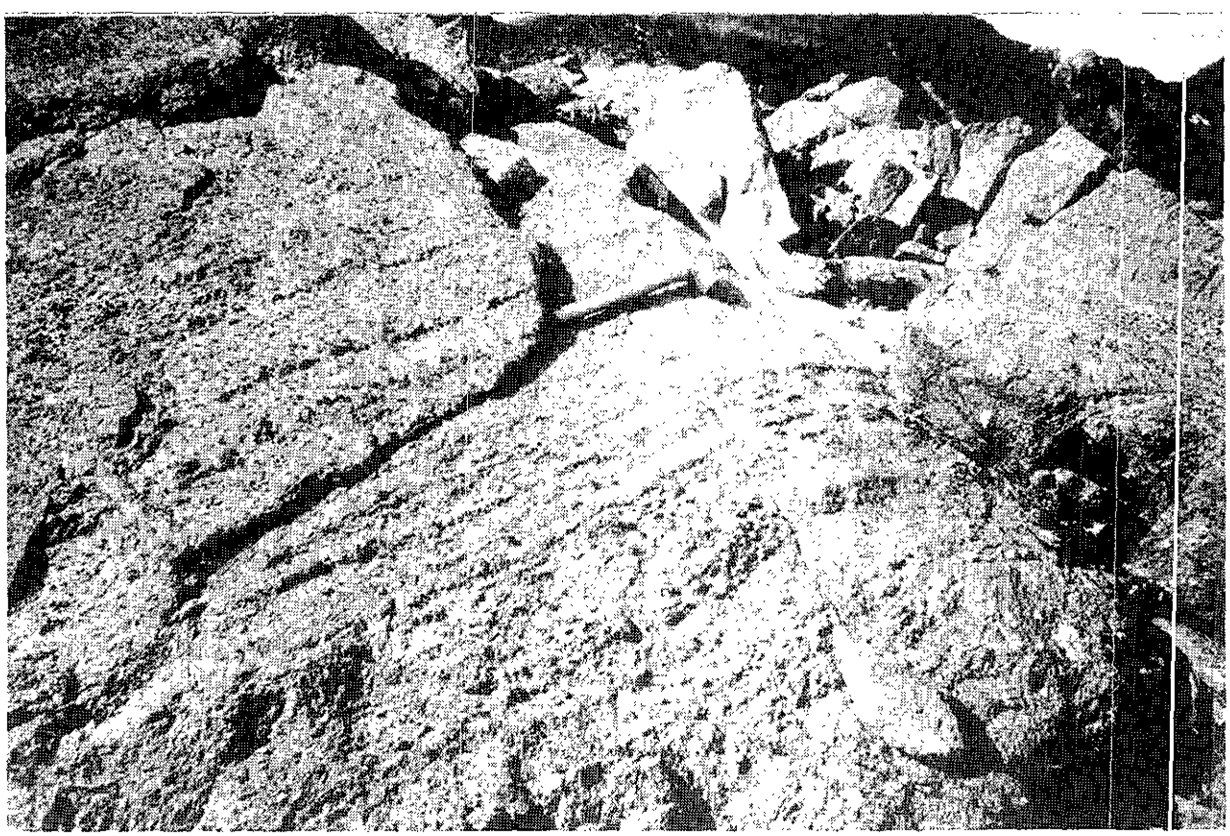

Photo 39. Layered harzburgite of the Shulaps Ultramafic Complex, north of East Liza Creek.

of variably serpentinized olivine accompanied by minor amounts of chromite and, locally, rare grains of orthopyroxene. Dunite locally defines layering within harzburgite, but is more common as unoriented pods and lenses, some of which crosscut layering and foliation within the harzburgite. This may reflect an upper mantle origin for the harzburgite unit, in the lower part of the transition zone to overlying ultramafic-mafic cumulates (T.J. Calon, personal communication, 1988).

Internal zones of sheared serpentinite suggest that the harzburgite unit is thrust imbricated, but these structures have not been mapped in detail. The unit lies structurally above cumulate-derived serpentinite mélange along its southwestern margin, where the contact is a northeast-dipping thrust system (Calon *et al.*, 1990). The structural base of the harzburgite in this area comprises foliated serpentinite that superficially resembles the sheared serpentinite forming the matrix to the underlying mélange; it is distinguished, however, by the absence of mafic plutonic, volcanic and sedimentary knockers, and by the composition of relatively less serpentinized blocks and kernels of peridotite (Calon *et al.*, 1990). This thrust contact is also exposed farther east, in a small window north of upper Peridotite Creek, but there the base of the unit is massive, relatively unserpentinized harzburgite that contrasts markedly with the underlying serpentinite mélange. The harzburgite unit also sits structurally above serpentinite mélange along its northeastern margin, but there the contact is poorly defined. It may, however, be a repetition of the southwestern thrust contact, implying that the harzburgite unit is exposed in the core of a broad northwest-trending synform. Elsewhere, the harzburgite unit is in contact with the Bridge River Complex across relatively late faults. These include a steeply dipping west-striking component of the Mission Ridge fault system that bounds the southern margin of the Shulaps Complex north of Serpentine Lake, and the easternmost strand of the north-striking Quartz Mountain fault system, that bounds the western margin of the complex west of Big Dog Mountain.

SERPENTINITE MÉLANGE UNIT (PSM)

The lower part of the Shulaps Ultramafic Complex comprises foliated serpentinite containing blocks of ultramafic, gabbroic, volcanic and sedimentary rock. The largest knockers, up to hundreds of metres across, derive from an igneous complex which includes layered ultramafic cumulates, layered gabbro and varitextured gabbro, all cut by swarms of mafic to intermediate dikes. These are inferred to be the remnants of a plutonic-volcanic suite characteristic of the upper part of an ophiolite complex (Calon *et al.*, 1990). Volcanic and sedimentary knockers are smaller and less common, and include basalt, bedded chert, limestone, sandstone and pebble conglomerate. These presumably represent still higher levels of the original ophiolite succession and/or a sampling of the footwall succession across which the Shulaps complex was emplaced.

The serpentinite mélange unit is best exposed in the southwestern part of the Shulaps Complex, between East Liza and Hog creeks, where it outcrops as a broad east-trending antiform (Figure 15, Section A). The well-exposed northern limb of the antiform comprises several east to northeast-dipping thrust duplex structures sandwiched between the harzburgite unit above and the Bralorne-East Liza Complex and Cadwallader Group below (Calon *et al.*, 1990); the lower contact is exposed only in a small half-window along East Liza Creek, at the west end of the mélange belt along the crest of the antiform. The southern limb of the antiform is truncated by the west-trending Brett Creek fault, across which the serpentinite mélange is placed against Bridge River schists. The mélange belt is also truncated on the east by a northwest-trending splay of the Mission Ridge fault system, where it is juxtaposed against the harzburgite unit.

The serpentinite mélange unit is repeated along the northeastern margin of the Shulaps Complex, where it comprises the northeast limb of a broad synform cored by the overlying harzburgite unit (Figure 15, Section A). There, it consists of serpentinite containing small knockers of diabase, amphibolite, gabbro, and rare greenstone and chert. The knockers are similar to those in the southwestern mélange belt but, in contrast, rarely exceed a few metres in size. This belt is moderately well exposed between the northern tip of the complex and the mouth of Peridotite Creek, and is also represented by scattered exposures near Lake La Mare. It continues southeastward from there, beyond the main part of the Shulaps Complex, as a poorly exposed lens between the Yalakom fault to the northeast and the Mission Ridge fault and a related splay(?) to the southwest (Figure 15, Section C).

The serpentinite mélange unit is also repeated to the south of the main part of the Shulaps Complex, where it is imbricated with the Cadwallader Group and Bridge River Complex and outlines a faulted west-trending fold that formed during Eocene deformation within the Shulaps - Mission Ridge metamorphic belt (Figure 15, Section B). It also occurs as narrow fault slivers within the Quartz Mountain fault system a short distance to the west and northwest of the main part of the Shulaps Complex (Figure 3).

The matrix of the serpentinite mélange unit consists mainly of sheared and foliated dark green serpentinite containing lenses and blocks, from several centimetres to several metres in size, of more massive, variably serpentinized ultramafite. Where protolith compositions can be discerned they comprise wehrlites, dunites and clinopyroxenites, indicating that the matrix of the serpentinite mélange unit was derived from ultramafic cumulates, rather than from correlatives of the structurally overlying harzburgite unit (Calon *et al.*, 1990). The serpentinite commonly displays several generations of foliations and slickensided shear surfaces. In places these fabrics are chaotic, but elsewhere they show systematic orientations and relationships that, in part, relate to southwest-directed thrusting within the mélange unit (*see* Figure 21). The latter occurrences include narrow zones of mylonite, some with well-developed S-C fabrics, that occur along the base of the unit and along contacts with large knockers within the unit. Locally, and particularly in the vicinity of Shulaps Peak, the serpentinite has been transformed into schists containing regenerated olivine porphyroblasts within narrow zones of prograde metamorphism adjacent to a suite of late kinematic dioritic dikes (*see* Chapter 3).

The majority of blocks within the Shulaps serpentinite mélange unit comprise mafic and ultramafic plutonic rocks. These range from less than a metre in size to more than 3 kilometres in longest dimension, and include fine to coarse grained isotropic gabbros, layered gabbro, dioritic and diabasic dikes, clinopyroxenite, wehrlite and dunite. These rock types are found in isolation or as various combinations in different blocks. Most of the common lithologic variants occur within the large block exposed near Shulaps Peak (Photo 40), which is presumed to offer a fairly representative section through a part of the plutonic complex from which most of the knockers were derived. The base of this block comprises a section, about 200 metres thick, of ultramafic rocks intruded by a swarm of diabasic dikes. The ultramafic rocks (in part equivalent to the "clinopyroxenite" unit of Leech, 1953 and Nagel, 1979) consist mainly of wehrlite and clinopyroxenite that contain local irregular pods of dunite. Locally, however, they comprise poorly defined cyclic sequences that typically include a relatively thin basal dunite layer, an overlying wehrlite layer, and an upper clinopyroxenite layer (Calon *et al.*, 1990). The ultramafic rocks are at least locally overlain by a section of distinctly layered gabbro, although the external contacts of this unit are largely obscured by younger dioritic dikes. Layering within the gabbro is defined by alternating clinopyroxene-rich and plagioclase-rich layers that range from a few centimetres to a few tens of centimetres wide. The upper and volumetrically dominant part of this composite plutonic block (referred to as the "main" gabbro by Nagel, 1979) comprises a heterogeneous assemblage of varitextured gabbros. It consists predominantly of medium to coarse grained isotropic clinopyroxene ± orthopyroxene gabbro, which is cut by, or grades into, dikes and pods of coarse grained pegmatitic gabbro and leucogabbro. The gabbro also encloses lenses of clinopyroxenite and fault-bounded domains of foliated gabbro, and is cut by a suite of diabasic and dioritic dikes.

Light grey tonalite forms a part of the ultramafic-mafic plutonic complex in the upper reaches of Jim Creek, where it occurs as a small pod, about 10 metres across, that intrudes gabbro within a plutonic block about 150 metres in diameter. The medium-grained tonalite consists of sheared and broken crystals of altered albitic plagioclase (50 to 60 per cent) and quartz (30 to 40 per cent), along with minor amounts of secondary epidote, chlorite, calcite and opaque minerals that typically occur in randomly distributed patches and clusters. U-Pb dating of four zircon fractions extracted from a sample of this tonalite yield a collinear discordia line with an upper intercept of 288 +17/-11 Ma, which is interpreted as the best estimate for the magmatic age (Appendix 8, Sample 89TCA-2-6-1).

Synplutonic deformation within the ultramafic-mafic plutonic complex represented by blocks in the Shulaps serpentinite mélange unit is indicated by deformation features, including ductile and brittle fault zones and foliated gabbro units, that are crosscut by younger phases of the plutonic suite (*see* Chapter 3). Mineral assemblages associated with these deformation fabrics formed under amphibolite to

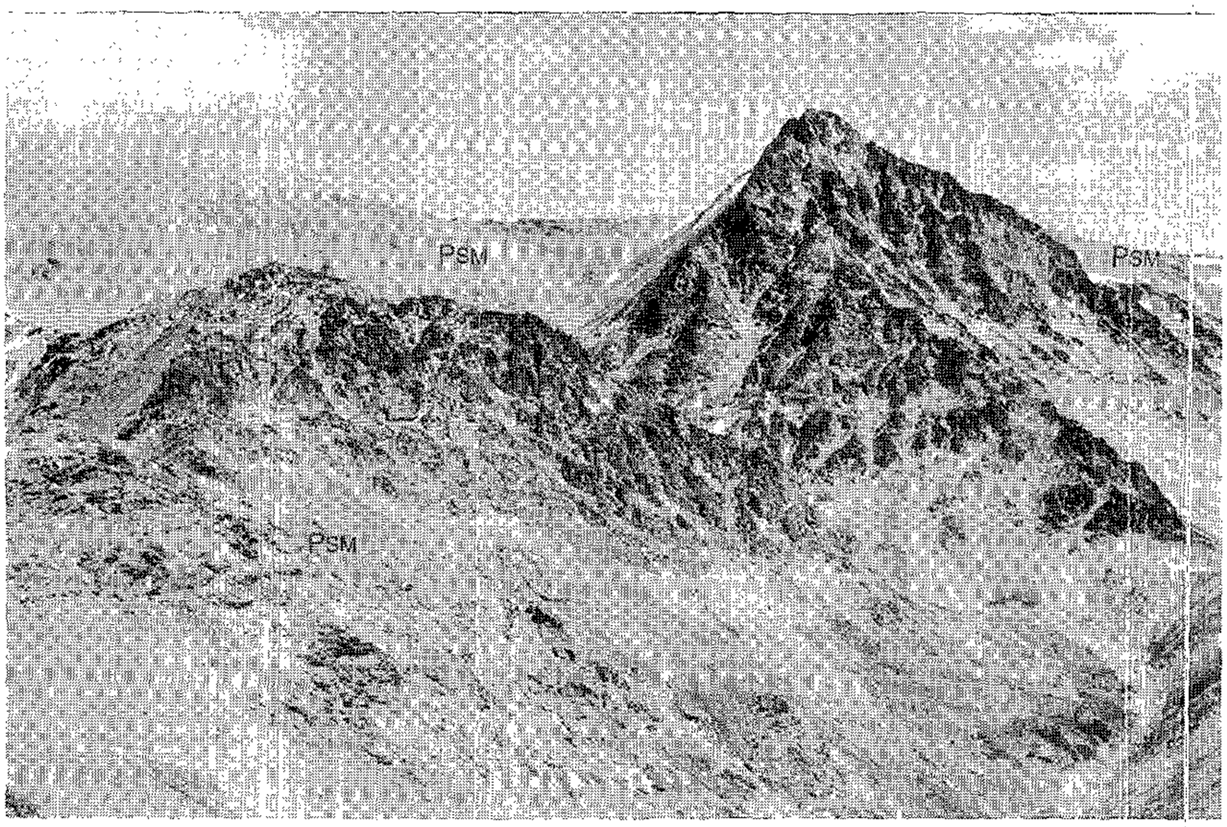

Photo 40. Large gabbro knocker, several hundred metres wide, within the Shulaps serpentinite mélange unit at the headwaters of Jim Creek. PSM=sheared serpentinite above and below the knocker.

greenschist facies conditions (Calon *et al.*, 1990). Amphibolite that is inferred to have formed during this event is a widespread, although not volumetrically abundant, component of the serpentinite mélange unit. It occurs as knockers ranging from a metre to several tens of metres in size, that comprise a foliated and/or lineated intergrowth of hornblende and plagioclase, locally grading into fine to medium-grained diabasic-textured rocks in which amphibole only partially replaces pyroxene. Hornblende separates from two of these knockers have been dated by the Ar-Ar method. One, from the northwestern margin of the Shulaps Complex, yields a plateau date of 271±16 Ma (Archibald *et al.*, 1991a; Appendix 7, Sample TL-88-23). The other, from the southwestern corner of the Shulaps Complex, yields a plateau date of 251±8 Ma (Appendix 7, Sample TL-88-4). These Permian dates are somewhat younger than the U-Pb magmatic age of 288+17/-11 Ma from the tonalite (although the 271±16 Ma date from sample TL-88-23 is the same within analytical error); they are interpreted to be the age of cooling following metamorphism, deformation and plutonism related to construction of Shulaps oceanic crust.

Dikes and boudinaged dike fragments are a common component of the Shulaps serpentinite mélange unit, and probably encompass a wide range of ages. Gabbroic dikes that occur as boudinaged fragments arranged in linear or en echelon arrays may in large part be related to the Early Permian plutonic suite represented by the large ultramafic-mafic plutonic blocks. Many of these dike fragments are partially or completely altered to white rodingite (Photo 41), consisting mainly of diopside, tremolite-actinolite, plagioclase, colourless garnet, chlorite and vesuvianite (Leech, 1953, Nagel, 1979). Some gabbroic dike fragments are probably younger, however, as they are lithologically similar to a suite of mid-Cretaceous sheeted hornblende gabbro dikes that intrude the Bridge River Complex south of the Shulaps Range (Archibald *et al.*, 1991a; Appendix 7, Sample TL-88-10). Diorite, quartz diorite and hornblende-feldspar porphyry comprise a suite of dikes that are inferred to be mainly Late Cretaceous in age, based on Ar-Ar dating of two samples from the northeastern part of the Shulaps Complex (Appendix 7, Samples TL-87-11 and TL-89-6). These dikes intrude both the serpentinite mélange unit and the overlying harzburgite unit. They locally preserve chilled margins against the enclosing serpentinite, and some of them occur within prograde metamorphic aureoles containing regenerated olivine porphyroblasts. Most dike contacts are sheared, however, and these dikes, too, are commonly boudinaged where they intrude the serpentinite mélange unit. They may have been intruded late in the contractional deformation episode that included imbrication and thrust-emplacement of the Shulaps Complex, or their deformation may be related to the subsequent episode of dextral strike-slip along the Yalakom fault (*see* Chapter 3).

Volcanic rocks are not common within the Shulaps serpentinite mélange unit, but relatively small knockers of massive greenstone, pillowed basalt and pillow breccia, in places containing lenses of limestone and chert, occur locally. Trace element geochemistry of these blocks suggests

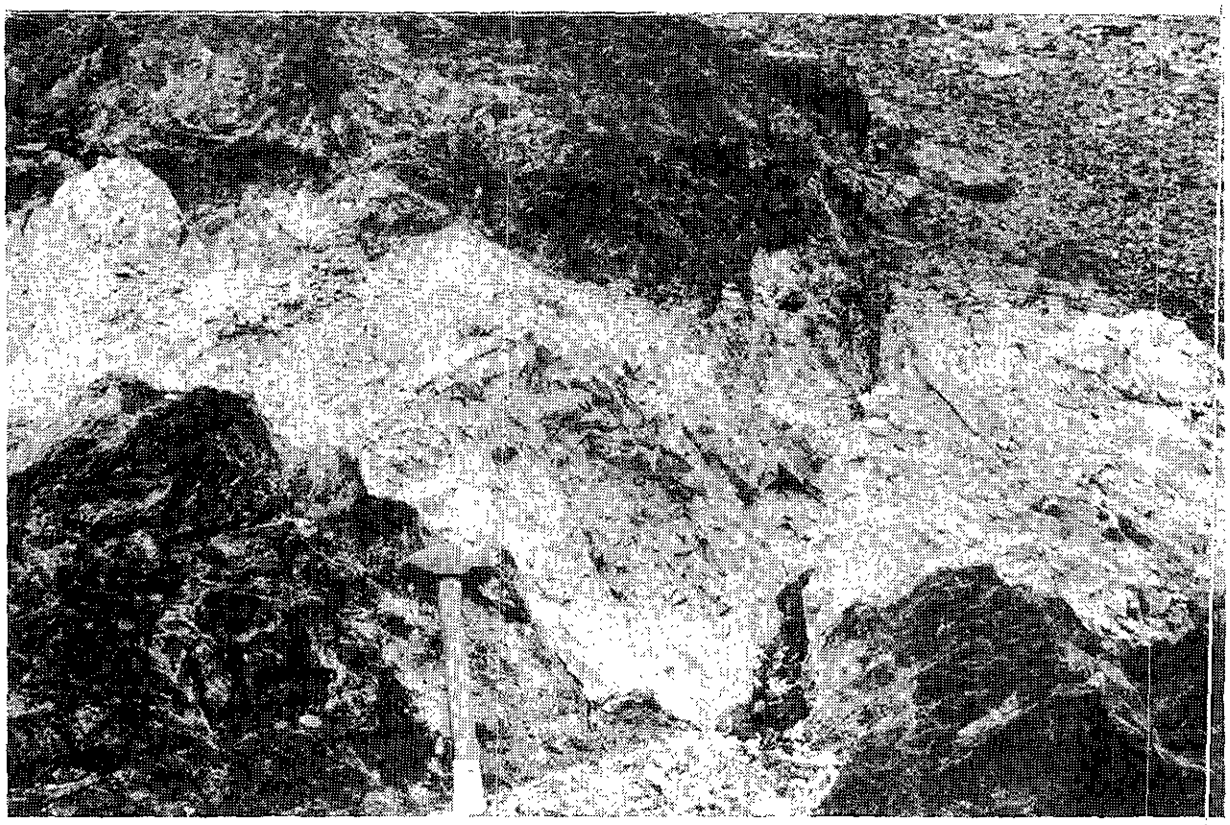

Photo 41. Rodingite dike boudin within the Shulaps serpentinite mélange unit, south of the mouth of Blue Creek.

derivation from alkalic, within plate and mid-ocean ridge basalts (Macdonald, 1990a,b). Some samples overlap the compositional field of volcanic rocks within the Bralorne-East Liza Complex, which is thought to correlate with the Shulaps Complex. These volcanic rocks may have originated in the upper levels of the original ophiolite stratigraphy that is best represented by the ultramafic-mafic plutonic rocks that also occur as blocks within the mélange. Other volcanic blocks are chemically similar to basalts of the Bridge River Complex, which may represent accumulations from a separate oceanic plate. These may be exotic blocks of Bridge River Complex incorporated into the mélange during its thrust imbrication and emplacement. Alternatively, they may simply reflect the diversity of the oceanic crust represented by the Shulaps and Bralorne-East Liza complexes.

Blocks of clastic sedimentary rock, and less common chert and limestone, are widespread within the Shulaps serpentinite mélange unit but only a few are sufficiently large to be shown on the geological map (Figure 3). The largest mappable block outcrops between East Liza and Jim creeks, two kilometres north of Marshall Lake, and consists of a poorly stratified assemblage of sandstones, slates and granule to small pebble conglomerates. Clastic grains are dominated by chert, cherty argillite and plagioclase feldspar, but also include monocrystalline and polycrystalline quartz, feldspathic volcanic rock, siltstone and quartz tectonite. Similar coarse clastic rocks outcrop as a separate(?) smaller block along Jim Creek, one kilometre to the east, and as a relatively small mappable block southwest of Rex Peak, within the belt of serpentinite mélange south of the main part of the Shulaps Complex. In each of the latter occurrences, however, the clastic rocks are intercalated with substantial intervals of light to medium grey bedded chert. Other sedimentary knockers, most too small to be shown on the geological map, comprise various combinations of bedded chert, argillite, slate, phyllite, siltstone and sandstone. Sandstone compositions generally resemble those of the large knockers described above, although one block of thin to medium bedded turbiditic sandstone in the upper reaches of Hog Creek contains mainly plagioclase feldspar and quartz grains. Limestone occurs rarely, either as separate small blocks, or as discontinuous narrow lenses within clastic rocks. One limestone knocker, from the narrow belt of serpentinite mélange in the southeastern corner of the map area, has yielded Late Triassic conodonts (Appendix 1, Sample 89RMA-28-4-1). The only other dated sedimentary block within the serpentinite mélange unit comes from 2.5 kilometres west of Shulaps Peak, where a chert knocker has yielded Permian or Triassic conodonts (Appendix 1, Sample 89RMA-15-3A).

BRALORNE-EAST LIZA COMPLEX

The Bralorne-East Liza Complex consists of serpentinite, gabbro, diorite, tonalite and greenstone that occur as structural slices interleaved with the Cadwallader Group throughout the southern part of the Taseko - Bridge River map area (*see* Figure 8). In the western part of the area it includes rocks that were assigned to the Bralorne and President intrusions by Cairnes (1937, 1943) as well as some volcanic rocks that were previously included in the Pioneer Formation of the Cadwallader Group. It also includes gabbro and greenstone that outcrop near the head of East Liza Creek and had previously been referred to as the East Liza igneous suite (Calon *et al.*, 1990; Macdonald, 1990a,b), the East Liza gabbro and East Liza volcanics (Nagel, 1979) or greenstone-gabbro complex (Leech, 1953, his map unit C). Other rocks presently included in the complex, near Liza Lake and in the southwestern Camelsfoot Range, had previously been mapped as Bridge River Complex (Schiarizza *et al.*, 1989a,b, 1990a,b; Coleman, 1990, 1991). All of these fault-bounded panels of rock presently included in the Bralorne-East Liza Complex are similar in that they include mafic volcanic rocks with the chemistry of ocean floor tholeiites, as well as ultramafic, mafic and intermediate plutonic phases that are readily interpreted as associated rocks within an original ophiolite succession. Many of the plutonic rocks are remarkably similar to the large gabbro blocks within the Shulaps serpentinite mélange unit, with which they are inferred to correlate. This correlation is supported by similar Early Permian radiometric dates that have been obtained from both complexes (R. Friedman, Appendix 8; Leitch *et al.*, 1991a). The different structural panels assigned to the Bralorne-East Liza Complex are also linked by their invariable spatial association with the Cadwallader Group (Figure 8). This spatial relationship may reflect an original stratigraphic relationship, with the Cadwallader Group having been deposited above an oceanic basement represented by the Bralorne-East Liza Complex. This has not been proven in the Taseko - Bridge River map area, however, as all observed contacts between the two units are faults.

In most areas, ultramafic rocks of the Bralorne-East Liza Complex are represented by fault-bounded lenses of serpentinite that occur locally within the unit or as slivers along external bounding fault zones. More extensive exposures occur in the vicinity of Roxey and Sumner creeks, along the southern margin of the belt that crosses Gun Creek, as well as in the lowest fault panel exposed southwest of Liza Lake, and at the northwest end of the belt that is truncated by the Dickson - McClure batholith near Mount Penrose. Primary compositions are largely obscured by serpentinization, but the protolith lithologies included, at least in part, clinopyroxenite and wehrlite. This is consistent with the correlation of the Bralorne-East Liza Complex with the blocks of ultramafic-mafic plutonic rocks found within the Shulaps serpentinite mélange unit. In contrast, the fault-bounded Pioneer Ultramafic Complex (Wright *et al.*, 1982) that is exposed a short distance south of the map area, about 5 kilometres southeast of Bralorne, comprises harzburgite and dunite that probably correlate with the Shulaps harzburgite unit.

Gabbro of the Bralorne-East Liza Complex is well exposed near East Liza Creek and in the fault panel that crosses Pearson Ridge and the lower reaches of Tyaughton Creek. Gabbro occurs locally within the extensive thrust panel in the southwestern Camelsfoot Range, and also within the fault block that crosses Gun Creek, where it was in part referred to as the Sumner gabbro by Cairnes (1937). The gabbroic rocks within the complex consist mainly of medium to coarse grained clinopyroxene gabbro, locally containing pods of clinopyroxenite, and commonly cut by small pods and dikes of pegmatitic gabbro, and by abundant gabbroic, diabasic and dioritic dikes. Sparse grains of orthopyroxene occur locally within the predominant gabbroic phase, and serpentine pseudomorphs after olivine were reported by Cairnes (1937) from the Sumner gabbro. Layering, defined by alternating clinopyroxene-rich and plagioclase-rich layers several centimetres wide, occurs within the gabbro at East Liza Creek, as do local plastic shear zones that predate intrusion of some pegmatitic gabbros and diabasic dikes (Calon *et al.*, 1990; Macdonald, 1990a). Similar features occur within plutonic blocks of the overlying Shulaps serpentinite mélange unit, and support the interpretation that the Bralorne-East Liza Complex and Shulaps Complex are correlative.

Diorite, referred to as the Bralorne diorite by Cairnes (1937, 1943), is the plutonic phase dominating the three structural panels of Bralorne-East Liza Complex exposed near Gold Bridge, Gun Creek and Lajoie Lake. Medium to fine-grained hornblende diorite is also present within the complex near East Liza Creek, where it occurs as late-stage dikes and pods that are concentrated within the transition zone between gabbro and overlying volcanic rocks. The Bralorne diorite is typically a mottled grey and green, medium-grained equigranular rock consisting predominantly of altered plagioclase and hornblende, with accessory sphene, apatite, opaque oxides and quartz. Augite, partly altered to amphibole, is reported to occur locally (Cairnes, 1937), but was not observed in thin sections examined from the present study area. The primary minerals are partially altered to an assemblage that includes various combinations of chlorite, epidote, clinozoisite, leucoxene, biotite, sericite, quartz, carbonate, prehnite and pumpellyite. These secondary minerals also occur within networks of narrow light-coloured veinlets that are characteristic of the rock.

The Bralorne diorite is inferred to be a relatively young phase of the Bralorne-East Liza Complex because, at the B.C. hydro quarry north of Gold Bridge, it locally forms the matrix of an intrusion breccia that contains xenoliths of a wide variety of rock types, including clinopyroxenite, gabbro and greenstone (Photo 42). This interpretation is consistent with the observations of Leitch (1989) farther to the south, who noted that diorite locally intrudes serpentinite, and that local hybrid zones referred to as "greenstone-diorite" at the Bralorne mine comprise contact zones that display varying degrees of assimilation of older ultramafic or volcanic rock by cross-cutting diorite. Similar complex interfingering and gradational relationships are characteristic of the contacts between diorite and associated volcanic rocks of the Bralorne-East Liza Complex elsewhere in the area. These relationships led Cairnes (1937, 1943) to suggest that the diorite and volcanic rocks (which he included in the Pioneer Formation of the Cadwallader Group) originated from the same magma body, and were erupted and intruded during a long period of igneous activity.

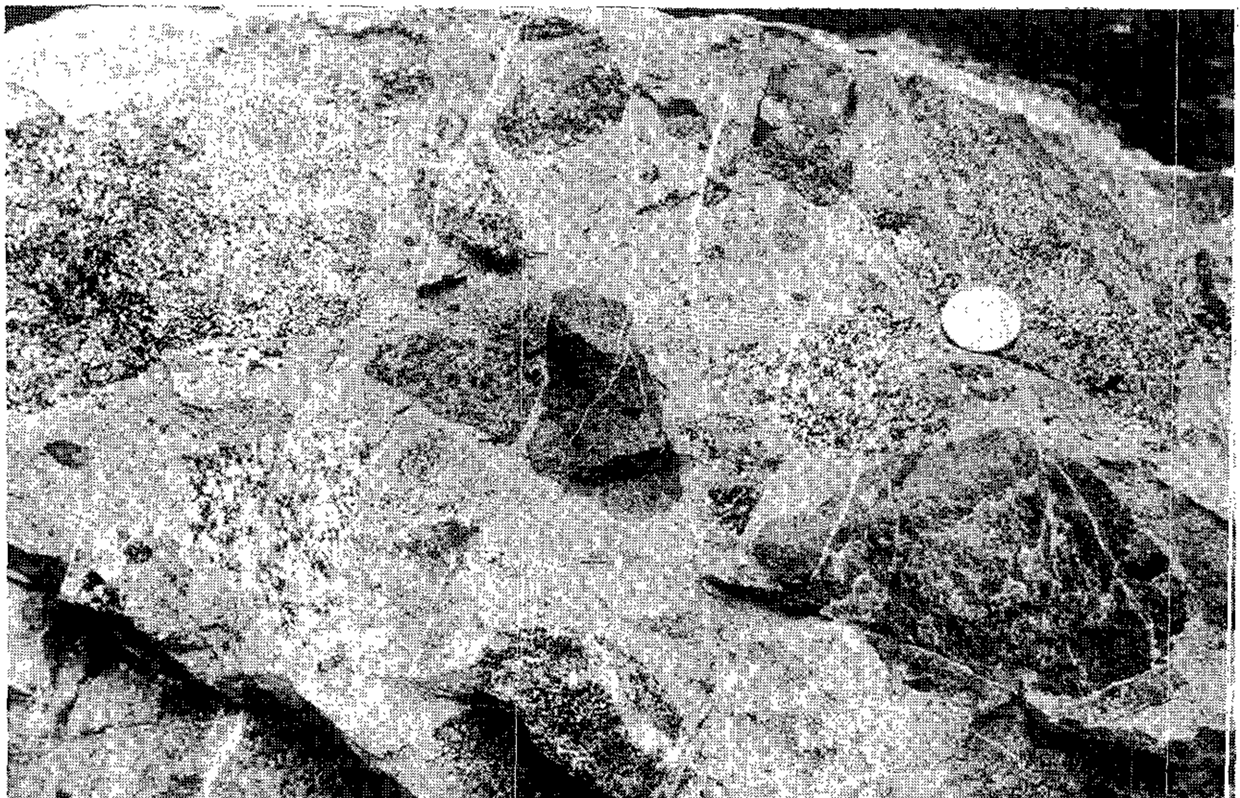

Photo 42. Intrusion breccia, Bralorne-East Liza Complex, Gold Bridge quarry.

Hornblende and zircon separates from different samples of Bralorne diorite collected at the Gold Bridge quarry yielded K-Ar and U-Pb radiometric dates of 287±20 Ma (Leitch *et al.*, 1991a) and 293 ±13 Ma (Church, 1996), respectively. A hornblende separate from diorite at the same location yields an Ar-Ar plateau date of 279±2.0 Ma and an integrated age of 295 ±36.4 Ma (Appendix 7, Sample GBQ). U-Pb dating of zircons from two samples from the Bralorne mine indicate a minimum age of 267 Ma (Leitch *et al.*, 1991a). A hornblende separate from one of these samples has yielded an Ar-Ar plateau date of 275.5±29.8 Ma and an integrated age of 298.7±41.0 Ma (Appendix 7, Sample C093A). These data suggest that the diorite in this part of the Bralorne-East Liza Complex crystallized and cooled through the argon retention temperature of hornblende in Late Carboniferous to Early Permian time.

Light grey tonalite (the Bralorne soda granite of Cairnes, 1937) is an important component of the Bralorne-East Liza Complex in the fault block exposed near Gold Bridge. It also occurs in the southern extension of this fault panel, which hosts the Bralorne and Pioneer mines (*see* Figure 20). The tonalite occurs as irregular dikes and veins within diorite, from a few centimetres to a few metres in size (Photo 43), and also as larger bodies that are more than 100 metes in longest dimension. In places it clearly intrudes the Bralorne diorite, but elsewhere contacts are gradational and indistinct, or else sheared. The tonalite consists of a fine to medium grained, equigranular intergrowth of sodic plagioclase and quartz, accompanied by chlorite, epidote, carbonate, leucoxene, sericite and opaque oxides, which are largely alteration products of original mafic grains. U-Pb dating of zircons extracted from two samples of Bralorne soda granite at the Bralorne mine suggest a minimum age of 272 Ma (Leitch *et al.*, 1991a). This date is, within error, the same as that obtained from the Bralorne diorite in the same area, although field relations there, as well as in the present study area, indicate that the soda granite (tonalite) is somewhat younger than the diorite. These relationships, as well as geochemical arguments presented by Leitch (1989), suggest that the soda granite as a differentiate of the same magma that produced the diorite.

Volcanic rocks occur within all fault panels of Bralorne-East Liza Complex exposed in the Taseko - Bridge River map area. They consist mainly of green, rusty to brown-weathering pillowed to massive flows and pillow breccias (Photo 44). The flows are commonly amygdaloidal and locally porphyritic. Amygdules are generally filled with mixtures of carbonate, chlorite, epidote, pumpellyite and prehnite. Relict phenocrysts of plagioclase and clinopyroxene are enclosed in a fine-grained groundmass of the same minerals together with opaque grains and alteration products that include sphene-leucoxene, chlorite, sericite, epidote, clinozoisite and carbonate. The contact between volcanic rocks and gabbro is locally well-exposed near East Liza Creek, where it is a zone several tens of metres wide consisting of abundant diabasic and dioritic dikes, gabbro pods and narrow screens of volcanic rock (Calon *et al.*, 1990). Similar complex contact zones characterize the tran-

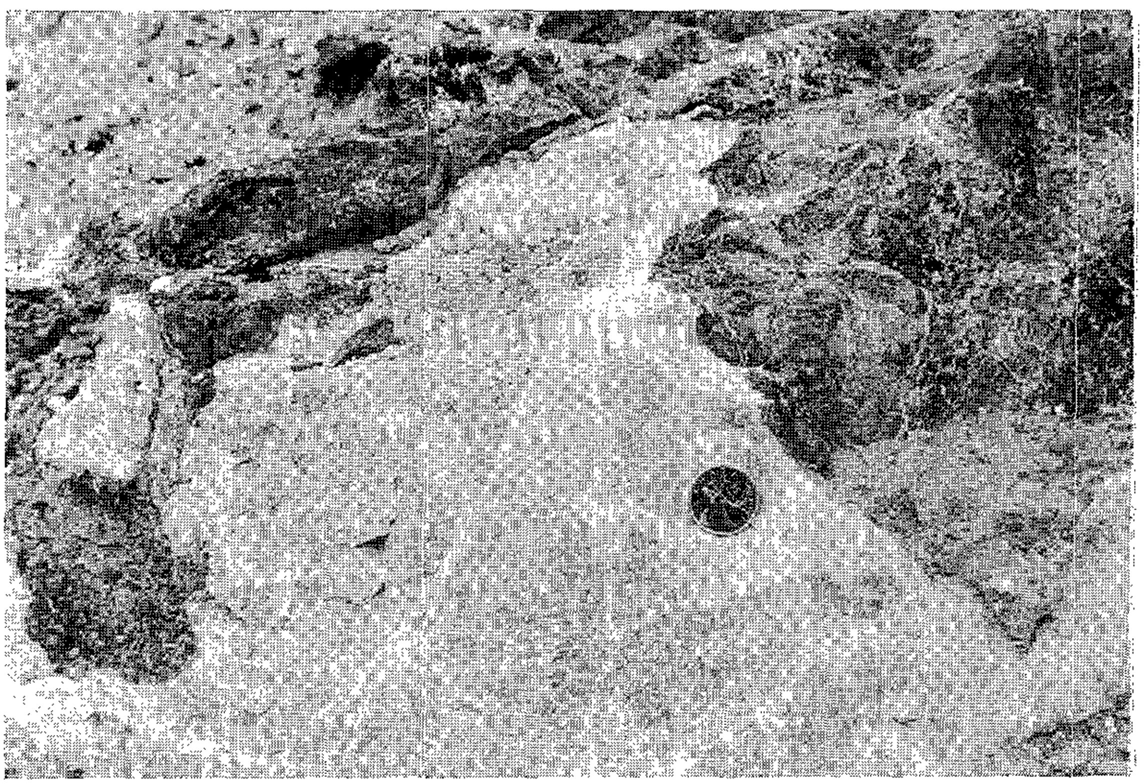

Photo 43. Tonalite intruding diorite, Bralorne-East Liza Complex, north of Gold Bridge.

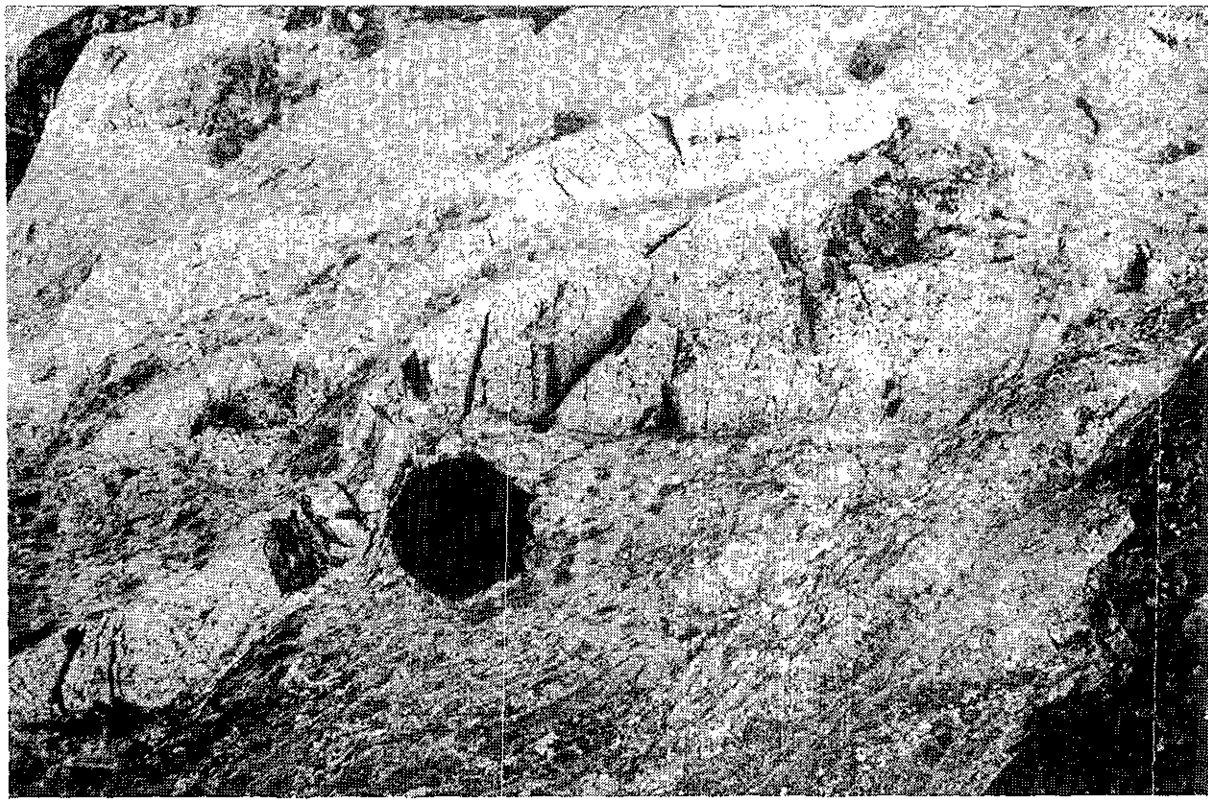

Photo 44. Deformed pillow breccia, Bralorne-East Liza Complex, north of Downton Lake.

sition from diorite to volcanic rocks in the Gold Bridge - Bralorne area (Cairnes, 1937; Leitch, 1989). In the Camelsfoot Range, pillowed and massive volcanics are associated with diabase and breccia comprising pebble-sized clasts of fine-grained greenstone and diabase in a sheared and veined calcareous matrix.

Volcanic rocks of the Bralorne-East Liza Complex are not readily distinguished from those of the Bridge River Complex on the scale of an individual outcrop, but characteristically occur within mappable units that also include gabbroic to dioritic plutonic rocks, and are invariably structurally imbricated with rocks of Cadwallader Terrane. The integrity of the Bralorne-East Liza Complex mapped by these criteria is confirmed by the chemistry of the volcanic rocks, which invariably display chemical characteristics of ocean-floor basalts (Macdonald, 1990a,b). On this basis they are distinct from greenstones of the Bridge River Complex (typically within plate and alkalic basalts; Potter, 1983) and from those of the Cadwallader Group (mainly island arc tholeiites; Rusmore, 1987).

Sedimentary rocks are not common within the Bralorne-East Liza Complex, but were observed in two places. The first is near the mouth of Shulaps Creek, where pillowed greenstone of the complex encloses a narrow lens of interbedded chert and siltstone. The other is about 2 kilometres west of Liza Lake, where light grey recrystallized limestone is in depositional contact with pillowed greenstone of the Bralorne-East Liza Complex near its thrust contact with the underlying Cadwallader Group. The underlying fault zone is, throughout its entire length, marked by a zone of sheared and brecciated chert, limestone and greenstone that may also have been derived from the Bralorne-East Liza Complex. Limestone from the fault zone and from the body that is in depositional contact with overlying pillowed greenstone were processed for microfossils but none were found. The ages of the sedimentary rocks associated with the Bralorne-East Liza Complex are therefore unknown.

METHOW TERRANE

JURASSIC ROCKS (lmJys, mJyv, mJcs)

Jurassic clastic sedimentary rocks were recognized near the mouth of Blue Creek by Leech (1953), and were further described by Frebold *et al.* (1969). They were mapped as a fault-bounded lens along the Yalakom fault by Tipper (1978), but the present study has established that they comprise the northwest end of a belt that extends almost continuously to the southeast corner of the map area, a distance of 40 kilometres. This belt of Jurassic rocks (Unit lmJys) is bounded by the Yalakom and Camelsfoot faults on the southwest and is in stratigraphic contact with the Yalakom Mountain facies of the Lower Cretaceous Jackass Mountain Group to the northeast. Rocks tentatively correlated with this Jurassic succession also occur within a separate fault-bounded lens farther to the northwest along the Yalakom fault, where they are locally intercalated with andesitic volcanic breccia of Unit mJyv. A separate, lithologically distinct succession of Middle Jurassic fine-grained sandstones, which outcrops north of the Yalakom fault along Lone Valley Creek, was also identified during the present study (Unit mJcs). These rocks sit stratigraphically beneath the Churn Creek facies of the Jackass Mountain Group.

The Jurassic rocks northeast of the Yalakom and Camelsfoot faults extend southeastward into rocks that had previously been mapped as Lower Cretaceous Lillooet Group by Duffell and McTaggart (1952). These rocks, along with at least parts of the Lillooet Group, are readily correlated with the Lower to Middle Jurassic Dewdney Creek Formation of the Ladner Group, as defined by O'Brien (1986, 1987), on the basis of age, lithology and stratigraphic position beneath the Jackass Mountain Group (Schiarizza *et al.*, 1990a; Mahoney, 1992, 1993). Within the Taseko - Bridge River map area, the Jurassic rocks of Unit lmJys comprise a steep to moderately dipping (locally overturned along the Yalakom fault) east to northeast-facing succession of sandstone, siltstone and mudstone, intercalated with lesser amounts of granule to pebble conglomerate. The sandstones are mainly coarse to medium grained, locally gritty, green to grey wackes and arenites containing variable proportions of plagioclase feldspar and volcanic-lithic detritus, accompanied by less abundant fine-grained sedimentary rock fragments and minor amounts of quartz. Leech (1953) reported detrital chromite, including some euhedral grains, from a heavy mineral concentrate of a sandstone sample, but it is not apparently a major component of the rock. Carbonaceous chips and plant fragments occur locally in sandstone beds, and are common in intercalated siltstone and mudstone.

The sandstone occurs both as medium to thick beds and as massive, apparently unbedded intervals several tens of metres thick. The sandstone in well-bedded intervals is typically intercalated with thin to thick beds of dark grey mudstone and siltstone (Photo 45). Sandstone beds are commonly graded, and some display sole marks, load casts and rip-up clasts of dark grey siltstone and carbonaceous mudstone. Thick beds of granule to small-pebble conglomerate are common locally, and contain mainly volcanic and fine-grained sedimentary clasts, including lenticular clasts of grey argillite and siltstone that were probably local rip-ups. Dark grey siltstone and mudstone define intervals up to several tens of metres thick within the coarser rocks. These intervals typically consist of thin bedded, commonly laminated mudstone and siliceous mudstone containing thin interbeds of buff to brown-weathering calcareous mudstone and crosslaminated siltstone.

Ammonites collected from the banks of the Yalakom River, 300 to 800 metres above the mouth of Blue Creek, were assigned a probable late Lower Jurassic age by McLearn (in Leech, 1953, p. 23) and an early Bajocian age by Frebold *et al.* (1969). More recent study of ammonites

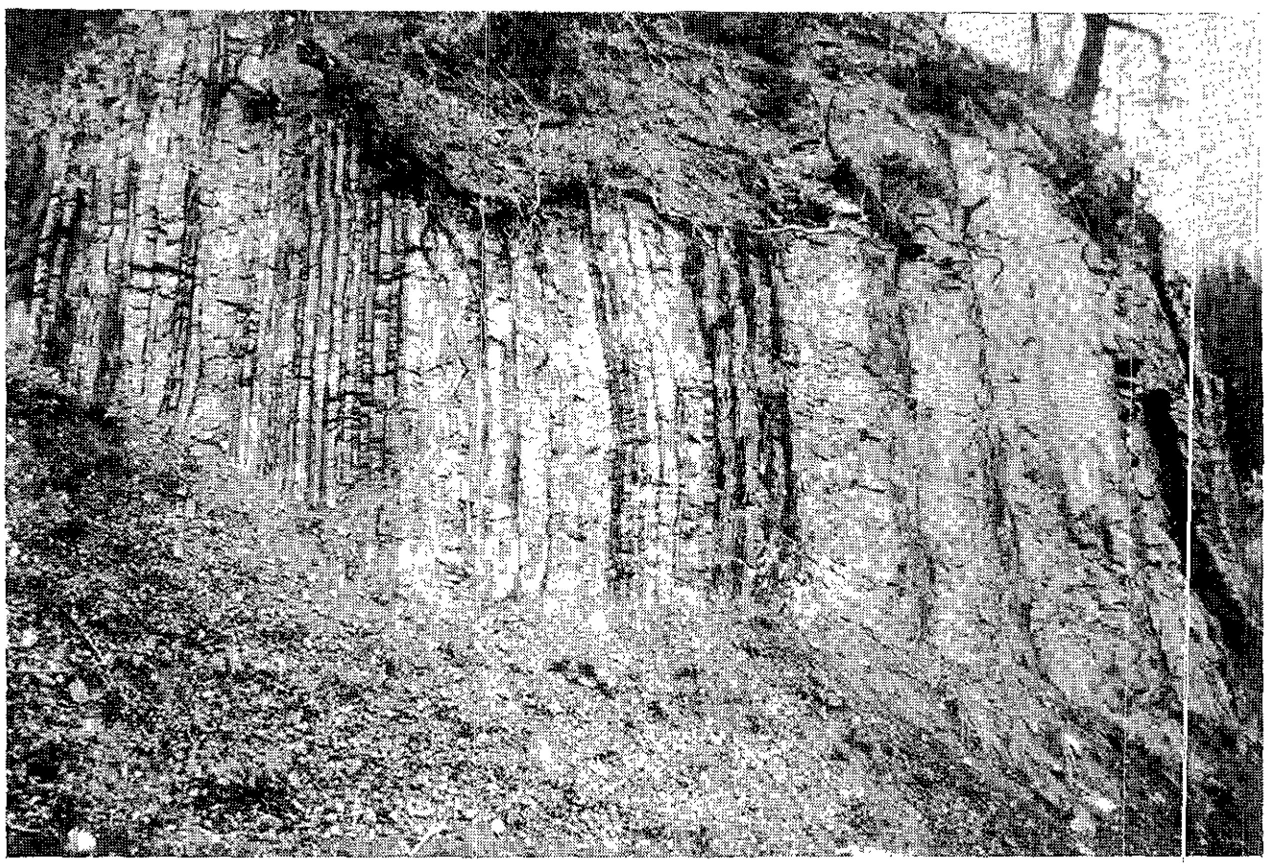

Photo 45. Well-bedded siltstone, sandstone and granule conglomerate of Unit lmJys, west side of the Yalakom River north of Blue Creek.

collected from the same area indicates that this part of the section is predominantly Aalenian in age, possibly ranging down into the late Toarcian (Poulton and Tipper, 1991). Stratigraphically higher parts of the section are probably Bajocian in age, based on two probable occurrences of Bajocian ammonites; one along the northeast bank of the Yalakom River 1.5 kilometres north of the mouth of Blue Creek (Photo 46), and the other opposite the mouth of Retaskit Creek, 7 kilometres to the southeast (Appendix 3, Sample F2-4TD66).

The stratigraphic base of Unit lmJys is not seen as it is truncated to the southwest by the Yalakom and Camelsfoot faults. The fossiliferous late Toarcian(?) to Bajocian interval exposed near Blue Creek is about 700 metres thick. An approximately equal thickness of lithologically similar clastic rocks sits stratigraphpically above it, and is in turn overlain by distinctive granitic-clast conglomerate and arkose of the Jackass Mountain Group (Unit lKJMy2 of this report). Schiarizza *et al.* (1990a,b) took this distinctive contact to mark the base of the Jackass Mountain Group, and consequently mapped all rocks beneath the distinctive arkoses as part of the Jurassic succession. A critical fossil location on the south slopes of Yalakom Mountain supplied by H.W. Tipper (Appendix 3, Sample F2-2TD66), as well as fossil locations reported by Jeletzky (*in* Roddick and Hutchison, 1973) from farther southeast along the belt, however, indicate that most of the interval above the fossiliferous Jurassic rocks is Lower Cretaceous (Barremian-Aptian) in age, and comprises a lower unit of the Jackass Mountain Group (Unit lKJMy1 of this report). The upper contact of the Jurassic section is not well defined but is tentatively placed a short distance above the uppermost siltstone/mudstone interval containing Jurassic fossils.

The main belt of Jurassic rocks assigned to Unit lmJys appears to by truncated along the Yalakom fault a short distance north of Blue Creek. However, rocks tentatively assigned to this unit also outcrop within a separate fault-bound lens farther to the northwest along the Yalakom fault. This lens extends from the headwaters of Churn Creek northwestward to Lone Valley Creek; it is bounded by the main branch of the Yalakom fault on the southwest and by a sub-parallel splay on the northeast (Figure 3). Rocks within the lens are not well exposed, but include a substantial thickness of thin-bedded, laminated mudstone and siltstone that outcrops adjacent to the Yalakom fault northeast of Quartz Mountain. Overlying rocks to the northeast are mainly medium to thick-bedded arkosic-lithic sandstones with thin interbeds of dark grey shale, and granule to small-pebble conglomerates containing mainly intermediate volcanic clasts. The uppermost part of the succession, exposed along a ridge northwest of Swartz Lake, is an assemblage of volcanic breccias and conglomerates together with feldspathic andesitic flows (Unit mJyv). The contacts of this assemblage are not exposed, and our preliminary map showed these rocks as a narrow fault-bounded lens of Upper Cretaceous volcanics (Glover *et al.*, 1988). More detailed petrography indicates that clasts in breccia and conglomerate of the volcanic assemblage are very similar to those in underlying

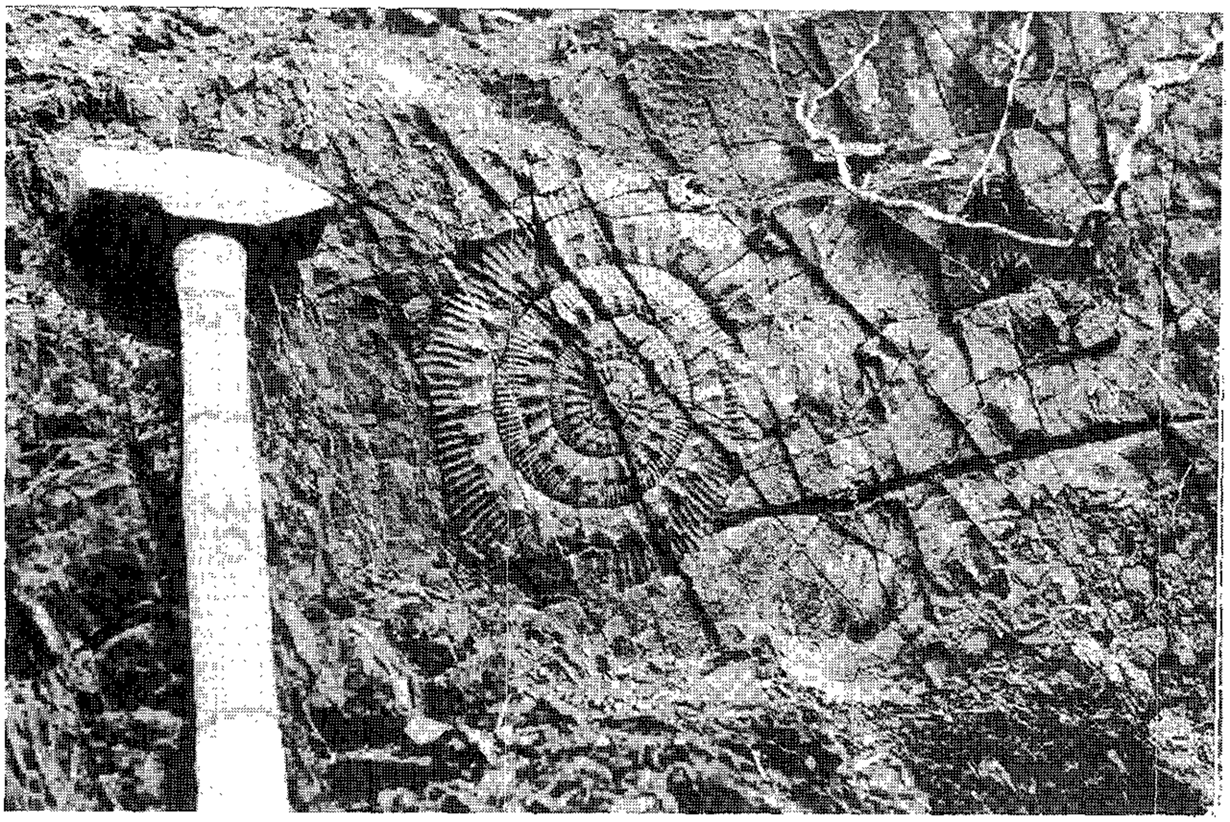

Photo 46. Middle Jurassic ammonite within the upper part of Unit lmJys, east side of the Yalakom River north of Blue Creek.

conglomerates of the sedimentary section, suggesting an association. Assignment of a Jurassic age to the volcanics hinges on the correlation of the underlying sedimentary section with the Jurassic section at Blue Creek. This is consistent with the regional geology of Methow Terrane, as andesitic flows and pyroclastic rocks are present in the Dewdney Creek Formation in its type area to the south-southeast (O'Brien, 1987).

Jurassic rocks along the lower reaches of Lone Valley Creek (Unit mJcs) are represented by scattered exposures of sandstone, one of which contains Early Bajocian ammonites (Appendix 3; Sample 87PS-35-6). The sandstones are medium to dark grey-green, fine to medium-grained arkosic wackes. They are typically massive and display spheroidal weathering patterns; laminations and thin to medium beds were observed, but are rare. The Jurassic sandstones apparently occupy the core of an east-plunging anticline. To the north and east they are overlain by volcanic conglomerate and sandstone of the lower part of the Churn Creek facies of the Jackass Mountain Group (Unit lKJMc1). The contact was not seen, but there is no suggestion of a structural discordance between the Jurassic and Cretaceous rocks. The western and southwestern boundaries of the Jurassic rocks are not closely constrained, but are thought to be faults across which they are juxtaposed against the Yalakom Mountain facies of the Jackass Mountain Group (Figure 3).

JACKASS MOUNTAIN GROUP

The name Jackass Mountain Conglomerate Group was first used by Selwyn (1872) for conglomerate and associated finer grained clastic sedimentary rocks exposed on the east slopes of the Fraser River, west of Jackass Mountain. The name was changed to Jackass Mountain Group by Richardson (1876) and the group has subsequently been mapped in a discontinuous belt that extends for about 450 kilometres, from south of the International Boundary northwestward to Tatlayoko Lake (Roddick *et al.*, 1979). Rocks within the present study area comprise part of the southwestern margin of a continuous belt of Jackass Mountain Group exposures that extends from south of Lillooet northwestward almost 150 kilometres to Big Creek. The southeastern part of this belt, in the Ashcroft map area, was described by Duffell and McTaggart (1952) and Trettin (1961). Exposures in the Pemberton map area to the northwest were described by Jeletzky (1971, and quoted by Roddick and Hutchison, 1973, p. 6-9), and those farther northwest, in the Taseko Lakes map area, were mapped by Tipper (1978) and described by Jeletzky and Tipper (1968). Selected Jackass Mountain Group exposures in the southeastern Taseko Lakes area and northeastern Pemberton area were subsequently described in detail by Kleinspehn (1982, 1985). The westernmost exposures of the Jackass Mountain Group are southwest of the Yalakom fault in the western Taseko Lakes map area and the adjoining Mount Waddington map area, where they were described by Tipper (1969) and Kleinspehn (1982, 1985).

In the Taseko - Bridge River map area, the Jackass Mountain Group has been subdivided into four distinct mappable units (Glover *et al.*, 1988a). These units are interpreted to comprise two broadly correlative facies belts, each con-

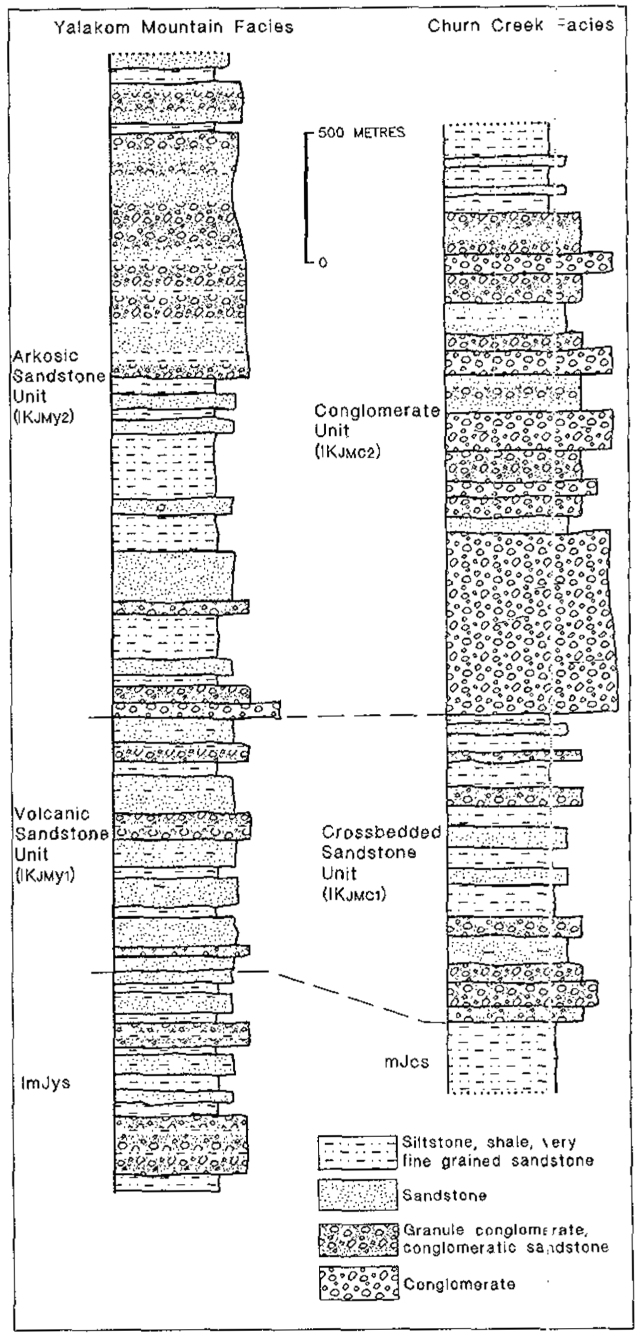

Figure 16. Schematic stratigraphic sections comparing Yalakom Mountain and Churn Creek facies of Methow Terrane.

sisting of two mappable units (Figure 16). The Yalakom Mountain facies is the more extensive of the two, and has been mapped across the entire width of the area, from Applespring Creek northwestward to the head of Dash Creek. The lower unit of the Yalakom Mountain facies (lKJMy1) comprises green volcanic-lithic sandstone intercalated with lesser amounts of granule to pebble conglomerate, siltstone and shale. It is restricted to the southwestern margin of the Jackass Mountain belt, where it is in part stratigraphically underlain by Jurassic rocks of Unit lmJys and in part bounded by the Yalakom and Camelsfoot faults. The volcanic sandstone unit has yielded sparse fossils of Barremian and Aptian age (Roddick and Hutchison, 1973; this report). To the northeast, it is overlain by a succession dominated by arkosic sandstone, pebbly sandstone, and conglomerate (Unit lKJMy2) containing significant amounts of granitoid detritus not seen in the underlying unit. The arkosic sandstone unit has yielded fossils of Albian age (Roddick and Hutchison, 1973; this study).

The Churn Creek facies of the Jackass Mountain Group outcrops in the northeastern corner of the map area, from the vicinity of Red Mountain westward to Churn Creek. The lower unit (lKJMc1) comprises sandstone, conglomerate and finer grained rocks that are rich in volcanic detritus and are characterized by abundant fossil plant remains. A collection of plants from this unit northwest of Red Mountain has been assigned an Aptian age (W.A. Bell, *in* Jeletzky and Tipper, 1968, p. 44). Unit lKJMc1 is abruptly overlain by a distinctive conglomerate unit (lKJMc2), dominated by pebble to boulder conglomerate intercalated with lesser amounts of sandstone, siltstone and shale. The conglomerate unit is rich in granitoid clasts, in contrast with the dominantly volcanic detritus in the underlying unit; no fossils have been collected from it. The basement to the Churn facies is exposed only along the lower reaches of Lone Valley Creek, where Middle Jurassic fine-grained sandstones of Unit mJcs underlie Unit lKJMc1.

An abrupt transition from volcanic-rich clastics to those rich in plutonic detritus marks the contacts between the mappable units of both the Yalakom Mountain facies and the Churn Creek facies. Moreover, the basal unit of the Yalakom Mountain facies (Unit lKJMy1) is at least in part the same age as Unit lKJMc1 at the base of the Churn Creek facies. The two facies are therefore inferred to be broadly coeval, and the contacts between the two mappable units within each facies are interpreted to reflect the same pulse of late Early Cretaceous uplift of the source terrain. The contacts between the Yalakom Mountain and Churn Creek facies are not well exposed, but appear to be mainly late northeasterly striking faults. At one locality within Churn Creek valley, however, Unit lKJMy2 of the Yalakom Mountain facies overlies Unit lKJMc1 of the Churn Creek facies across a moderately south-dipping fault (Figure 3). This fault may reflect structural telescoping of the Jackass Mountain Group basin during mid-Cretaceous contractional tectonism, or it may be a younger thrust fault kinematically related to the Yalakom fault (*see* Chapter 3). In either case, the general position of the more proximal Churn Creek facies to the northeast of the Yalakom Mountain facies is consistent with the paleocurrent data presented by Kleinspehn (1985), which indicates that the Jackass Mountain Group sediments were derived from a source terrane to the northeast.

VOLCANIC SANDSTONE UNIT (lKJMy1)

Rocks of the volcanic sandstone unit, comprising the base of the Yalakom Mountain facies, outcrop as a discontinuous northwesterly trending belt along the southwestern margin of the Methow Terrane exposures. The southeastern segment of the belt extends from near Horse Lake, where it apparently pinches out along the Yalakom fault, to the southeastern limit of the map area. These rocks are bounded to the southwest in part by the Yalakom and Camelsfoot faults, and in part by stratigraphically underlying Jurassic sedimentary rocks of Unit lmJys (Figure 3). The northwestern segment of the belt extends from the tributary of Churn Creek draining Swartz Lake northwestward to the headwaters of Dash Creek along the northern boundary of the map area. It is bounded on the southwest by the Yalakom fault and related Swartz Lake splay, and is truncated on the southeast by an apparently older north-northeast-striking fault that juxtaposes it against the Churn facies.

The volcanic sandstone unit consists mainly of coarse to medium-grained, green to grey volcanic-lithic sandstone and gritty sandstone. The volcanic grains are accompanied by variable, but generally significant proportions of feldspar and quartz, and commonly by several per cent pyroxene and hornblende grains. Plutonic and fine-grained sedimentary rock fragments are rare. Locally, quartz occurs as conspicuous glassy grains that display corroded and embayed margins in thin section, suggesting a nearby volcanic source.

Within the southeastern, more extensive segment of the volcanic sandstone belt, the sandstone typically occurs as distinct, thin to thick, locally graded beds with relatively thin caps or interbeds of grey shale. The sandstone is intercalated with lesser amounts of thick to very thick bedded granule to pebble conglomerate containing mainly volcanic clasts, as well as with intervals of thin-bedded, laminated to crosslaminated siltstone and shale. Brown-weathering beds of calcareous sandstone, conglomerate and siltstone occur locally, and thin to medium beds of silty limestone were noted rarely. Sandstone in the northwestern segment of the belt occurs mainly as massive exposures in which rare bedding is apparent only as subtle variations in grain size or as trains of siltstone intraclasts. Thick, graded beds with flutes, grooves and rip-ups along their bases occur locally.

The volcanic sandstone unit is equivalent to Jeletzky's (1971) "variegated clastic division" of the Jackass Mountain Group (mapped as Unit 7b by Roddick and Hutchison, 1973). It is assigned a Barremian to Aptian age on the basis of fossils collected by Jeletzky and H.W. Tipper from the southeastern segment of the belt, between Applespring Creek and Yalakom Mountain. These include two collections of Barremian faunas from the ridge southeast of Antoine Creek, and an Aptian fauna collected from the upper part of the unit along the west slopes of Ore Creek (*see* Roddick and Hutchison, 1973, for locations and descriptions of Jeletzky's collections). Belemnites collected during the present study, from the vicinity of Jeletzky's Barremian localities, were not diagnostic beyond a general Middle Jurassic to Early Cretaceous age (Appendix 3, Sample 89APS-31-8-3). Fossils collected by H.W. Tipper from the south slopes of Yalakom Mountain are from the northwestern end of the same belt of volcanic sandstones; these were assigned a Barremian age by Jeletzky (Appendix 3; Sample F2-2TD66).

The volcanic sandstone unit is underlain by Jurassic rocks of Unit lmJys along the slopes northeast of the Yalakom River from the vicinity of Yalakom Mountain southeastward to Antoine Creek. The contact is inferred to be stratigraphic because there is no evidence for a fault or discordance in bedding attitudes between the Jurassic and Cretaceous packages along several ridges that cross the boundary. The contact is not well defined, however, as the Cretaceous and Jurassic rocks are lithologically very similar, and fossil control is limited. The large time interval between the youngest fossils from the Jurassic section (Bajocian) and the oldest fossils from the Cretaceous unit (Barremian) suggests that the contact is a significant disconformity.

CROSSBEDDED SANDSTONE UNIT (lKJMc1)

Unit lKJMc1 comprises the base of the Churn Creek facies of the Jackass Mountain Group, and is inferred to be, at least in part, a facies equivalent of the volcanic sandstone unit (Figure 16). It outcrops in the upper part of Churn Creek west of Poison Mountain, in lower reaches of the creek near its confluence with Lone Valley Creek, and to the north and northwest of Red Mountain. Unit lKJMc1 consists of green to grey, brown, grey or mottled green and white-weathering sandstone, pebbly sandstone and pebble conglomerate, locally intercalated with dark grey siltstone and mudstone (Photo 47). These rocks are commonly arranged in fining-upward sequences with basal crossbedded sandstones, and contain abundant tree branches, coal seams, full-length fern fossils and other fossil plant remains. These features suggest deposition within a fluvial environment. Sandstones contain mainly feldspar and volcanic-lithic grains; conglomerates are dominated by intermediate volcanic clasts, but locally contain granitoid fragments.

Jeletzky and Tipper (1968, p. 44) report that a collection of plant fossils obtained from the crossbedded sandstone unit northwest of Red Mountain were assigned an Aptian age by W.A. Bell. This is the only age constraint presently available for the unit.

The crossbedded sandstone unit is apparently underlain by Middle Jurassic sandstones of Unit mJcs along the lower reaches of Lone Valley Creek, although the contact was not seen. It is abruptly overlain by the conglomerate unit of the Churn Creek facies (Unit lKJMc2) north of Red Mountain, and in a northwest-trending belt along Churn Creek, west of Poisonmount Creek. Other external contacts are faults. These include a south-dipping thrust(?) fault that places Unit lKJMc1 beneath the arkose unit of the Yalakom Mountain facies along Churn Creek, 4.5 kilometres north-northeast of Swartz Lake. This fault may relate to telescoping of the two facies of the Jackass Mountain Group, either during mid-Cretaceous time or during a later structural regime dominated by dextral movement along the Yalakom fault.

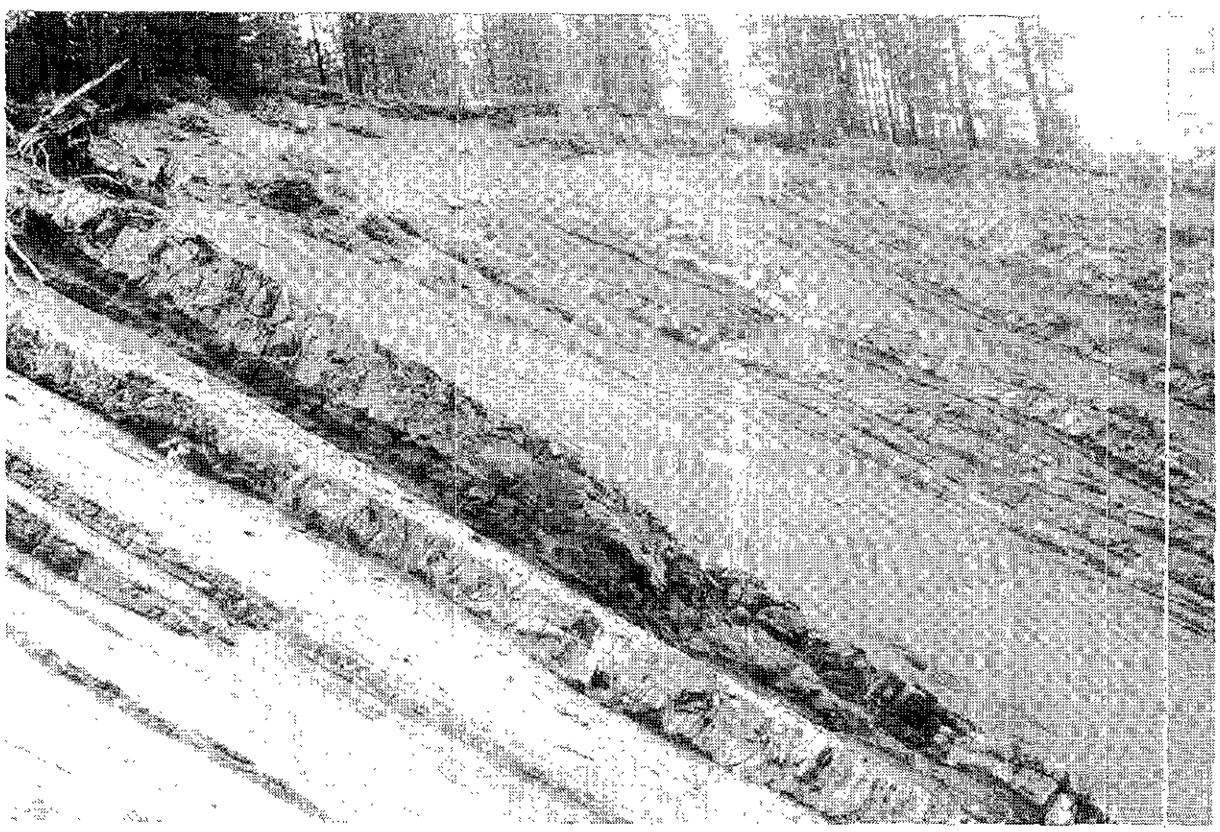

Photo 47. Well-bedded sandstone, siltstone and mudstone of Unit lKJMc1, Churn Creek.

ARKOSIC SANDSTONE UNIT (lKJMy2)

The arkosic sandstone unit, comprising the upper part of the Yalakom Mountain facies, consists of arkosic sandstones and gritty to pebbly sandstones, together with lesser amounts of pebble conglomerate, siltstone and shale. It sits stratigraphically above the volcanic sandstone unit and is the most extensively exposed unit of the Jackass Mountain Group within the map area. There are continuous exposures from the southeastern corner at Applespring Creek, northwestward to Poison Mountain. There, the belt is truncated by a northeast-striking fault that places it against the Churn Creek facies of the Jackass Mountain Group. The arkosic sandstone unit also outcrops farther to the northwest, west of Churn Creek, where it is well exposed on the ridges north and south of Dash Creek.

The sandstones of Unit lKJMy2 are predominantly medium to coarse-grained feldspathic-lithic wackes, commonly with sparsely scattered granules to small pebbles of volcanic, plutonic and sedimentary rock fragments. They range in colour from olive-green to blue-green, and commonly form bold buff to brown-weathering exposures (Photo 48). The sandstones are commonly massive, with bedding only locally defined by pebble concentrations or trains of siltstone intraclasts. Locally, however, as in exposures along the Yalakom River and Dash Creek, the sandstones are thick to medium-bedded turbidites with partial and complete Bouma sequences well displayed. Siltstone and shale, occurring as distinct thin beds that may be graded or crosslaminated, are most common in the lower part of the unit, where they locally dominate intervals up to several hundreds of metres thick. Similar fine-grained intervals higher in the section generally range from less than a metre to only several tens of metres thick (Photo 49). Pebble to cobble conglomerates occur mainly at or near the base of the arkosic sandstone unit, and rarely as thick beds of granule to small-pebble conglomerate intercalated with sandstones higher in the section. The conglomerates, together with gritty and pebbly sandstones found throughout the unit, contain clasts of aphyric and feldspar-phyric intermediate volcanic rocks, granitic to dioritic plutonic rocks, feldspar, quartz, and relatively minor proportions of sedimentary and metamorphic rock fragments.

The arkosic sandstone unit, as mapped here, is apparently equivalent to Jeletzky's (1971) grey siltstone-shale division and overlying massive greywacke division (mapped as Units 7c and 7d by Roddick and Hutchison, 1973). Jeletzky collected lower Albian fossils from the lower part of the unit (his grey siltstone-shale division) in the upper reaches of Ore Creek, and Albian fossils from higher in the section (within his massive greywacke division) in the same area (*see* Roddick and Hutchison, 1973, for locations and descriptions of Jeletzky's collections). An Albian age for the unit is confirmed by lower Albian ammonites collected from it in the canyon of Churn Creek, 4 kilometres north-northeast of Swartz Lake, during the present study (Appendix 3, Sample 87JG-302).

The base of the arkosic sandstone unit was seen at one locality, 5 kilometres east of the mouth of Blue Creek, and was closely approached in several other places to the southeast, as well as at two localities between Lone Valley and Dash creeks to the northwest. The unit is concordant with the underlying volcanic sandstone unit in all these locations, although the contact is typically marked by several metres to tens of metres of conglomerate at the base of the arkose unit. The two units are lithologically distinct because the conglomerate, together with overlying sandstones, contains abundant plutonic detritus that is not seen in the underlying strata. The top of the arkosic sandstone unit was not mapped during the present study. It was tentatively identified by Jeletzky (1971), however, a short distance outside the map area, north and east of Mount Birch and Mount Duncan. There, his massive greywacke division of the Jackass Moun-

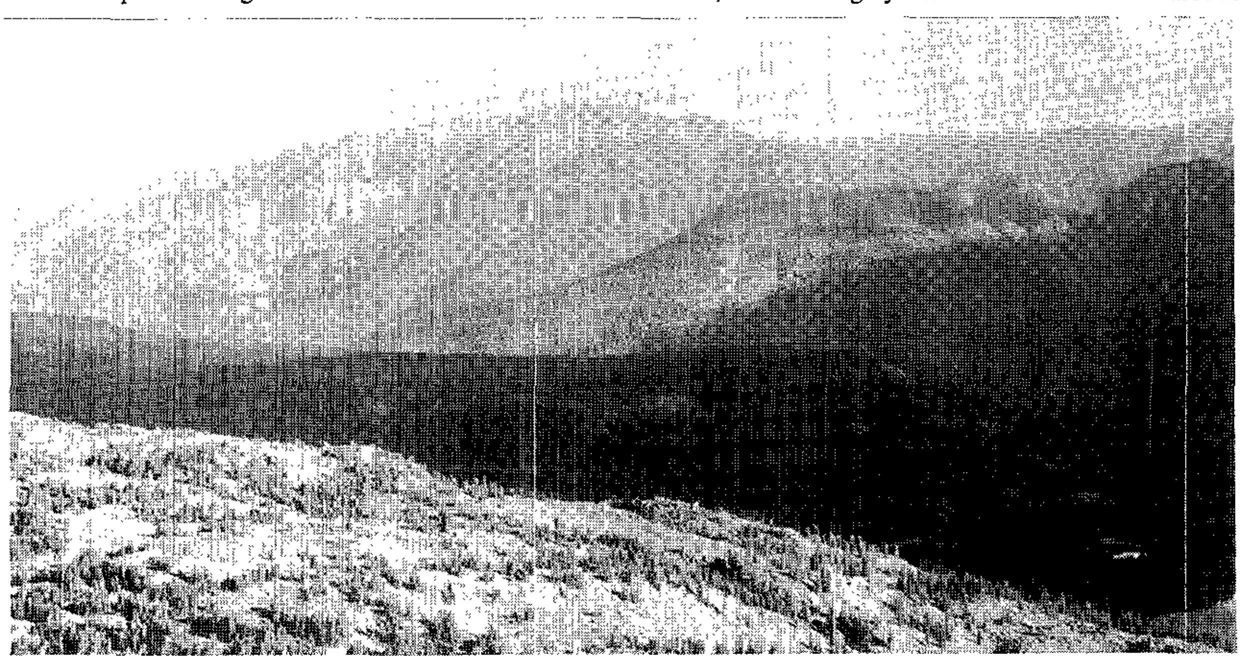

Photo 48. Yalakom Mountain, underlain by resistant sandstones of Unit lKJMy2, viewed northward from the central Shulaps Range. Unit lKJMy2 is underlain by more recessive rocks of units lKJMy1 and lmJys on the lower slopes southwest of the mountain..

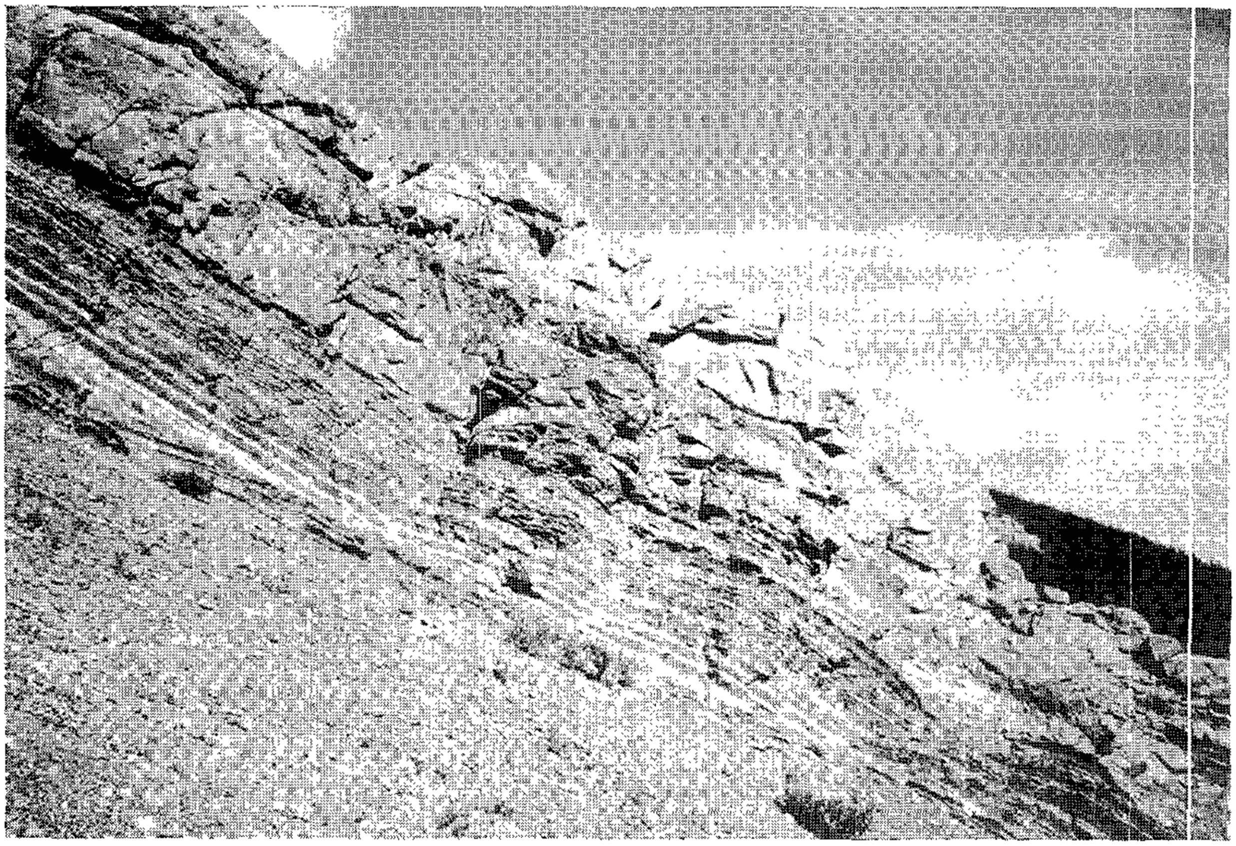

Photo 49. Interval of thin-bedded siltstones and fine-grained sandstones, about 5 metres thick, within thick-bedded coarse-grained sandstones of Unit lKJMy2; slopes northeast of the Yalakom River, west of Evelyn Creek.

tain Group is overlain by a succession of apparently nonmarine sandstones and granule to fine-pebble conglomerates (unit 9 of Roddick and Hutchison, 1973).

CONGLOMERATE UNIT (lKJMc2)

Boulder to cobble conglomerate of Unit lKJMc2 is the most distinctive lithology within the Jackass Mountain Group. Similar conglomerate occurs west of Jackass Mountain, where the group was first described (Selwyn, 1872), as well as farther north along the Fraser River, north and south of Lillooet (Duffell and McTaggart, 1952). Exposures within the present study area extend eastward to the upper reaches of French Bar Creek, and northwestward along the south side of Hungry Valley (Jeletzky and Tipper, 1968). These rocks were described as the French Bar Formation by MacKenzie (1921b) and assigned an Oligocene age. They were recognized as part of the Jackass Mountain Group by Jeletzky and Tipper (1968), and correlated with the similar conglomerates exposed near Jackass Mountain and Lillooet.

The conglomerates contain poorly sorted, predominantly well-rounded clasts of mainly granitic and intermediate volcanic rocks, together with metamorphic and foliated plutonic rocks, chert and clastic sedimentary rocks (Photo 50). In the area northwest of Poisonmount Creek, the base of the conglomerate unit comprises about 700 metres of massive conglomerate with relatively little intercalated finer grained material. This passes upward into layers of massive conglomerate, generally between 50 and 200 metres thick, alternating with layers of similar thickness of finer grained rock. The finer grained layers are dominated by massive, gritty to pebbly sandstones, but locally include intervals, up to several metres thick, of thin bedded sandstone-siltstone couplets. Farther northeast, near Red Mountain, inverse to normally graded conglomerate beds up to several metres thick alternate with generally thinner intervals of sandstone and siltstone.

The conglomerate unit overlies the crossbedded sandstone unit of the Churn Creek facies north of Red Mountain and west of Poisonmount Creek. The contact is abrupt, but there is no indication of an angular discordance across it. At Red Mountain the conglomerate unit is unconformably overlain by the Paleogene(?) Red Mountain volcanics. Other external contacts are faults. These include important north-northeast and northeast-striking structures that separate the conglomerate unit from the arkosic sandstone unit of the Yalakom Mountain facies northeast of Swartz Lake and west of Poison Mountain, respectively.

The conglomerate unit is not dated within the present study area, but must be Aptian or younger if the Aptian age assigned to the underlying fluvial unit is correct. The conglomerate records the first major input of granitic detritus into the Churn Creek facies, just as the arkosic sandstone unit does in the Yalakom Mountain facies. This suggests

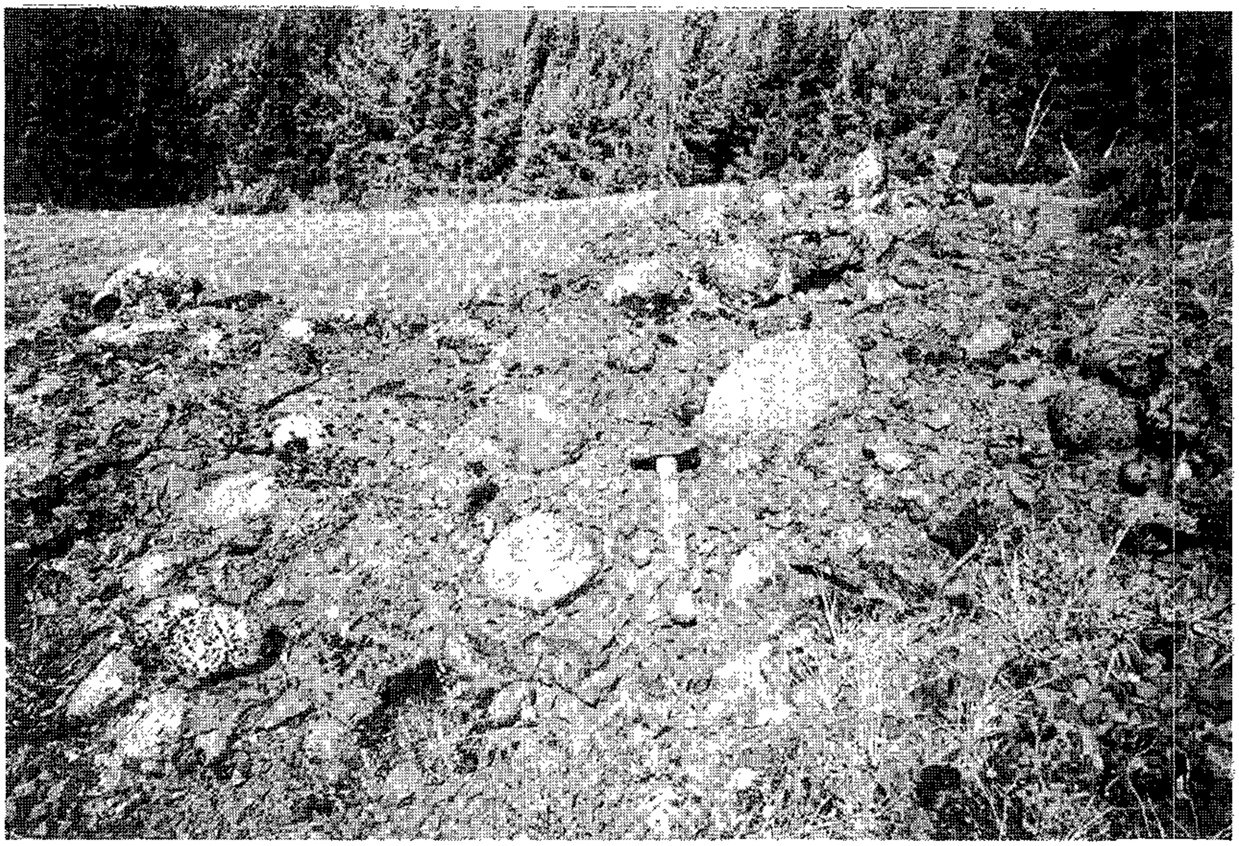

Photo 50. Boulder-cobble conglomerate of Unit lKJMc2, Buck Mountain.

that the two units may be correlative and, therefore, that the conglomerate unit is Albian in age.

The conglomerates of Unit lKJMc2 probably represent channel deposits within a proximal submarine fan environment. Their sharp contact with underlying nonmarine to shallow-marine sandstones of Unit lKJMc1 suggests abrupt subsidence of this part of the Jackass Mountain basin. This subsidence was coincident with uplift of the source area, as indicated by the abrupt appearance of abundant granitic detritus. These events reflect an important pulse of mid-Cretaceous tectonism within the region.

INTERMONTANE BELT

ROCKS ALONG DASH AND CHURN CREEKS (KDC1, KDC2, KDC3)

Methow Terrane, described in the previous section, is generally regarded as the easternmost tectonic element of the southern Coast Belt. Rocks farther to the east and northeast are included in the Intermontane Belt. Rocks of the Intermontane Belt are not well represented in the Taseko - Bridge River area, where they comprise a succession of volcanic and volcaniclastic rocks exposed over a small area near the confluence of Dash and Churn creeks. The informally named Dash-Churn succession is separated from Methow Terrane to the south by a northwest-striking fault, previously mapped as the Hungry Valley fault (Tipper, 1978).

The Dash-Churn succession is subdivided into three lithologic units, although the regional persistence and significance of these divisions is unknown. The lowest unit (KDC1; base not exposed) consists mainly of poorly stratified, dark grey to black carbonaceous sandstones and granule to pebble conglomerates containing rounded aphyric and feldspar-phyric intermediate volcanic clasts. Coarser grained volcanic-cobble-boulder conglomerates were mapped near the top of the unit. The middle unit (KDC2) consists of green to purple volcanic breccias and rare feldspar-phyric flows, locally intercalated with thin intervals of bedded volcanic sandstone and pebble to boulder conglomerate. Breccia fragments and clasts in conglomerates consist almost exclusively of intermediate, commonly feldspar-phyric, volcanic rocks. The upper unit (KDC3; top not exposed) consists of matrix-supported laharic breccias and volcanic conglomerates, with local intercalations of thin to medium-bedded volcanic sandstone. The breccias and conglomerates typically occur as distinct beds ranging from 0.5 to 5 metres thick. Clasts are rounded to subangular, range to more than a metre in diameter, and consist almost entirely of intermediate volcanic rocks, commonly with the phenocryst assemblages plagioclase, plagioclase-hornblende and plagioclase-clinopyroxene.

Rocks of the Dash-Churn succession, and in particular Units KDC2 and KDC3, are lithologically similar to the Upper Cretaceous Powell Creek formation, with which they were correlated by Tipper (1978, his Kingsvale Group). The

Dash-Churn succession, however, is in fault contact with the northeast side of Methow Terrane, whereas the Powell Creek formation was deposited above Tyaughton basin rocks to the southwest of Methow Terrane. The intervening Methow Terrane does not contain any potentially correlative rocks within the Taseko - Bridge River area, although Powell Creek correlatives do outcrop in Methow Terrane to the southeast, near the International border (Midnight Peak Formation; McGroder *et al.*, 1990).

The Dash-Churn succession is in apparent continuity with rocks exposed farther north that have also been correlated with the Powell Creek formation and associated rocks of the Tyaughton basin. These include chert-rich conglomerates that pass up-section into volcanic-clast conglomerates, volcanic breccias and local hornblende-feldspar-phyric flows, comprising a succession that has been correlated with the Silverquick - Powell Creek section of the Taseko - Bridge River area (Green, 1990; Hickson *et al.*, 1991; Mahoney *et al.*, 1992).The correlation is supported by sparse palynomorph collections that have been assigned Late Cretaceous (L.V. Hills, in Green, 1990; Mathews and Rouse, 1984) and late Albian to Early Cenomanian (Hickson *et al.*, 1991) ages.

The rocks correlated with the Silverquick formation to the north of the present study area lie unconformably(?) above mid-Cretaceous volcanic rocks that have been correlated with the Spences Bridge Group (Mathews and Rouse, 1984; Rouse *et al.*, 1990; Green, 1990; Hickson, 1992). The Spences Bridge Group comprises late Albian volcanic and volcaniclastic rocks that outcrop mainly on the east side of the Fraser fault, to the east and southeast of the Taseko - Bridge River area, where they unconformably overlie a variety of older rocks of the Quesnel and Cache Creek terranes (Thorkelson and Rouse, 1989). The basement to the Spences Bridge Group west of the Fraser fault is not exposed. Nevertheless, the inferred deposition of Silverquick and Powell Creek formations on both Tyaughton basin and Spences Bridge Group requires that the southeastern Coast Belt was tied to the adjacent Intermontane belt by late Albian to Cenomanian time. This tie is contradicted by two recent sets of tilt-corrected paleomagnetic data: one from the Spences Bridge Group east of the Fraser fault (Irving *et al.*, 1995) and other from the Silverquick - Powell Creek succession near Mount Tatlow, a short distance northwest of the Taseko - Bridge River area (Wynne *et al.*, 1995). These data indicate that, in mid-Cretaceous time, the Silverquick - Powell Creek succession and associated rocks of the southeastern Coast Belt were situated about 2000 kilometres south of the Spences Bridge Group and associated rocks of the Intermontane Belt. These data suggest that correlation of volcanic and sedimentary rocks in the Churn Creek - Gang Ranch area, including the Dash-Churn succession described here, with the Silverquick and Powell Creek formations may be suspect. Alternatively, it may be the Spences Bridge correlation or the paleomagnetic data that are erroneous.

TERTIARY VOLCANIC AND SEDIMENTARY ROCKS

PALEOGENE SUCCESSIONS

Intermediate to felsic volcanic rocks, with local mafic volcanic and sedimentary intervals, overlie Upper Cretaceous and older rocks at several localities within the study area. These include the Red Mountain volcanic complex, which overlies Methow Terrane northeast of the Yalakom fault, as well as four separate volcanic accumulations on the southwest side of the fault (Figure 17). The volcanic rocks are commonly associated with felsic intrusive rocks of units PEp and Ep, and appear to represent a number of discrete volcanic centres. They are not well dated, but available constraints and correlations suggest that they range from Paleocene to Middle or Late Eocene in age.

MOUNT SHEBA COMPLEX (PESv, PESb)

The volcanic succession at Mount Sheba comprises a lower unit of dacitic to rhyolitic rocks locally intercalated with sandstone and conglomerate (Unit PESv) and an upper unit of basalt and basaltic breccia (Unit PESb). Both units are extensively intruded by dacitic porphyries of unit PEp, which underlie the summit of Mount Sheba itself (Photo 51). The volcanic succession is exposed in a belt that extends for 11 kilometres northwest and southeast from Mount Sheba, along the ridge system between Tyaughton and Gun creeks. A small outlier outcrops on the ridge top south of Lizard Lake, 1.5 kilometres west of the main belt. The Mount Sheba volcanics overlie the Powell Creek formation throughout most of this belt, but sit directly above the Elbow Pass formation of the Taylor Creek Group north and east of Mount Sheba. Felsic volcanic rocks of unit PESv also outcrop over a small area on the north side of Tyaughton Creek, 8 kilometres north-northeast of Mount Sheba; there, they overlie the Last Creek formation and Relay Mountain Group, and are associated with a large intrusive body of hornblende-biotite-quartz-feldspar porphyry assigned to Unit PEp.

The Mount Sheba volcanic succession is dominated by felsic to intermediate rocks of unit PESv. Most common are purple, grey and light green weathering, aphyric to hornblende-feldspar-phyric dacitic flows and flow breccias (Photo 52). These are characterized by planar to contorted flow banding, on a scale of a few millimetres to a few centimetres, that imparts a distinct fissility to the rock; elsewhere the rock is more massive and lacks the distinctive flow banding. Also present, but less common, are glassy quartz-phyric rhyolite flows and, at one locality noted by Payne and Russell (1988), a welded crystal-lapilli ash-flow tuff.

Unit PESv is relatively thin directly south and west of Mount Sheba, where it consists mainly or entirely of sedimentary rocks. The sedimentary section comprises arkosic sandstone intercalated with boulder conglomerate containing well-rounded granite and hornblende feldspar porphyry clasts in a sandy matrix of quartz, biotite and feldspar. At least locally, this sedimentary interval lies directly above Upper Cretaceous volcanic rocks of the Powell Creek formation, and is in turn overlain by the upper basalt unit of the Mount Sheba complex. Sedimentary rocks also occur far-

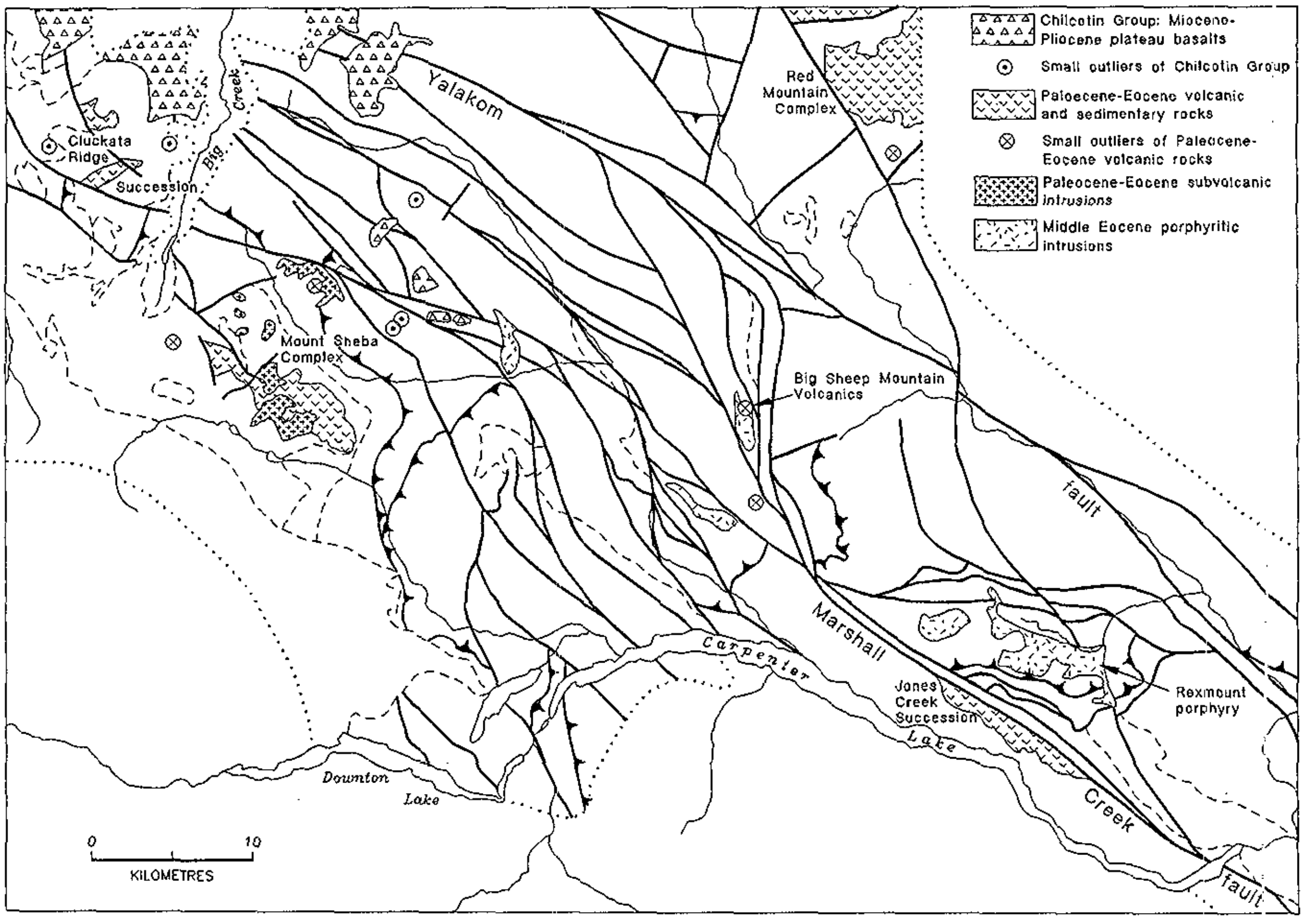

Figure 17. Distribution of Tertiary volcanic and sedimentary rocks in the Taseko - Bridge River map area.

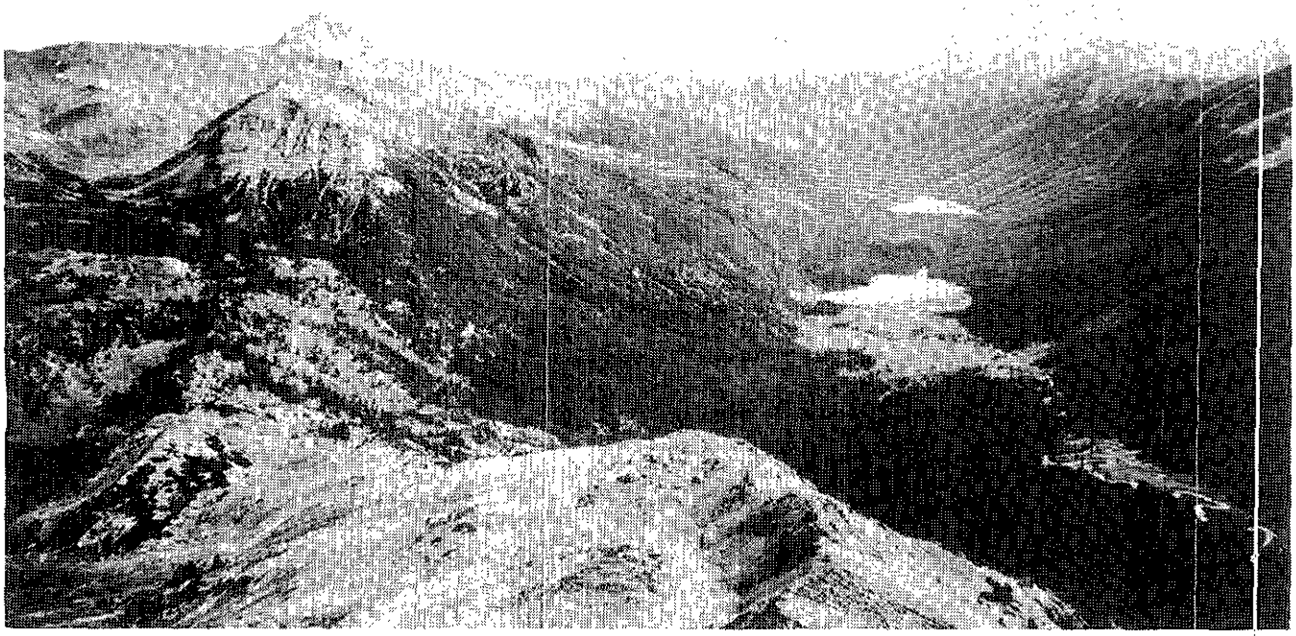

Photo 51. Mount Sheba, on the left-hand skyline, is underlain by intrusive porphyry of Unit PEp, which comprises part of the Mount Sheba volcanic-plutonic complex. View is to the east-southeast down Gun Creek, including Trigger and Hummingbird lakes. Stratified rocks in the middle ground, west of Mount Sheba, are volcanic and sedimentary rocks of the Powell Creek formation, which underlies the Mount Sheba complex.

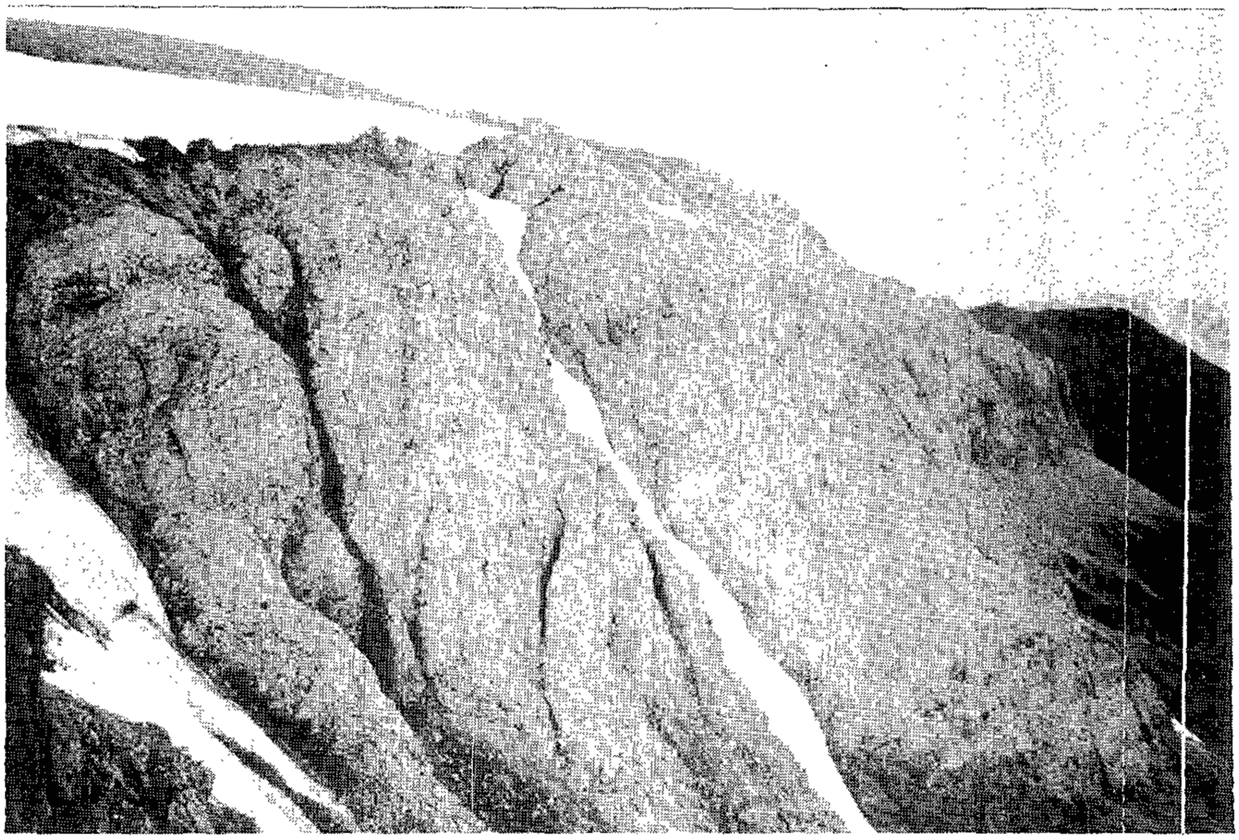

Photo 52. Intermediate flows and flow breccias of the Mount Sheba Complex, northeast of Mount Sheba.

ther to the northwest, where green lithic sandstone, conglomeratic sandstone and pebble conglomerate occur as relatively minor intercalations within typical dacitic rocks of unit PESv.

The upper part of the Mount Sheba complex comprises dark grey, brown to reddish brown-weathering basalt (Unit PESb) that outcrops for about 7 kilometres along the upper part of the Mount Sheba ridge system. It occurs as a series of distinctly layered, flat-lying flows and flow breccias that are one to several metres thick. The basalts locally contain clinopyroxene phenocrysts, and are commonly vesicular or amygdaloidal, with quartz, calcite and chlorite amygdules. They lie above either dacitic volcanics or sedimentary rocks of Unit PESv, and locally seem to fill depressions, reflecting an uneven paleosurface in the underlying rocks (Payne and Russell, 1988).

The basalts of Unit PESb were thought to be post-Eocene by Cairnes (1943) and were likewise assigned to the Miocene-Pliocene Chilcotin Group by Tipper (1978). They are presently included in the Mount Sheba complex because, together with underlying rocks of Unit PESv, they are intruded by dacitic porphyries of Unit PEp (Glover and Schiarizza, 1987; Payne and Russell, 1988). A hornblende separate from a sample of Unit PEp, collected from the west flank of Mount Sheba summit, yielded an Ar-Ar total fusion radiometric date of 57.2±1.4 Ma (Archibald *et al.*, 1989; Appendix 7, Sample TL-87-1). The volcanic and sedimentary rocks of units PESv and PESb are therefore inferred to be very early Eocene or older in age. As pointed out by Payne and Russell, extrusion of Unit PESb basalts sometime between extrusion of Unit PESv volcanics and intrusion of compositionally similar porphyries of Unit PEp is somewhat enigmatic, and argues against the porphyry unit being a direct feeder for the dacitic to rhyolitic volcanics. Nevertheless, the clear spatial association of these three units, and their common Late Cretaceous or younger and early Eocene or older age, suggests a relationship within a perhaps long-lived and chemically complex volcanic centre.

CLUCKATA RIDGE SUCCESSION (PECv)

Volcanic and sedimentary rocks assigned to Unit PECv outcrop for about 3.5 kilometres along the top of Cluckata Ridge, and as a separate outlier 3 kilometres to the north, on the north side of Tosh Creek. In both areas the Tertiary succession lies above Upper Cretaceous rocks of the Powell Creek formation and is bounded on the west by northwest-striking faults (Figure 3).

Unit PECv consists mainly of dark brown weathering, medium grey, columnar-jointed feldspar and quartz feldspar porphyry flows. These are intercalated with light grey quartz feldspar porphyry flows, pink to grey quartz-bearing crystal tuffs, and breccias with aphyric and feldspar-phyric volcanic fragments and rare clasts of flow-banded quartz-phyric rhyolite. On Cluckata Ridge, the base of the unit is commonly marked by a complex interfingering of laterally discontinuous sedimentary rocks, volcanic flows and breccias overlying an irregular paleosurface above the Powell Creek formation (*see* Plate 3-4-4 of Glover and Schiarizza, 1987). The sedimentary rocks are light grey to greenish grey, medium to thin-bedded sandstones and granule to pebble conglomerates, locally associated with thinly parallel bedded to laminated ash tuffs, tuffaceous shales and mudstones. Similar sedimentary rocks occur within the succession north of Tosh Creek, where they are intercalated with the volcanic rocks at one or more stratigraphic levels above the base of the unit. Wood fragments are common in the sedimentary intervals, but no diagnostic fossils were discovered.

The Cluckata Ridge succession is not dated, but is thought to be Paleocene or Eocene in age because it clearly overlies the Upper Cretaceous Powell Creek formation across an erosional unconformity, and is compositionally similar to the volcanic rocks and associated Paleocene-Eocene intrusions of the Mount Sheba complex.

JONES CREEK SUCCESSION (EJv)

Volcanic and sedimentary rocks assigned to Unit EJv underlie the slopes northeast of Carpenter Lake, where they form a conspicuous belt of outcrops that crosses the middle reaches of Jones Creek. This gently northeast dipping succession lies unconformably above the Bridge River Complex and is truncated to the northeast by the Marshall Creek fault. A small patch of similar volcanic rocks lies unconformably above the Bridge River Complex 15 kilometres to the northwest, 2 kilometres north of Liza Lake.

The main belt of Unit EJv consists of nearly 1000 metres of light grey to buff-weathering volcanic flows and breccias, locally underlain by several tens of metres of sedimentary rocks. The volcanic rocks are mainly hornblende, biotite, quartz and feldspar-phyric dacites. The sediments consist of conglomerate, sandstone and shale, with local narrow seams of lignite (McCann, 1922). Clasts in the conglomerate include chert with lesser amounts of granitic and felsic volcanic rock.

An attempt to date the basal sediments of Unit EJv by palynology was unsuccessful. Garver *et al.* (1994) report a zircon fission-track age of 43.5±6.1 Ma from volcanic rocks in the lower part of the section, which they interpret as a depositional age. This Middle to Late Eocene age is consistent with the interpretation that the Jones Creeks volcanics are an extrusive equivalent of the Rexmount porphyry (Drysdale, 1916; Roddick and Hutchison, 1973), which intrudes Bridge River schists 3 kilometres northeast of the volcanic belt, on the opposite side of the Marshall Creek fault (Figure 17). The Rexmount porphyry intrudes the 47 Ma Mission Ridge pluton, and may be equivalent to a porphyry unit that was intruded into the Mission Ridge fault zone late in its Middle to Late Eocene movement history (Coleman, 1990).

BIG SHEEP MOUNTAIN VOLCANICS (EBv)

Columnar-jointed quartz feldspar porphyry that outcrops on the main summit of Big Sheep Mountain is assigned to Unit EBv. It consists of sparse to abundant quartz and feldspar phenocrysts, up to 2 millimetres in size, within a very fine grained, light grey to buff quartzofeldspathic groundmass. The porphyry is locally flow banded and some areas contain vuggy cavities lined with small quartz crystals. In the single thin section examined the quartz phenocrysts are euhedral to strongly embayed, and both feldspar phenocrysts and groundmass are largely altered to sericite. The rhyolite porphyry is in contact with Lower Cretaceous micaceous sandstones of the Lizard formation to the north and east, but to the south and west it overlies hornblende-biotite-feldspar porphyry (Unit Ep) that comprises part of an elongate intrusive body that extends for 3.5 kilometres in a north-south direction. Although contact relationships are not well defined, unit EBv is thought to be an extrusive or very high-level intrusive phase within this igneous complex. These rocks are not dated, but are tentatively correlated with

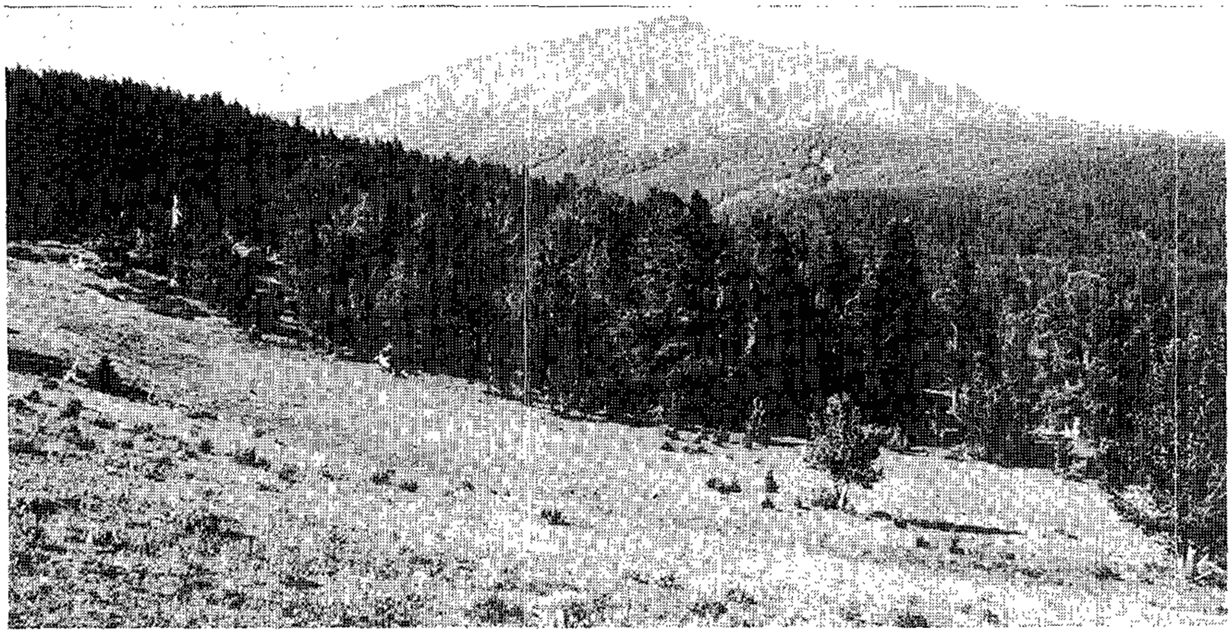

Photo 53. Red Mountain, viewed from the south near Poison Mountain.

the compositionally similar Middle to Late Eocene Jones Creek volcanics and Rexmount porphyry.

RED MOUNTAIN COMPLEX (ERa, ERr, ERs)

The Red Mountain volcanic complex consists of interlayered andesites and rhyolites that extend from Red Mountain to beyond the northeastern corner of the map area (Photo 53). These volcanics, as well as a small outlier of andesites that caps a ridge crest 4 kilometres south-southeast of Red Mountain, unconformably overlie Unit lKJMc2 of the Jackass Mountain Group. Similar andesites underlie a poorly exposed belt along the northern boundary of the map area, 10 kilometres north of Red Mountain. These rocks are separated from the Jackass Mountain Group that underlies the main Red Mountain volcanic complex by an east-striking fault.

The volcanic succession exposed at Red Mountain is about 800 metres thick. It consists mainly of reddish brown-weathering, platy to massive, aphyric andesite flows (unit ERa) that are locally vesicular and/or amygdaloidal and in places are columnar jointed. Flow breccias and brick-red regolith zones locally mark flow contacts. Massive andesite flows at the base of the succession are porphyritic and contain phenocrysts of pyroxene, hornblende and plagioclase. Discontinuous units of light grey to white-weathering flow-banded rhyolite (ERr), commonly with phenocrysts of quartz and/or feldspar, are exposed at three different stratigraphic levels within the Red Mountain succession. The most extensive unit is locally more than 150 metres thick. The rhyolites include significant zones of flow breccia, vesicular glass and glassy breccia. Siliceous sinter(?) deposits with botryoidal textures occur locally.

Sedimentary rocks (Unit ERs) occur locally within the Red Mountain succession, where they comprise lenses of rusty brown and chalky white weathering thin-bedded volcanic sandstone and siltstone which range up to several tens of metres thick. The sedimentary intervals occur along rhyolite-andesite contacts, or as lateral equivalents of rhyolite. Volcanic conglomerate outcrops at one locality, 2.5 kilometres northeast of Red Mountain summit, where it separates a rhyolite unit from underlying andesite. It comprises unsorted, angular andesitic to dacitic volcanic clasts, up to 80 centimetres across, within a friable siltstone matrix.

North-northeast-trending dikes of andesite and felsite are locally common within the Red Mountain volcanics. Quartz-biotite-hornblende-feldspar porphyry occurs as dikes of the same orientation, and as small intrusive plugs (Unit Ep). Flow-banded rhyolite at the base of the volcanic succession (Unit ERri) is at least in part intrusive, and locally grades into similar quartz-biotite-hornblende-feldspar porphyry.

The Red Mountain volcanic rocks are not dated. Quartz-biotite-hornblende-feldspar porphyry of Unit Ep that intrudes andesite 2 kilometres northwest of Red Mountain has, however, been dated (Archibald *et al.*, 1989). Hornblende and biotite from a sample of this porphyry (Appendix 7, Sample TL-87-8) yield discordant Ar-Ar total fusion dates of 53.5±0.8 and 47.4±0.5 Ma, respectively. Although the reason for the spread in the two dates is unknown, an Early to Middle Eocene age is indicated. This may be close to the age of the volcanic succession itself, given the spatial relationship of the porphyry to the volcanics and the local gradation from flow-banded rhyolite to porphyry. Early to Middle Eocene K-Ar dates have also been obtained on volcanic rocks from several localities to the north and northeast (Mathews and Rouse, 1984; Church, 1987; Hickson *et al.*, 1991); these include dates of 48.4±1.6 Ma, 50.6±1.8 Ma and 51.5±1.9 Ma on hornblende separates from dacite at Black Dome Mountain, 15 kilometres north-northeast of Red Mountain.

NEOGENE PLATEAU BASALTS OF THE CHILCOTIN GROUP (MPC)

Flat-lying basalt flows of the Chilcotin Group (Tipper, 1978; Bevier, 1983; Mathews, 1989) outcrop in the north-central part of the map area where they unconformably overlie a variety of rock units and structures, including the Yalakom fault (Figure 17). They comprise part of the southern margin of an extensive belt of Early Miocene to Early Pleistocene plateau lavas that covers about 25 000 square kilometres of the Interior Plateau of south-central British Columbia (Mathews, 1989). The basalts outcrop most extensively on a series of high plateaus, including the Dil Dil Plateau, extending for about 25 kilometres along the northern boundary of the map area; this presumably once continuous outcrop belt is now dissected by the drainages of Dash, Big and Nadilla creeks, exposing older, underlying rocks. The basalts also occur as two small isolated outliers south and southwest of the Dil Dil Plateau, and cap several peaks and ridges farther south, in the area between Relay and Tyaughton creeks. The most extensive exposures in the latter area are on Relay and Cardtable mountains and Fortress Ridge (Figure 3).

Within the map area, Chilcotin Group basalt occurs as reddish brown, grey or brick-red weathering vesicular flows. Individual flows typically range from 1 to 3 metres thick (Photo 54), and commonly display pahoehoe texture and columnar jointing. Fresh basalt is commonly medium to dark grey, locally light grey, purple or red, and generally consists of variable proportions and combinations of feldspar, olivine and clinopyroxene phenocrysts within a very fine grained groundmass.

Basalts from two localities in the cluster between Tyaughton and Relay creeks have yielded Early to Middle Miocene dates. One sample, from Cardtable Mountain, yielded a whole-rock K-Ar date of 18.6±0.6 Ma (Mathews, 1989); the other, from a different outlier in the same area, gave a date of 14.2±0.4 Ma by the same method (Farquharson and Stipp, 1969; recalculated using new decay constants). Regionally, basalts included in the Chilcotin Group by Mathews (1989) have yielded whole-rock K-Ar dates ranging from Oligocene to Early Pleistocene. Eruptions were particularly abundant during the Miocene, at 16 to 14 and 9 to 6 Ma, and during the Pliocene and Early Pleistocene, at 3 to 1 Ma.

Within the map area, the elevation of the base of the Chilcotin basalts varies from 2230 to 2470 metres in the area between Tyaughton and Relay creeks, and generally from 2000 to 2430 metres on the Dil Dil and adjacent plateaus

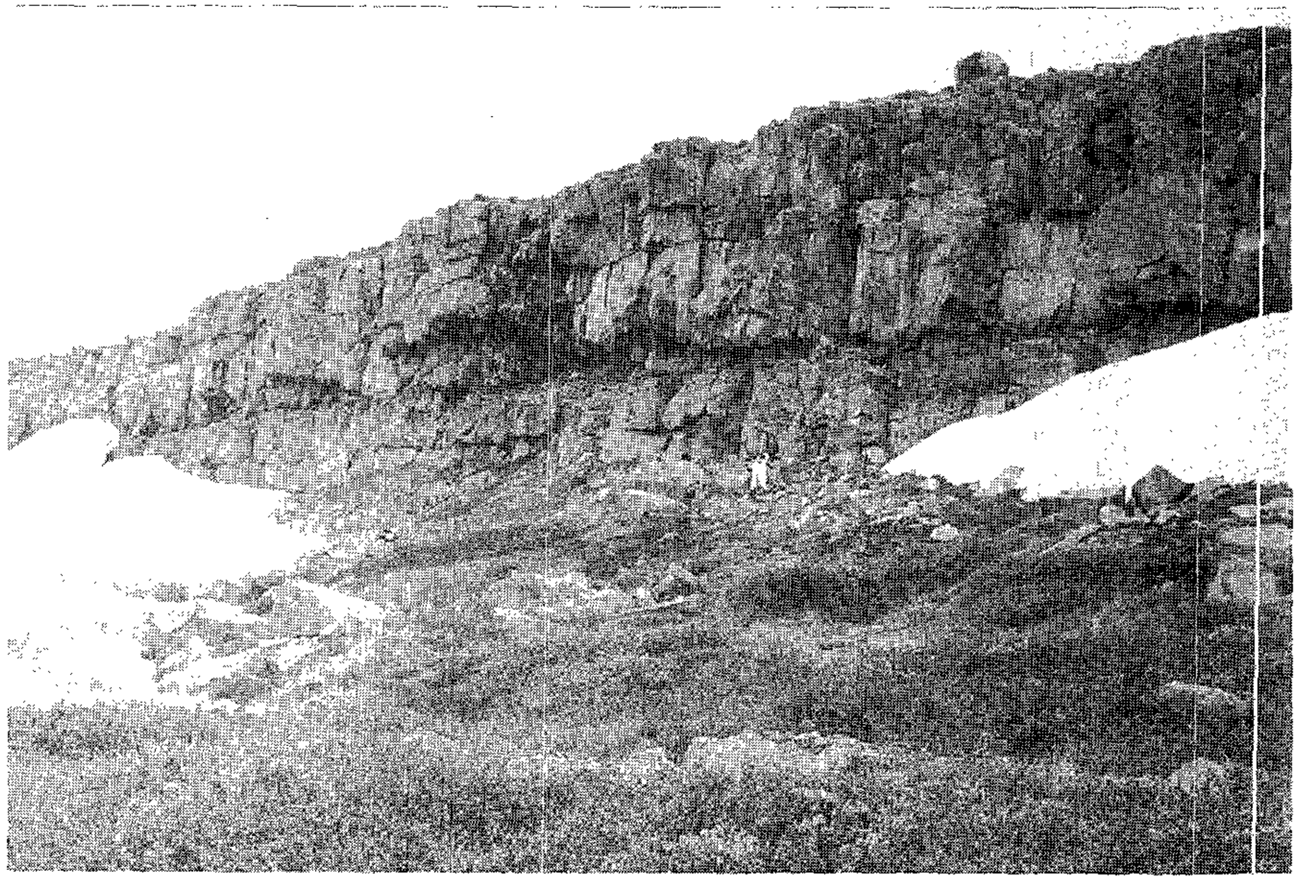

Photo 54. Flat-lying basalt flows of the Chilcotin Group, east side of the Dil Dil Plateau.

along the northern boundary of the area. The base is highest beneath a small isolated outlier that caps a mountain peak directly northeast of Powell Pass, where it is at 2590 metres elevation. It appears, therefore that the basalts were deposited on a fairly regular paleosurface of low to moderate relief. Abrupt irregularities are apparent locally, as on the southern margin of the Dil Dil Plateau, where paleohills up to 100 metres high are centred on intrusive plugs of Unit KTp. The thickness of the basalts is not great; it is apparently between 300 and 350 metres where the greatest vertical accumulation is exposed on Relay Mountain.

BRIDGE RIVER ASH

Deposits of light grey, unconsolidated, postglacial volcanic ash are conspicuous throughout much of the Bridge River valley and adjacent slopes, where they were first reported by Robertson (1911). The ash locally attains a thickness approaching a metre in the valley bottoms south and east of Gun Lake, but is more commonly 1 to 10 centimetres thick. It comprises ash to lapilli-sized fragments of dacitic pumice that contain feldspar and mafic phenocrysts; the largest fragment seen during the present study measured 8.5 centimetres across. The ash was derived from the vicinity of Plinth Peak, 53 kilometres west-northwest of Gold Bridge, in the Pliocene to Recent Meager Mountain Volcanic Complex (Read, 1979; Green *et al.*, 1988; Stasiuk and Russell, 1989). The ash thins and fines dramatically to the east of the Bridge River, but has been recognized as far east as western Alberta; its known distribution defines a narrow fan that extends more than 500 kilometres east-northeast of Plinth Peak (Nasmith *et al.*, 1967).

Read (1979) assigned the proximal tephra deposits northeast of Plinth Peak an age of 2350±50 years BP, based on a radiocarbon date of 2500±50 years BP obtained from the centre of a charred tree within the tephra (Lowden and Blake, 1978) combined with a correction for the approximate age of the tree. More recent radiocarbon dates from the outer rings of trees entombed within the tephra indicate that the eruption occurred between 2704 years BP and 2349 years BP, and probably around 2360 years BP (Clague *et al.*, 1995). A comparable age of 2332±50 years BP is reported by Leonard (1995) for the distal Bridge River ash in southwestern Alberta, based on a varve count of varved sediments that enclose the 1 centinetre-thick ash layer in Hector Lake.

CRETACEOUS AND TERTIARY INTRUSIVE ROCKS

Intrusive rocks are widespread in the Taseko - Bridge River map area, where they comprise numerous mappable plutons and stocks of intermediate to felsic composition, as well as abundant felsic to mafic dikes. Currently available dates indicate that igneous intrusion, at times associated with volcanism, occurred during much of the interval from the mid-Cretaceous through to the Neogene (Figure 18). These intrusions coincided with major deformational events

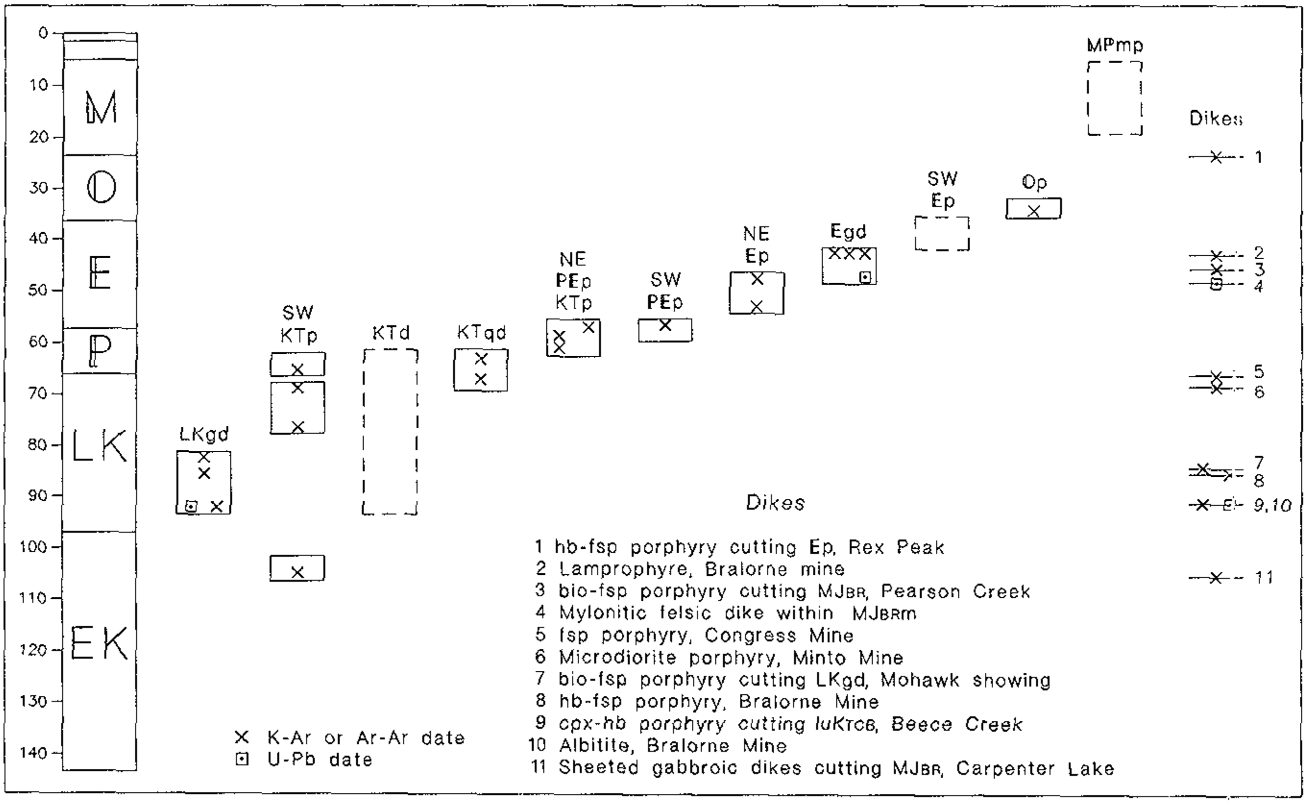

Figure 18. Summary of isotopic dates for Cretaceous and Tertiary intrusive rocks in the Taseko - Bridge River map area. cpx=clinopyroxene; hb=hornblende; bio=biotite; fsp=feldspar. Map unit codes as in Figure 3. SW=southwest of the Yalakom fault; NE=northeast of the Yalakom fault.

in the region, and spanned the change from a dominantly contractional structural regime in the middle to Late Cretaceous to one of dextral strike-slip and normal faulting in the latest Cretaceous and Tertiary.

Coarse to medium-grained equigranular granitic rocks make up the Late Cretaceous Dickson - McClure batholith (LKgd), the latest Cretaceous to Early Tertiary Eldorado pluton (KTqd) northeast of the batholith, and three Eocene plutons (Egd) that are localized in uplift zones within dextral strike-slip fault systems. Overlapping in age with these plutons are stocks of mid-Cretaceous to Early Tertiary(?) hornblende feldspar porphyry (KTp) and diorite (KTd), as well as more felsic hornblende-biotite-quartz-feldspar porphyry stocks of mainly Paleocene to Eocene age (PEp, Ep). The youngest dated pluton is a small Oligocene hornblende porphyry stock (Op) east of Lizard Lake, although small mafic plugs (MPmp) that may be Neogene in age occur locally. Dikes are mainly porphyritic rocks containing variable proportions and combinations of hornblende, feldspar, biotite and quartz phenocrysts; available dates range from Late Cretaceous to Miocene. Mafic dikes also occur, and include rare, sheeted gabbroic dikes dated as late Early Cretaceous, as well as basaltic dikes that probably fed Neogene plateau lavas. Lamprophyre dikes are, at least in part, Eocene in age.

EARLY CRETACEOUS SHEETED GABBROIC DIKES

Sheeted gabbroic dikes were noted at two locations within the map area: within the Bridge River Complex on the north side of Carpenter Lake, 8.5 kilometres west of the Terzaghi dam, and within serpentinite mélange on the south side of the Shulaps Ultramafic Complex, 1 kilometre south of Shulaps Peak. Those within the Bridge River Complex comprise a set of nearly east-striking, steeply dipping dikes approximately 15 metres wide. Individual dikes are less than 2 metres thick and typically display only one chilled margin, commonly their southern contact. The dikes are apparently intrusive into pillowed greenstone of the Bridge River Complex, although the southernmost dike appears to be chilled against, and to follow, a linear, altered breccia zone. Some internal contacts and most fracture surfaces in the dikes and the enclosing volcanic rocks have slickensides with highly variable orientations. The dikes within the Shulaps Complex comprise a similar sequence, 15 to 20 metres wide. External contacts with serpentinite are sharp and possibly intrusive, but it is not clear if the dikes intruded serpentinite or the serpentinite protolith.

In thin section, the dikes are seen to consist of brown and green amphibole, clinopyroxene, saussuritized plagioclase, chlorite, quartz and calcite. Clinopyroxene occurs as remnants largely altered to green amphibole and chlorite, as rounded inclusions in amphibole, and as microphenocrysts within chilled margins. The amphibole occurs as subhedral to euhedral prisms, with green amphibole commonly forming a thin rind around brown amphibole grains.

A separate of brown amphibole from the centre of a dike 1.5 metres thick within the dike complex north of Carpenter Lake was dated by Ar-Ar step-heating (Appendix 7, Sample TL-88-10). It yielded an integrated date of 108±7 Ma, a plateau date of 105±6 Ma, and a well-defined correlation plot isochron date of 107±3 Ma; the latter date is considered the best estimate of the cooling age of the dikes (Archibald *et al.*, 1991a).

The sheeted dikes were presumed by Schiarizza *et al.* (1989a) to be components of the Bridge River and Shulaps complexes, respectively, emplaced in spreading-centre environments within the Bridge River and Shulaps ocean basins. It is unlikely, however, that the late Early Cretaceous date obtained from the dikes in the Bridge River Complex reflects the age of relict Bridge River oceanic crust, because cherts from the immediate area are Late Triassic in age and are only known to be as young as late Middle Jurassic for the complex as a whole (Cordey and Schiarizza, 1993; see also Appendix 2). It might be argued that the green amphibole rims reflect reheating of the dikes under conditions sufficient to reset the K-Ar system of amphibole, but there is no evidence of such a metamorphic event in surrounding Bridge River rocks which are at prehnite-pumpellyite metamorphic grade. It is considered more likely that the dikes are the products of a younger magmatic event, and that the multiple emplacement of the dikes provided the heat for their alteration. Assuming that dike intrusion was not a protracted event, the 107 Ma date is thought to provide a good estimate of their age. The sheeted dikes in the Shulaps Complex are thought to belong to the same suite because they are virtually identical in composition, texture and general appearance.

Gabbroic to diabasic dikes are also exposed elsewhere in the area, but none are dated. These may in part be related to the sheeted gabbroic dikes, but some diabasic dikes are clearly younger because they intrude the upper Cretaceous Powell Creek volcanics. Others may be older, such as diabasic and gabbroic dikes within the Bridge River Complex that may in part be intrusive equivalents of basaltic rocks that are widespread within the complex.

LATE CRETACEOUS PYROXENE HORNBLENDE PORPHYRY DIKES

A distinctive suite of Late Cretaceous pyroxene hornblende porphyry dikes were seen at several localities between the head of Beece Creek and Vic Lake These dikes cut the Beece Creek succession of the Taylor Creek Group, and typically occur as swarms of parallel dikes separated by thin screens of sedimentary rock. The dikes consist of abundant hornblende phenocrysts, locally to 2 centimetres in size, and fewer and smaller clinopyroxene phenocrysts, in part rimmed by hornblende, within a dark grey to green fine-grained groundmass. The groundmass consists of a meshwork of plagioclase laths and mafic grains largely altered to chlorite and epidote. Ar-Ar step-heating of a hornblende separate from one of these dikes has yielded a plateau age of 91.64 ±1.65 Ma (Appendix 7, Sample 86PS-26-9-2). This date suggests that these dikes may be part of a feeder system to the Powell Creek volcanics which overlie the Beece Creek succession in this area.

DICKSON - McCLURE BATHOLITH (LKgd)

Late Cretaceous granodiorite that outcrops over a broad area in the southwestern corner of the map area is here referred to as the Dickson - McClure batholith. It comprises part of a suite of Late Cretaceous granodioritic to tonalitic plutons that are common within the eastern part of the southern Coast Belt (Monger and Journeay, 1994). The northern contact of the Dickson - McClure batholith trends roughly east-west near the western boundary of the map area, where the granodiorite intrudes volcanic rocks of the Taylor Creek Group and Powell Creek formation, and truncates the Tchaikazan fault. The contact then trends southeasterly for about 30 kilometres, from the mouth of Denain Creek to the confluence of Slim and Leckie creeks. It intrudes the Powell Creek formation over most of this distance, but cuts the Taylor Creek and Relay Mountain groups in the southeast. From there, the granodiorite contact has a general southerly trend to the southern boundary of the map area, but locally diverges as an east-trending apophysis that extends from Dixon Peak to the northwestern shore of Gun Lake. The granodiorite in this area intrudes the Bridge River Complex, Cadwallader Group and Bralorne-East Liza Complex, and truncates northwest-striking structures of the Lajoie Lake fault system.

Within the map area, the Dickson - McClure batholith consists of light grey, massive, coarse to medium-grained hornblende biotite granodiorite of rather uniform composition. The granodiorite is locally cut by dikes and small plugs of hornblende feldspar porphyry, quartz feldspar porphyry, diorite and granite.

Zircons extracted from the southeastern part of the batholith, near Dickson Peak, have yielded a U-Pb crystallization age of 92.4±0.3 Ma (Parrish, 1992; Sample 86WV-2 on Figure 49). A biotite separate from a sample collected about 5 kilometres to the north, near Slim Creek, has yielded similar Ar-Ar total fusion and plateau dates of 91.35±0.21 Ma and 92.34±1.15 Ma, respectively (Garver *et al.*, 1994; Appendix 7, Sample 91JG-44). Ar-Ar and K-Ar radiometric dates from the northwestern end of the pluton are younger and more variable, but in the absence of U-Pb data it is not known if this reflects significantly different crystallization ages for the granodiorite, or thermal overprinting related to zones of hydrothermal alteration and mineralization recognized within and adjacent to the batholith in this area (*see* Chapter 4). These dates come from Wilson Ridge, 25 kilometres northwest of the Slim Creek locality, and Granite Creek, 10 kilometres farther to the west, near the western boundary of the map area. The sample collected from Wilson Ridge gave Ar-Ar total-fusion dates of 82.1±2.0 Ma on hornblende and 71.8±0.6 Ma on biotite (Archibald *et al.*, 1989; Appendix 2, Sample TL-87-4), whereas biotite separates from granodiorite and a crosscutting dike near Granite Creek yielded K-Ar dates of 86.7±2.6 Ma and 84.7±2.5 Ma, respectively (McMillan, 1983).

HORNBLENDE FELDSPAR PORPHYRY STOCKS AND DIKES (KTp)

Hornblende feldspar porphyry intrusives are very common in the map area, where they form a number of mappable stocks and plugs and also occur as abundant dikes. The few radiometric dates available suggest that they range from mid-Cretaceous to Paleocene in age.

Hornblende feldspar porphyry is particularly abundant in the western part of the map area, where it comprises several large stocks and numerous plugs and dikes that intrude the Powell Creek formation and Taylor Creek Group in a belt that extends westward from Warner Lake and Big Creek (Figure 3). The porphyry consists of variable proportions of plagioclase and hornblende phenocrysts within a grey to green aphanitic to very fine-grained groundmass. It locally grades into equigranular medium-grained diorite and commonly displays varying degrees of chlorite-epidote alteration. The three largest stocks in this area crop out at Warner Lake, Dorrie Peak, and Vic Lake. Only the Dorrie Peak stock has been dated. Hornblende from a sample collected from FeO Spur, 4 kilometres southwest of Dorrie Peak, yielded an Ar-Ar total-fusion date of 64.7±2.1 Ma (Archibald *et al.*, 1989; Appendix 7, Sample TL-87-6). This date suggests Early Paleocene cooling of the stock.

Hornblende feldspar porphyry is also common in a belt that extends from upper Relay Creek northwestward to Dash Hill, where it forms stocks, plugs and dike swarms that intrude the Taylor Creek Group. These porphyries comprise variable proportions of hornblende and feldspar phenocrysts, up to several millimetres in size, within a massive, grey aphanitic groundmass. Carbonate, propylitic and sericitic alteration is common in the porphyries and adjacent country rocks, and the area has been explored for porphyry copper and disseminated gold deposits. Hornblende separated from a small stock that intrudes the Taylor Creek volcanic unit 7.5 kilometres north-northeast of Relay Mountain yielded an Ar-Ar plateau date of 104.5 ±16.6 Ma (Appendix 7, Sample TL-87-14). This date has large analytical uncertainty, but suggests that the hornblende-feldspar porphyry in this area may be comagmatic with the Taylor Creek volcanics.

Hornblende feldspar porphyries exposed in and adjacent to the Blue Creek watershed were referred to as Blue Creek porphyries by Leech (1953). They locally grade into equigranular diorite and hornblende-biotite quartz diorite. They occur as abundant dikes and small plugs that intrude both harzburgite and serpentinite mélange units in the northern part of the Shulaps Complex. Similar rocks also outcrop in the southern part of the complex, where they include a suite of hornblende±feldspar porphyry dikes that caused local synkinematic metamorphism within serpentinite mélange (Archibald *et al.*, 1989, 1990; Calon *et al.*, 1990). Two of the largest Blue Creek porphyry plugs cut the harzburgite unit 6 kilometres west of the mouth of Blue Creek and host the Elizabeth and Yalakom gold-quartz vein systems. Ar-Ar step-heating of hornblende from the northwestern plug has yielded a plateau date of 70.27±5.25 Ma (Appendix 7, Sample TL-89-6). This may be a more accurate cooling age than a whole-rock K-Ar date of 58.4 ±2.0 Ma reported by Church and Pettipas (1989) for this same plug. A hornblende feldspar porphyry dike that intrudes serpentinite mélange along the Yalakom fault, 4 kilometres to the northwest, has also been dated. Fresh hornblende separates from this rock give an Ar-Ar total-fusion date of 75.6±2.8 Ma, and a plateau date of 76.5±9.6 Ma from an Ar-Ar step-heating experiment (Archibald *et al.*, 1989, 1990; Appendix 7, Sample TL87-11). As there is no evidence in the age spectrum of a later thermal overprint or of the presence of initial argon, these dates are considered to be a reliable cooling age for the dike.

DIORITE PLUGS (KTd)

Small plugs of diorite, none of which are dated, intrude Upper Cretaceous and older rocks in scattered localities throughout the northwestern and western part of the map area. These rocks in part resemble diorite that is gradational with hornblende feldspar porphyry of Unit KTp in some large stocks, and may be related. They are most common in the northwestern corner of the area, where five plugs have been mapped on the west, east and south margins of the Beece Creek pluton. These plugs intrude the Powell Creek formation and the Beece Creek succession of the Taylor Creek Group. They are locally juxtaposed directly against, and thought to be intruded by, Eocene granodiorite of the Beece Creek pluton; however, contact relationships are not well exposed. The dioritic rocks comprise medium green to grey, medium-grained, equigranular intergrowths of mafic grains and plagioclase, with lesser amounts of interstitial quartz, opaque grains and apatite, and alteration assemblages that include epidote, chlorite and calcite. The plagioclase is relatively fresh andesine to labradorite that is in part normally zoned. The mafic grains include hornblende in one thin section, and clinopyroxene together with uralitic amphibole and rare biotite flakes in another.

Diorite also outcrops on the slopes east of the north end of Lorna Lake. There, it intrudes Jura-Cretaceous rocks of the Relay Mountain Group and structurally overlying rocks of the Tyaughton Group, apparently crosscutting the thrust fault separating the two groups. The medium green, fine to medium-grained diorite consists of a meshwork of subhedral sodic plagioclase laths intergrown with ragged grains of actinolitic amphibole, patches of chlorite, epidote and leucoxene, and small grains of apatite, quartz and calcite.

The only other diorite body assigned to Unit KTd, and sufficiently large to be portrayed on the geological map, occurs north of the confluence of Gun and Eldorado creeks. There, a small diorite plug and peripheral dikes intrude shale and sandstone of the Hurley Formation. This body was included within the Bralorne intrusions by Cairnes (1943), who thought they were Jurassic in age and intrusive into the Cadwallader Group and Bridge River Complex. The Bralorne diorite is now known to be Permian in age and structurally imbricated with the younger Cadwallader Group, while the diorite body north of the mouth of Eldorado Creek is truly intrusive into the Cadwallader Group. It is therefore Late Triassic or younger in age, and is tentatively included in Unit KTd, which is predominantly Cretaceous or younger.

CRETACEOUS TO TERTIARY QUARTZ DIORITE STOCKS (KTqd)

Equigranular, medium to coarse-grained, biotite hornblende quartz diorite and granodiorite of latest Cretaceous age comprise a small stock that outcrops mainly west and south of Eldorado Mountain, in the west-central part of the map area. The main body of this pluton intrudes the Eldorado fault and adjacent rocks of the Hurley Formation, Bralorne-East Liza Complex and Bridge River Complex. The eastern part of the pluton intrudes the Castle Pass fault zone and rocks of the Taylor Creek Group which occur east of the fault. The eastern lobe of the stock appears to be dextrally offset by about 200 metres from the main body of the pluton across the Castle Pass fault, although no evidence of faulting was observed within the pluton itself. It is also fault-bounded to the east, where it is in contact with the Taylor Creek Group across another northerly-striking splay of the Castle Pass system. Nevertheless, the minor offset, if any, of the stock across the main strand of this major fault system (*see* Chapter 3), indicates that the Eldorado pluton post-dates most movement on the Castle Pass fault. This is corroborated by a tight fold in the Eldorado fault where it is truncated by the Castle Pass fault. The geometry of this fold suggests that it formed during dextral translation along the younger Castle Pass fault, and this fold is clearly intruded by the Eldorado pluton (Figure 3).

An Ar-Ar step-heating experiment on biotite from the central part of the Eldorado stock yielded an excellent plateau date of 67.2±0.7 Ma (Garver *et al.*, 1994; Appendix 7, Sample TL-88-17). This latest Cretaceous date is slightly older than a Paleocene date of 63.7±2.2 Ma obtained by K-Ar dating of biotite from the lithologically similar plug that hosts the Robson polymetallic vein occurrence just to the northwest of the Eldorado pluton (Leitch *et al.*, 1991a). Dikes and plugs of feldspar porphyry and biotite-hornblende-feldspar porphyry that may be of similar age are common within a broad zone adjacent to the Castle Pass fault that extends northward from the Eldorado pluton to the vicinity of Castle Peak and southward to beyond Carpenter Lake (mapped as KTp on Figure 3). Whole-rock K-Ar dating of dikes within this belt at the Minto and Congress mines yielded dates of 69.4±2.4 Ma and 67.1±2.2 Ma, respectively (Pearson, 1977; Leitch *et al.*, 1991a). This belt of intrusions is along strike from Bendor suite of granodioritic plutons which intrude Bridge River Terrane to the south of the map area. The Bendor pluton has yielded a 63±2 Ma U-Pb zircon date (Friedman and Armstrong, 1990), and several Paleocene to Early Eocene dates have been obtained by K-Ar and Ar-Ar dating of hornblende and biotite from it and associated plutons within the belt (Wanless *et al.*, 1978; Garver *et al.*, 1994).

A small plug of altered, medium-grained quartz diorite that intrudes the Relay Mountain Group 1 kilometre west-southwest of Elbow Mountain is also assigned to Unit KTqd. It consists of altered sodic plagioclase and quartz, together with clots of chlorite, sericite and calcite that may represent altered mafic grains. The intrusive rocks are locally silicified, and the plug appears to be the centre of a zone of pyrite-silica alteration that extends for 500 to 700 metres outward into the adjacent sedimentary rocks. The plug is undated, but must be late Early Cretaceous or younger because it intrudes Hauterivian rocks of Unit lKRM3; it is provisionally included within Unit KTqd because its composition and texture more closely resemble those of the Eldorado stock than other intrusive suites in the area.

PALEOCENE TO EOCENE PORPHYRY STOCKS (PEp)

Rocks assigned to Unit PEp outcrop mainly in the Tyaughton Creek area, where they are part of the Mount Sheba volcanic - plutonic complex. They comprise light grey to white-weathering porphyritic intrusions, containing variable proportions of feldspar, hornblende, biotite and quartz phenocrysts within an aphanitic to very fine grained quartzofeldspathic groundmass. These intrusions are most common along a northwest-trending belt, centred near Mount Sheba summit, that extends from west of Spruce Lake to Lizard Creek. Stocks and plugs of Unit PEp within this belt intrude the Mount Sheba volcanic succession as well as underlying rocks of the Powell Creek formation and Taylor Creek Group. Similar porphyry crops out 8 kilometres north of Mount Sheba, where a large stock intrudes Jurassic rocks of the Last Creek formation and structurally underlying Relay Mountain Group northeast of upper Tyaughton Creek. This stock also intrudes a small area of felsic to intermediate volcanic rocks correlated with the Mount Sheba volcanics (Unit PEsv), and is therefore inferred to be an offshoot or outlier of the Mount Sheba igneous complex. Two small porphyry plugs that also intrude the Last Creek formation and Relay Mountain Group east of the main stock may represent equivalent rocks dextrally offset by the Fortress Ridge fault (Figure 3). Hornblende from a sample of Unit PEp, collected from the west flank of Mount Sheba summit, yielded an Ar-Ar total-fusion date of 57.2±1.4 Ma, suggesting Late Paleocene to Early Eocene cooling (Archibald *et al.*, 1989; Appendix 7, Sample TL-87-1).

Similar Late Paleocene cooling ages have been obtained from porphyritic intrusions near Poison Mountain, northeast of the Yalakom fault. There, several small stocks intrude the Jackass Mountain Group near the divide separating the Churn Creek and Yalakom River drainage basins (Figure 3). The two western intrusions, mapped as Unit PEp, host porphyry copper-molybdenum-gold mineralization of the Poison Mountain deposit. These comprise relatively unaltered cores of equigranular to porphyritic hornblende quartz diorite to granodiorite that pass outward into biotite-altered feldspar porphyry containing sparse primary biotite and hornblende phenocrysts. Sulphides occur in the biotite-altered outer margin of the stocks as well as within adjacent biotite-hornfels of the Jackass Mountain Group (Seraphim and Rainboth, 1976). Hornblende from the unaltered core of the largest mineralized intrusion has yielded a K-Ar date of 59.3±2.7 Ma, and K-Ar dates of 61.4±2.1 Ma and 57.3±2.0 Ma have been obtained from primary hornblende and biotite, respectively, within the altered and mineralized outer portion of the stock (Brown, 1995).

Two stocks that occur east of the Poison Mountain deposit are mapped as Unit KTp on Figure 3. One of these is a north-trending body underlying Poison Mountain itself, and the other outcrops about 3 kilometres to the east. These stocks are apparently unmineralized but they, along with the adjacent sedimentary rocks, are locally chloritized and epidotized. They consist of crowded feldspar porphyry containing large plagioclase phenocrysts, and smaller and less common hornblende and biotite phenocrysts, within a fine-grained grey groundmass. Samples from the stock underlying Poison Mountain have yielded biotite K-Ar dates of 58.2±2.0 Ma and 57.8±2.0 Ma (Brown, 1995), suggesting that these stocks are of about the same age as the mineralized porphyry directly to the west.

EOCENE GRANODIORITE PLUTONS (Egd)

Light grey, equigranular, medium to coarse-grained hornblende biotite granodiorite to quartz monzonite of Middle Eocene age occurs as three separate plutons within the Taseko - Bridge River map area. These are the Mission Ridge pluton in the southeast corner of the area, the Lorna Lake stock at the head of Big Creek and the Beece Creek pluton in the northwest corner of the area. All three plutons are in structural settings suggesting that they were intruded and uplifted during Eocene dextral strike-slip faulting.

The Mission Ridge pluton (Potter, 1983) is a markedly elongate body of coarse-grained granodiorite that extends from 4 kilometres south of the study area (Coleman, 1991) for about 30 kilometres northwestward to the head of Holbrook Creek. It intrudes Bridge River schists over this entire length. The pluton and enclosing Bridge River schists are separated from lower grade rocks of the Bridge River and Shulaps complexes to the northeast, northwest and southwest by the South Shulaps, Mission Ridge and Marshall Creek faults. The Mission Ridge granodiorite is itself intruded by the younger Rexmount hornblende-biotite-quartz-feldspar porphyry, which also crosscuts the bounding South Shulaps and Mission Ridge faults.

The Mission Ridge pluton is approximately concordant with the northwest-southeast structural grain of the schist belt, but it locally transects foliation in the schists. Granodiorite in the interior of the pluton is massive, but it has foliated, commonly mylonitic margins and, within the schist belt, is accompanied by strongly to weakly deformed dikes of similar composition (*see* Photo 10). Fabrics in these foliated plutonic rocks are congruent with those in the enclosing schists, and indicate dextral shear along gently northwest or southeast-plunging stretching lineations (Coleman, 1990). Intrusion of the Mission Ridge pluton and associated dikes is therefore interpreted to have been synkinematic with respect to foliation development in the surrounding schists, which is inferred to have occurred during dextral strike-slip motion along the Yalakom fault system (Coleman, 1990).

Uranium-lead analyses of zircons from two samples of the Mission Ridge pluton, from near its southwest and northeast margins in the Bridge River canyon, yielded dates of 47.5±0.2 Ma and 47.3±0.2 Ma respectively (Coleman, 1990; Samples MC89-1 and MC89-3 on Figure 49). Biotite from near the northern end of the pluton has a slightly younger K-Ar date of 43.6±2.4 Ma (Wanless *et al.*, 1978). Coleman (1990) also analysed zircons from two granodioritic dikes that intrude Bridge River schists. A strongly foliated dike that is concordant with foliation in the enclosing schists in the Bridge River canyon, north of the Mission Ridge pluton, yielded a date of 48.5±0.1 Ma (Sample MC89-2 on Figure 49); a date of 46.5±0.2 Ma was obtained from a less deformed dike south of the present map area, near the east end of Seton Lake. She reports that the younger dike crosscuts foliation in the enclosing Bridge River schists, but has a subparallel mylonitic foliation, with C and S fabrics indicating northeast-southwest directed dextral shear. Dextral shear within the schist belt therefore continued to at least 46.5 Ma. Later uplift of the Mission Ridge pluton and enclosing schists was, in part, accommodated by extensional faulting, mainly along the South Shulaps and Mission Ridge faults. Movement along the Mission Ridge fault postdated dextral mylonitic fabrics in the Bridge River schists and associated intrusions, but may have predated dextral strike-slip on the Marshall Creek fault and at least part of the Yalakom system (Chapter 3; Coleman, 1990); intrusion and uplift of the Mission Ridge pluton appear, therefore, to have been synchronous with dextral strike-slip faulting.

The Lorna Lake stock intrudes the upper Cretaceous Powell Creek formation and, locally, Jurassic rocks of Unit muJRM1. The pluton has a narrow chlorite-epidote alteration envelope and minor associated chalcopyrite-molybdenite mineralization. Fresh biotite from near the northwest margin of the stock yielded an Ar-Ar total-fusion date of 43.5±0.3 Ma (Archibald *et al.*, 1989; Appendix 7, Sample TL-87-7).

The Beece Creek pluton intrudes the Taylor Creek Group and overlying Powell Creek formation, as well as several small diorite stocks. A prominent roof pendant of the Taylor Creek Group in the southwestern part of the pluton suggests that, at least there, the present level of erosion is close to the top of the intrusion. The granodiorite is locally cut by small quartz-tourmaline-epidote veins and stockworks, and mafic grains within it are locally altered to chlorite. Chlorite-epidote alteration is extensive in rocks peripheral to the pluton. Fresh biotite from the pluton, collected on the west side of Beece Creek, just north of the map area, yielded an Ar-Ar total-fusion date of 43.9±0.6 Ma (Archibald *et al.*, 1989; Appendix 7, Sample TL-87-20).

The Beece Creek pluton and Lorna Lake stock are apparently undeformed, and external contacts are intrusive wherever observed. The uniform northeastern contact of the Beece Creek pluton appears, however to be continuous with, and perhaps controlled by, a fault that represents the northwest end of the Fortress Ridge fault system. Fifteen kilometres to the southeast, the Lorna Lake stock was intruded into a zone of complex faults at the southwest end of the Chita Creek fault system. The intervening zone, bounded by the northwestern segment of the Fortress Ridge fault and Beece Creek pluton on the northeast, and by the southeast segment of the Chita Creek fault and Lorna Lake stock on the southwest, has been uplifted relative to surrounding areas, as indicated by the stratigraphic levels now exposed (Figure 3). This zone of uplift is thought to reflect a left-stepping transfer of dextral motion from the Fortress Ridge fault system to the Chita Creek fault system. The Beece Creek and Lorna Lake intrusions were apparently localized in extensional settings at the terminations of the respective fault systems, and may now be exposed due to the broad uplift within the zone. This setting may be analogous to that in which the Mission Ridge pluton was intruded and uplifted, between the Yalakom and Marshall Creek faults (Chapter 3). The K-Ar cooling age on biotite from the Mission Ridge pluton is identical to those obtained from the Lorna Lake stock and Beece Creek pluton. This suggests that that intrusion and uplift of these Middle Eocene plutons, although localized in different dextral fault systems, was approximately synchronous over the entire width of the map area.

MIDDLE TO LATE EOCENE PORPHYRY STOCKS (Ep)

Porphyritic intrusions assigned to Unit Ep are common within a belt that extends from the Bridge River, in the southeast corner of the map area, northwestward about 60 kilometres to the slopes north of Tyaughton Creek. These stocks and plugs contain variable proportions of feldspar, quartz, biotite and hornblende phenocrysts within a light grey, aphanitic to very fined grained quartzofeldspathic groundmass. They are lithologically similar to the Mount Sheba intrusions (Unit PEp), but are somewhat younger in age. Like the Mount Sheba intrusions, those of Unit Ep are in part associated with volcanic rocks (Jones Creek and Big Sheep Mountain volcanic successions). Similar intrusions also occur locally within the Red Mountain volcanic complex, northeast of the Yalakom fault.

The felsic porphyritic intrusions assigned to Unit Ep in the southeastern part of the map area have been referred to as Rexmount porphyry (Drysdale, 1916; Leech, 1953). They outcrop mainly in the Shulaps Range between LaRochelle and Hog creeks and may be an intrusive equivalent of the dacitic volcanics (Unit EJv) that are exposed on the other side of the Marshall Creek fault, 3 kilometres to the southwest (Drysdale, 1916; Roddick and Hutchison, 1973). In the southwestern part of this belt the porphyry occurs as dikes and sills cutting Mission Ridge granodiorite and adjacent Bridge River schists along the northeastern margin of the pluton. The younger porphyry becomes the dominant intrusive phase to the northwest, and extends from the head of Holbrook Creek 10 kilometres northwestward as a moderately northeast-dipping sheet cutting Bridge River schists and Shulaps serpentinite mélange (Photo 55). Separate bodies of porphyry comprise the Hog Creek stock to the west as well as a series of small plugs extending several kilometres to the east. Hornblende-phyric felsite that intrudes both hangingwall and footwall rocks along the Mission Ridge fault south of the Bridge River (Coleman, 1989, 1990) may also be correlative. The Rexmount porphyry is not dated, but must be younger than the 47.4±0.3 Ma (Coleman, 1990) Mission Ridge pluton, and is older than a 21.5±0.8 Ma dike that cuts the porphyry east of Rex Peak (Appendix 7, Sample DAA-1-12-1). The 43.5±6.1 Ma zircon fission-track date that is interpreted as a stratigraphic age for the Jones Creek volcanics (Garver *et al.*, 1994) may also be a reasonable estimate of the age of the Rexmount porphyry.

Porphyritic intrusions assigned to Unit Ep northwest of the Shulaps Range include a stock that intrudes the Bralorne-East Liza Complex and Cadwallader Group northwest of Liza Lake, and the Big Sheep Mountain stock that intrudes the Taylor Creek Group 2 to 3 kilometres to the north. The latter stock seems to include several discrete phases, including biotite-hornblende-feldspar porphyry, quartz feldspar porphyry and flow-banded porphyritic rhyolite that underlies the summit of Big Sheep Mountain. Farther northwest, Unit Ep is represented by two stocks of

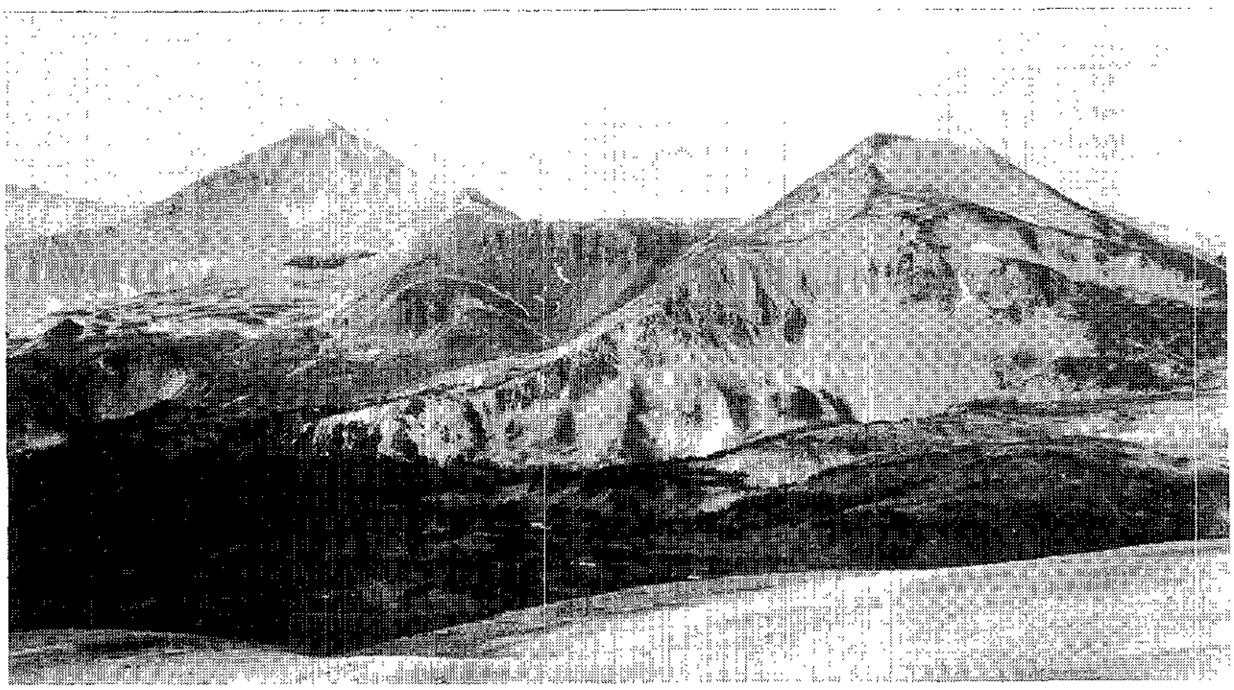

Photo 55. View to the south-southwest at Rex Peak and unamed flat-topped peak to the north. The peaks are underlain by a single northeast-dipping sheet of Rexmount porphyry. Darker coloured rocks of the underlying Bridge River schists are exposed in an erosional window between the 2 peaks.

hornblende-biotite-quartz-feldspar porphyry that outcrop on the slopes north of Tyaughton Creek, west of its confluence with Relay Creek. The largest stock crosscuts the Fortress Ridge fault (Figure 3), in apparent contrast with rocks assigned to unit PEp farther northwest which may be offset by this same fault.

Dikes of hornblende-biotite-quartz-feldspar porphyry are found mainly in association with plutons of the same composition, but also occur elsewhere in the map area. One such occurrence is a hornblende-biotite-feldspar porphyry dike that cuts Bridge River chert 4 kilometres south of Eldorado Mountain. A biotite separate from this dike yielded an Ar-Ar plateau date of 46.1±0.5 Ma (Appendix 7, Sample TL-90-8). Light grey to yellowish weathering, commonly flow-banded dikes of quartz feldspar porphyry show a more general distribution, and commonly form parallel swarms with dikes of hornblende-feldspar porphyry. None of these are dated, but it is suspected that some are coeval with the Tertiary intrusions of units PEp and Ep, although some may be older.

Porphyritic intrusions assigned to Unit Ep are not common in the Red Mountain area, but occur locally as small plugs and dikes cutting the Eocene volcanic-sedimentary complex. Some of these grade into flow-banded rhyolite of Unit ERr. Hornblende and biotite from a sample of this porphyry, collected 2 kilometres northwest of the Red Mountain summit, yielded discordant Ar-Ar total-fusion dates of 53.5±0.8 and 47.4±0.5 Ma, respectively (Archibald *et al.*, 1989; Appendix 7, Sample TL-87-8). The spread in the dates may be caused by excess argon in the hornblende or argon loss from the biotite. Nevertheless, a general Eocene age is indicated for the porphyry, and probably also for the enclosing volcanics, with which it is in part gradational.

OLIGOCENE TO MIOCENE HORNBLENDE PORPHYRY PLUGS AND DIKES (Op)

The youngest mappable intrusive body known in the area is a small stock (500 m diameter) that intrudes the Powell Creek formation 3 kilometres east of Lizard Lake. It consists of light grey hornblende porphyry, comprising slender hornblende needles within a very fine grained feldspathic groundmass. Hornblende from this stock yielded an Ar-Ar total-fusion date of 34.7±1.9 Ma (Archibald *et al.*, 1989; Appendix 7, Sample TL-87-16). This Oligocene date provides an upper limit for faulting and alteration in this part of the area, as it crosscuts a relatively late northwest-trending fault and a rusty carbonate-alteration zone in the Powell Creek volcanics.

A younger date was obtained from a lithologically similar hornblende porphyry dike that intrudes Rexmount porphyry (Unit Ep) one kilometre east-northeast of Rex Peak. This dike consists of black, euhedral hornblende phenocrysts within a grey aphanitic matrix. A hornblende separate from the dike yielded a Miocene Ar-Ar plateau date of 21.5±0.8 Ma (Appendix 7, Sample 89DAA-1-12-1).

LAMPROPHYRE AND BASALT DIKES

Dikes of dark brown to grey biotite-phyric lamprophyre, up to several metres wide, are exposed throughout much of the map area, but are not abundant. Their orientations are variable, but they generally strike northerly and dip steeply. They have chilled margins, but their contacts are commonly sheared. Biotite separated from a lamprophyre dike at the Bralorne mine, just south of the map area, provided a Middle Eocene K-Ar date of 43.5±1.5 Ma (Leitch *et al.*, 1991a).

Dikes of dark grey to green basalt also crop out sparsely throughout the map area. They are typically very fine grained to aphanitic, commonly vesicular and/or amygdaloidal, and locally contain olivine and/or pyroxene phenocrysts. These dikes may encompass a number of ages, but they are thought to be feeders, at least in part, to the Neogene Chilcotin Group basalts. Leech (1953) reports xenoliths of Rexmount porphyry in a basalt dike that intrudes the Shulaps Complex southeast of Burkholder Lake, confirming a post Middle Eocene age for this dike.

NEOGENE MAFIC PLUGS (MPmp)

A cluster of three small circular plugs, comprising dark grey, very fine grained, columnar-jointed mafic rock, occur in a northerly trending array east of Eldorado Creek, where they cut sedimentary rocks of the Hurley Formation. A fourth plug intrudes the Hurley Formation 5 kilometres farther north, east of Spruce Lake. These plugs may represent feeder vents for Neogene Chilcotin Group basalts, as suggested by Cairnes (1943). A small mafic volcanic neck on the south branch of Relay Creek, 2 kilometres northwest of Relay Mountain, described by MacKenzie (1921), may have a similar origin.

CHAPTER 3 STRUCTURE AND METAMORPHISM

OVERVIEW

The structure of the Taseko - Bridge River area is dominated by a system of northwest to north-trending faults that reflect a complex history of mid-Cretaceous to Tertiary contractional, strike-slip and extensional deformation. The oldest map-scale structures include systems of mainly southwest-vergent thrust faults that have been mapped within several discontinuous belts extending from the southeast corner of the map area to Big Creek. These faults are, at least in part, Cretaceous in age and are inferred to be broadly synchronous with deposition of synorogenic clastic rocks of the mid-Cretaceous Taylor Creek Group and Silverquick formation; angular unconformities beneath the Hauterivian unit of the Relay Mountain Group, the Albian Taylor Creek Group, and the Upper Cretaceous Silverquick and Powell Creek formations may relate to this protracted interval of deformation. Contractional deformation continued into the Late Cretaceous and generated a later suite of southwest-vergent oblique-sinistral reverse faults, including the Eldorado fault system, as well as northeast-vergent thrust faults and folds that are recognized at several places within the map area.

Later deformation was dominated by dextral strike-slip faulting, which occurred in latest Cretaceous through Eocene time. Dextral faults are the most prominent and continuous structures in the map area, and include the Castle Pass fault and the Yalakom - Marshall Creek - Relay Creek fault system. Extensional faults, such as the Mission Ridge fault (Coleman, 1990), are locally important and are spatially and temporally associated with dextral strike-slip systems. Northeast-striking faults with minor offsets are not abundant, but are conspicuous as they transect the northwest structural grain of the area; they are among the youngest structures in the map area..

The Cretaceous and Tertiary structures which dominate the map pattern of the region are superimposed on older structures that are generally not well understood. The oldest recognized structures are synplutonic faults and ductile shears within plutonic knockers of the Shulaps serpentinite mélange, that formed during late Paleozoic construction of Shulaps oceanic crust. Early structures also include outcrop-scale brittle faults that pervade the Bridge River Complex, leading to a pronounced lenticularity of lithologic units. Much of this deformation, as well as that recorded in penetratively deformed blueschist-facies rocks, is attributed to deformation within an accretion-subduction complex. This deformation was apparently operative, perhaps episodically, from the Middle Triassic to at least late Middle Jurassic time, after which the Bridge River Complex was depositionally overlain by clastic sedimentary rocks of the Relay Mountain Group and Cayoosh assemblage. Late Jurassic or Early Cretaceous deformation is also documented locally within the area, by an angular unconformity separating the lower and upper units of the Relay Mountain Group east of Lorna Lake. However, the extent of Jurassic and Early Cretaceous deformation remains poorly understood. Although the Middle Jurassic has been postulated as the time of initial thrust-amalgamation of Cadwallader Terrane with the Bridge River and Shulaps complexes (Potter, 1986; Rusmore *et al.*, 1988), the present study documents structures of this age only in the Bridge River Complex, and provides no clear evidence for thrust imbrication and uplift of adjacent terranes until the mid-Cretaceous.

Within the Taseko - Bridge River map area, penetratively deformed metamorphic rocks are restricted to the Shulaps Range and contiguous Mission Ridge, where they are represented mainly by the Bridge River schists (Potter, 1983, 1986; Coleman and Parrish, 1991) of the Shulaps - Mission Ridge metamorphic belt. Potter (1983) attributed the metamorphism and related ductile deformation to overthrusting of the Bridge River Complex by the Shulaps Ultramafic Complex in Early to Middle Jurassic time. Subsequent dating of penetratively deformed Eocene dikes within the Bridge River schists led him to revise this interpretation somewhat, and suggest a Mesozoic phase of amphibolite to greenschist-facies metamorphism associated with Shulaps thrusting, followed by a phase of Eocene deformation and greenschist-facies metamorphism (Potter, 1986). During the course of the present study, work by Archibald *et al.* (1989, 1990, 1991a,b), Calon *et al.* (1990) and Coleman (1990) has provided further constraints on the structural and metamorphic evolution of the Shulaps - Mission Ridge metamorphic belt. These studies suggest that the metamorphic rocks in the Shulaps Range record at least three distinct events: Permian ocean-floor metamorphism of the Shulaps ophiolite complex; metamorphism related to Cretaceous dike intrusion during the late stages of imbrication and emplacement of the Shulaps Complex above the Bralorne-East Liza Complex and Cadwallader Group; and Eocene metamorphism and ductile deformation that affected the Bridge River schists before their uplift and juxtaposition against the Shulaps Complex across a system of Eocene normal faults. The Eocene events were synchronous with dextral strike-slip on the Yalakom - Marshall Creek - Relay Creek fault system.

Most rocks outside the Shulaps Range are unmetamorphosed or at very low metamorphic grade; higher-grade rocks occur locally near some of the larger Cretaceous-Tertiary plutons. In general, the Bridge River Complex, Cadwallader Group and Bralorne-East Liza Complex commonly contain metamorphic minerals indicative of prehnite-pumpellyite-facies metamorphism, whereas other units, comprising mainly Jurassic and Cretaceous sedimentary rocks, are essentially unmetamorphosed. Within the former units, metamorphic minerals are most common in mafic volcanic and intrusive rocks, where they occur in veins and amygdules, and locally as partial replacements of original groundmass and phenocryst phases. The metamorphic minerals commonly observed include chlorite, epidote, pumpellyite, prehnite, calcite, stilpnomelane, albite and quartz. The assemblage chlorite-epidote-actinolite was recorded in Bridge River metabasalt at one locality west of lower Sebring Creek, and in greenstone of the Bralorne - East Liza Complex that outcrops between the two strands of the Marshall Creek fault directly north of Marshall Lake. Actinolite is also reported from the volcanic unit of the Cadwallader Group in the Eldorado Creek area, where it rims clinopyroxene crystals and also occurs as small needles in the basalt groundmass (Rusmore, 1985). Greenish biotite is present in some of the actinolite-bearing rocks (Rusmore, 1985, 1987), and was also noted with calcite and epidote in a sample of Bridge River greenstone from the north shore of Downton Lake. Clastic rocks of the Hurley Formation and Bridge River Complex commonly contain calcite and chlorite, often in association with either sericite or epidote. One Hurley sample from the Camelsfoot Range contains chlorite, calcite and pumpellyite; and another, chlorite, epidote and greenish biotite. Sericite is a common component of Bridge River chert and cherty argillite, which also may contain chlorite or stilpnomelane.

The low metamorphic grade of rocks outside the Shulaps - Mission Ridge metamorphic belt is corroborated by the colour alteration indices (Epstein *et al.*, 1977) of conodonts extracted from the Cadwallader Group and Bridge River Complex (Appendix 1). The colour alteration index commonly ranges from 2 to 4 for samples collected north of Carpenter Lake, although higher values occur locally near the Eldorado pluton and other small intrusive bodies. The index is higher and more variable for samples collected south of Carpenter Lake, and may reflect proximity to the Bendor pluton.

The age of the low-grade metamorphism of the Bridge River Complex, Cadwallader Group and Bralorne-East Liza Complex is not well constrained. It may in part have occurred during Cretaceous contractional deformation, as greenschist to amphibolite-facies regional metamorphism of this age is well documented in the deeper parts of the north Cascades - eastern Coast Belt orogen to the south (Journeay, 1990; McGroder, 1991). Alternatively, or in addition, some of the metamorphism may be related to older terrane-specific events, such as Triassic-Jurassic accretion-subduction within the Bridge River Complex, and ocean-floor metamorphism within the Bralorne-East Liza Complex.

PERMIAN OCEAN-FLOOR METAMORPHISM

Calon *et al.* (1990) document a number of synplutonic deformation features within ultramafic-mafic plutonic knockers found in the serpentinite mélange of the Shulaps Ultramafic Complex. They suggest that this deformation occurred during generation of oceanic crust in a divergent-plate setting. This deformation was in part ductile in nature, and included local development of penetrative schistosity and mineral elongation lineations in gabbro knockers. Metamorphic recrystallization ranged from growth of hornblende rims around porphyroclastic pyroxene grains, to complete replacement of mafic grains by foliated and lineated amphibole. The ductile deformation zones are locally crosscut by leucogabbro and gabbroic to dioritic dikes, indicating that they were broadly contemporaneous with plutonism during construction of Shulaps oceanic crust.

Synplutonic metamorphism within the Shulaps Ultramafic Complex is assigned an Early Permian age, based on Ar-Ar dating of two separate amphibolite knockers from the serpentinite mélange. Similar knockers are widespread throughout the mélange unit, where they commonly range from less than a metre to several tens of metres in size. They typically comprise a foliated and/or lineated intergrowth of hornblende and plagioclase, but locally grade into fine to medium-grained diabasic-textured rocks in which amphibole only partially replaces pyroxene. Their composition and textural variations are similar to those of synplutonic ductile deformation domains within larger gabbroic knockers (Calon *et al.*, 1990).

One dated knocker occurs on the northwestern margin of the Shulaps Complex, about 1.5 kilometres south of Noaxe Lake. This tabular mass is about 6 metres wide, and comprises coarse-grained, massive to weakly lineated, locally brecciated amphibolite. The sample from this knocker contains well-preserved brown hornblende, saussuritized plagioclase and epidote, cut by closely spaced quartz veins. Step-heating of a hornblende separate from this rock (Archibald *et al.*, 1991a; Appendix 7, Sample TL-88-23) yielded an integrated date of 253.7±14.7 Ma and a plateau date of 260.8±10.7 Ma. An Ar-Ar correlation analysis of the plateau segment revealed an initial 40Ar-36Ar ratio that was slightly less than the expected atmospheric ratio, and an older age for the plateau segment of 271±16 Ma. This Early Permian correlation plot date is considered to be a reliable cooling age for this sample (Archibald *et al.*, 1991).

The other dated Permian amphibolite knocker outcrops in the southwestern corner of the Shulaps Complex, about 4 kilometres north of Marshall Lake. It is about 10 metres in diameter, and occurs 100 metres east of the thrust contact between serpentinite mélange and underlying gabbro of the Bralorne-East Liza Complex. It comprises massive to well-foliated green amphibole intergrown with saussuritic plagioclase, minor amounts of sphene and quartz, and postfoliation prehnite-chlorite-quartz veinlets. Step-heating of an amphibole separate yielded an integrated age of 206±10 Ma and a plateau date of 251±8 Ma (Appendix 7, Sample TL-88-4). This sample may have been partially overprinted, but the plateau date is, within analytical error, the same as the date obtained for sample TL-88-23 from south of Noaxe Lake.

The Permian dates from the amphibolite knockers are interpreted to be the age of cooling following metamorphism, deformation and plutonism related to construction of Shulaps oceanic crust. The 271 Ma date from sample TL-

88-23 is considered the more reliable of the two, and is similar to the U-Pb zircon date of 288+17/-11 Ma from a tonalite block in the mélange, which is inferred to be a magmatic age (Appendix 8). These dates span the same range as latest Carboniferous to Early Permian U-Pb, K-Ar and Ar-Ar dates obtained from diorite and soda granite of the Bralorne-East Liza Complex (Leitch, 1989; Leitch *et al.*, 1991a; Appendix 7 of this report). The coincident dates support the correlation of the Shulaps and Bralorne-East Liza complexes and suggest that they are part of an oceanic basin that formed, or was widening, in Early Permian time. This correlation is supported by the recognition of synplutonic ductile deformation zones in the Bralorne-East Liza Complex (Calon *et al.*, 1990) that are similar to those within knockers of the Shulaps serpentinite mélange. Permian or older deformation within the Bralorne-East Liza Complex was also postulated by Leitch *et al.* (1991a) to account for emplacement of ultramafic rocks into relatively high structural levels prior to their being intruded by Permian diorite.

SUBDUCTION-RELATED DEFORMATION OF THE BRIDGE RIVER COMPLEX

Accumulation of the Bridge River Complex as an accretion-subduction complex is suggested by its wide age range, commonly observed outcrop-scale faulting, and consequent lack of a coherent internal stratigraphy. The most compelling evidence for deformation in this environment, however, is provided by high pressure blueschist-facies rocks within the complex. The blue amphibole within Bridge River blueschists ranges in composition between crossite and glaucophane (microprobe analyses by Alison Till, University of Washington), and occurs as a component of several different parageneses. These include blue amphibole-lawsonite and blue amphibole-epidote-garnet-white mica in mafic rocks; and blue amphibole-epidote-stilpnomelane-calcite-quartz in metachert. Locally, blue amphibole envelops cores of barroisitic amphibole, suggesting an earlier, higher temperature phase of metamorphism. The blue amphibole-bearing assemblages are locally cut by veins of pumpellyite and quartz, but were nowhere seen overprinted by greenschist-facies assemblages. This suggests that the blueschist-facies rocks did not experience significant heating during their uplift.

Small-scale structures within Bridge River blueschists indicate a complex history of multiple deformations. Synmetamorphic deformation is indicated by the common occurrence of penetratively foliated and lineated blueschist. The deformation was markedly inhomogeneous as penetratively deformed rocks locally enclose large lenses of non-penetratively deformed metabasalt with the same parageneses, and elsewhere narrow zones of strongly foliated blueschist occur within almost undeformed pillowed metabasalt, also with the same blueschist-facies mineral assemblages. The penetrative schistosity is locally axial planar to tight to isoclinal folds of metachert layers, and has itself been folded by two or more generations of later folds and crenulations. The age of this later deformation is not well constrained, although some is Late Cretaceous and related to northeast-vergent thrusting and folding (Garver, 1991).

The 230 Ma Ar-Ar dates on white mica from Bridge River blueschists (Chapter 2) indicate that subduction-related deformation occurred, at least in part, in the late Middle Triassic. Subduction-accretion-related deformation probably continued at least into the late Middle Jurassic since cherts of this age are imbricated within the complex, whereas younger clastic rocks that overlie the Bridge River Complex display a coherent stratigraphy. Specific structures related to Triassic-Jurassic deformation of the Bridge River Complex are thought to be included in the abundant outcrop-scale faults and folds that characterize the complex (Photo 56), but are not readily distinguished from structures related to Cretaceous-Tertiary deformation. However, these older structures probably include the outcrop-scale "ductile" faults described by Potter (1983, 1986), which he attributed to Triassic-Jurassic deformation prior to complete lithification of the Carpenter Lake assemblage.

PRE-HAUTERIVIAN DEFORMATION WITHIN THE RELAY MOUNTAIN GROUP

Evidence for pre-Hauterivian deformation is found within the Relay Mountain Group in the fault-bounded block that extends from Sluice Creek southeastward to Lizard Creek (Figure 3). There, the middle unit of the formation is missing, and the lower unit (muJRM1) is overlain by the upper unit (lKRM3) across an angular unconformity. Middle to Upper Jurassic rocks of Unit muJRM1, which underlie most of the block, are deformed by abundant mesoscopic folds and faults, and are commonly cut by a penetrative cleavage that is not typical of the unit elsewhere. The folds are of variable orientation, but commonly plunge to the east near Lorna Lake and to the north or south near Lizard Creek. Relationships displayed on the slopes directly east of the north end of Lorna Lake indicate that the deformation is pre-Hauterivian in age. There, siltstone and sandstone turbidites of unit muJRM1 underlying the lower part of the slope are deformed by east-plunging, south-vergent overturned folds and associated thrust faults. An axial planar slaty cleavage is moderately well developed in many of the finer grained beds. The beds are overturned in the uppermost exposures of the unit, where they dip at moderate angles to the north and are cut by shallower north dipping cleavage. These overturned beds are overlain by non-cleaved shales of unit lKRM3, which contain fossils of probable Hauterivian age (Appendix 3, Samples 86PS-18-7-1).

The regional significance of the deformation within unit muJRM1 near Lorna Lake is uncertain. Structures of this age have not been recognized elsewhere in the area, although the base of the Hauterivian (unit lKRM3) is typically an abrupt contact that juxtaposes shales above predominantly coarser clastic rocks of unit JKRM2. Farther west, regional uplift and unroofing of the southwestern Coast Belt is indicated by an erosional unconformity of about the same age which separates Hauterivian sedimentary and volcanic rocks of the Gambier Group from older assemblages, including Late Jurassic plutonic rocks (Mon-

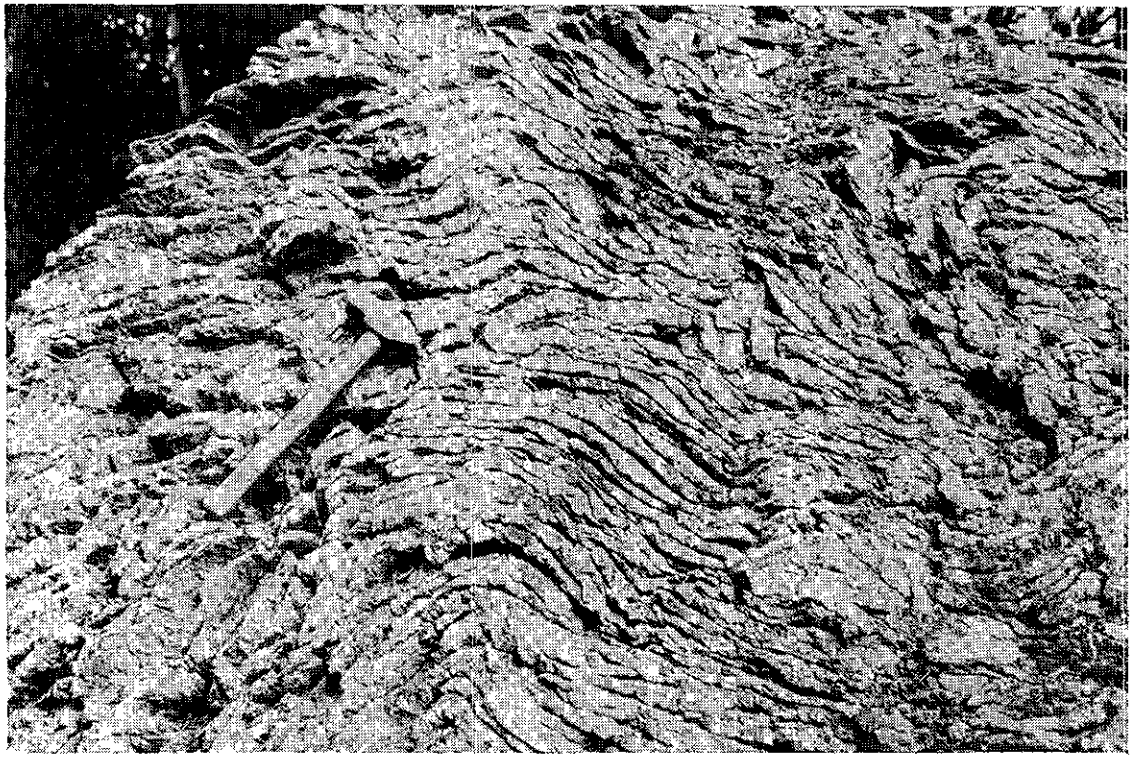

Photo 56. Folded ribbon chert of the Bridge River Complex, Carpenter Lake road north of Gold Bridge.

ger, 1993). Hauterivian volcanic and sedimentary rocks that may correlate with the Gambier Group occur a short distance to the west of the Taseko - Bridge River area (McLaren, 1990). These rocks may even extend into the area and be represented by the Tosh Creek succession. It is suspected, therefore, that the pre-Hauterivian deformation within Unit muJRM1 is an eastern expression of the tectonism associated with uplift in the western Coast Belt. An alternative interpretation, however, is suggested by the fact that the rocks of Unit muJRM1 are inferred to have been deposited above the Bridge River Complex but overlap in age with the youngest cherts imbricated within the complex. This raises the possibility that the deformation within unit muJRM1 is considerably older than Hauterivian, and is related to the latest stages of accretion within the Bridge River Complex.

MID-CRETACEOUS CONTRACTIONAL AND OBLIQUE-SINISTRAL FAULT SYSTEMS

Systems of Cretaceous thrust, reverse and reverse-sinistral faults are recognized across much of the map area, but their continuity is disrupted by younger faults. The most prominent structures are southwest-vergent thrust faults that imbricate mid-Cretaceous and older rocks of the Tyaughton basin, Bridge River Complex, Cadwallader Terrane and Bralorne-East Liza and Shulaps complexes. The most common stacking order preserved in these thrust belts comprises imbricated Cadwallader Terrane and Bralorne-East Liza Complex above Bridge River Complex and Relay Mountain Group, and below the Shulaps Ultramafic Complex. Somewhat younger southwest-vergent reverse and reverse-sinistral faults locally reverse this predominant stacking order and place the Bridge River Complex above the Cadwallader Group and Bralorne-East Liza Complex. Northeast-vergent thrust faults and folds are evident locally, and may in part be coeval with the southwest-vergent reverse and reverse-sinistral faults.

The contractional faults are first described in terms of the several belts where they are best exposed (Figure 19). A final section presents an interpretive summary of their evolution.

GUN CREEK - ELBOW MOUNTAIN THRUST BELT

The Gun Creek - Elbow Mountain thrust belt extends from Gun Lake to Big Creek. The lowest structural level consists of imbricated Relay Mountain and Taylor Creek groups. These rocks are structurally overlain by imbricated Tyaughton Group and Last Creek formation, which in turn are structurally overlain by imbricated Cadwallader Group and Bralorne-East Liza Complex.

Southwest-vergent thrust faults in the Relay Mountain and Taylor Creek groups are best displayed in a northwest-trending belt near Elbow Mountain. Northeast-dipping faults are concentrated in a zone 1 to 2 kilometres wide that has been traced from Big Creek southeastward about 6 kilometres to the Fortress Ridge fault. Within this zone, thrust faults are defined mainly by younger-over-older relation-

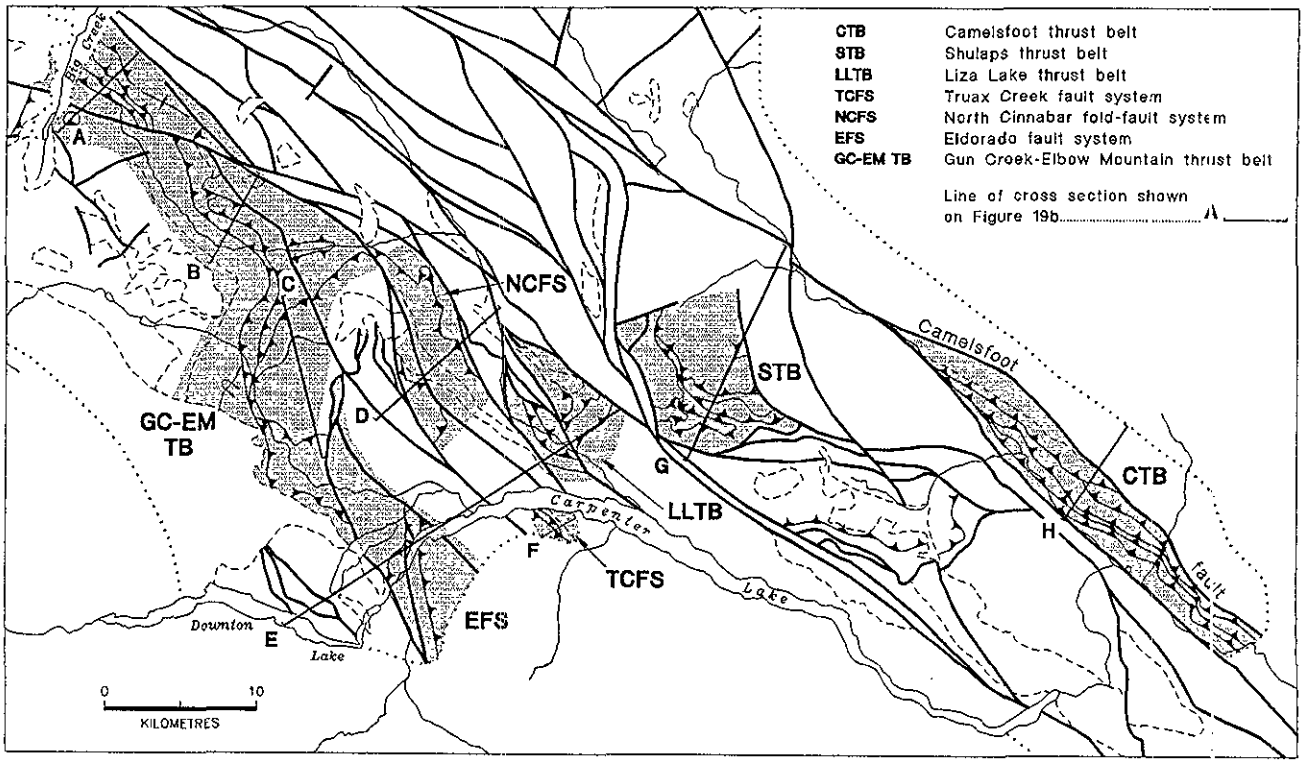

Figure 19a. Cretaceous contractional fault systems in the Taseko - Bridge River map area.

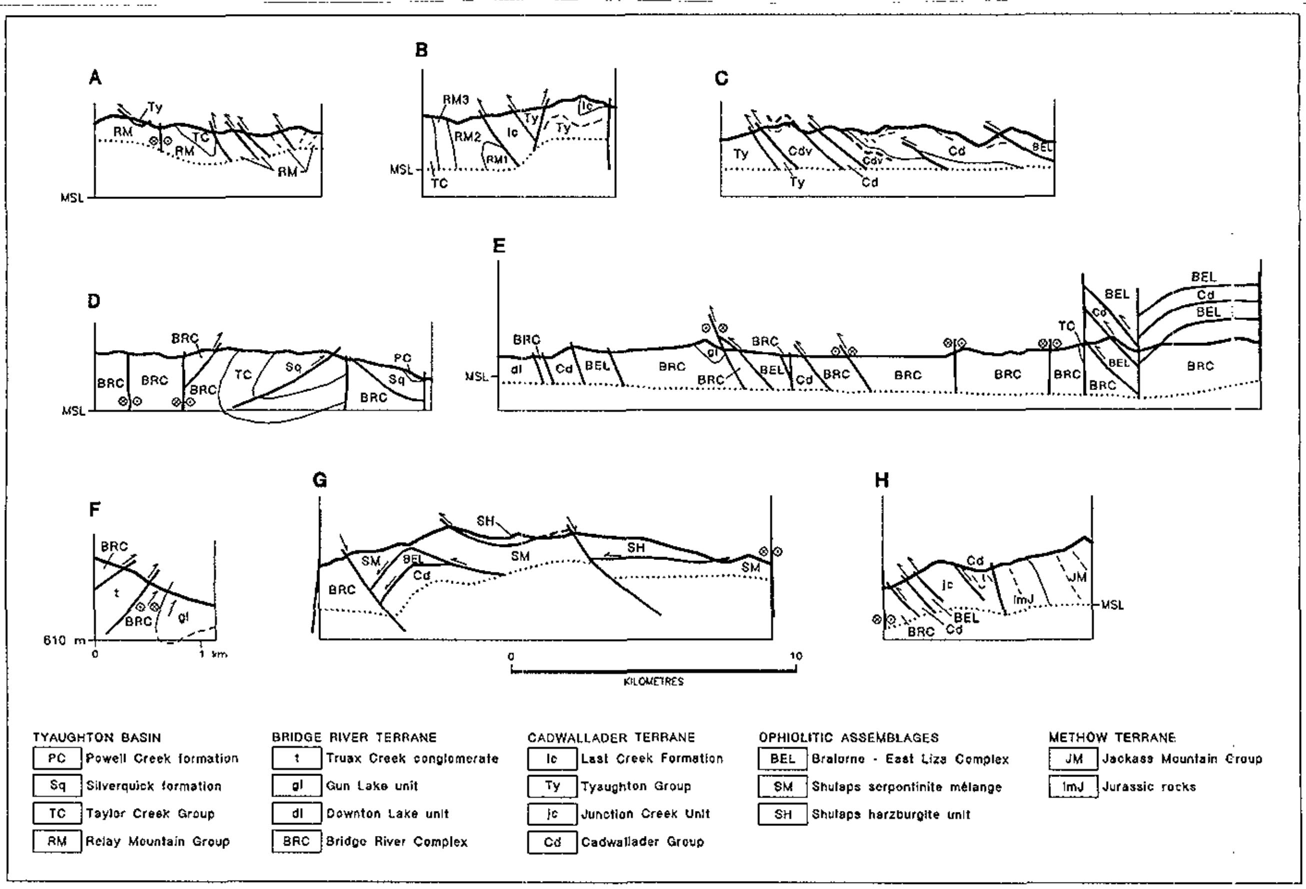

Figure 19b. Cross sections to accompany Figure 19a. Note that the scale for section F differs from the others.

ships between the three mappable units of the Relay Mountain Group, as well as by repetition of faunal zones in the richly fossiliferous middle unit of the group (Jeletzky and Tipper, 1968; Tipper, 1978; Umhoefer *et al.*, 1988). Where observed, the faults are marked by narrow zones of breccia-tion and rusty alteration parallel, or at low angles, to bedding (Jeletzky and Tipper, 1968; Umhoefer, 1989). Southwest-directed thrust movement, implied by the dip of the faults and younger-over-older relationships, is confirmed by local mesoscopic thrust faults with a ramp geometry as well as by a low-angle hangingwall cutoff mapped along one of the faults (Umhoefer, 1989). The lowest thrust fault recognized within this belt places the upper unit of the Relay Mountain Group above the Taylor Creek Group; the footwall Taylor Creek Group is disposed as a southwest-overturned syncline that probably formed during thrusting (Figure 19, Section A). This belt of Taylor Creek Group also outcrops on the slopes west of Big Creek, where it is unconformably over-lain by relatively undeformed Cenomanian Powell Creek volcanics. This pronounced angular unconformity is recognized throughout the northwestern part of the map area (Glover and Schiarizza, 1987) and constrains the timing of thrusting and related deformation to the mid-Cretaceous.

The Elbow Mountain thrust belt is not recognized south of the Fortress Ridge fault, but a steeply dipping to overturned southwest to west-facing panel of Relay Mountain and Taylor Creek rocks extends more than 15 kilometres southward from the Fortress Ridge fault to the northern margin of the Dickson-McClure batholith. This panel is structurally overlain by the Last Creek formation, and probably correlates with the lower part of the Elbow Mountain thrust system, including the footwall Taylor Creek Group. A west-vergent overturned anticline within the lower unit of the Relay Mountain Group south of Spruce Lake is in about the same structural position as the main locus of thrusting within the Elbow Mountain belt, and may represent the southern expression of the thrust belt.

The Relay Mountain Group south of the Fortress Ridge fault is bounded to the east by the Last Creek formation of Cadwallader Terrane. The contact is not well exposed, but is mapped as a fault (the Spruce Lake fault) because it truncates the west-vergent anticline within the Relay Mountain Group south of Spruce Lake, and truncates the contact between the lower and middle units of the group a short distance south of the Fortress Ridge fault. It is inferred to be an easterly-dipping thrust as this is consistent with the pattern of thrust faults documented within both the Tyaughton basin rocks to the west and Cadwallader Terrane to the east. The Last Creek formation also outcrops on the north side of the Fortress Ridge fault, where it is bounded to the west, north and east by the lower unit of the Relay Mountain Group (Figure 3). The northeastern contact between the two units in this area is a northwest-striking fault that was inferred by Umhoefer *et al.* (1988) and Umhoefer (1989) to be a faulted unconformity. We prefer an alternative interpretation, in which the Last Creek formation northeast of the Fortress Ridge fault originated as a klippe separated from underlying Relay Mountain Group by a thrust fault that is the offset equivalent of the Spruce Lake fault to the south. This interpretation is consistent with the 2 kilometre dextral offset of the Last Creek formation (and bounding Spruce Lake fault) across the Fortress Ridge fault, as it compares closely with offsets of intrusive porphyry units and the Castle Pass fault.

Thrusting of Cadwallader Terrane above the Relay Mountain Group is confirmed by a small klippe of Tyaughton Group that rests above the Relay Mountain Group east of the north end of Lorna Lake, 8 kilometres west of the main belt of Cadwallader Terrane rocks. (Figure 19, Section A). The exposures east of Lorna Lake show gently dipping, right-way-up sandstones and pebble conglomerates of the upper Tyaughton Group resting directly above Hauterivian shales and siltstones of the upper unit of the Relay Mountain Group. Where observed, the contact is marked by several metres of friable rock pervaded by a system of gently dipping, closely spaced anastomosing fractures.

In the main belt of Cadwallader Terrane rocks to the east, the Last Creek formation is structurally overlain by the Tyaughton Group (Figure 19, Section B). Although the contact is not well exposed, the distribution of units outlined by detailed mapping west of Castle Peak suggests that it is at least in part a low angle fault that has been later folded (Umhoefer *et al.*, 1988). The structure within the overlying Tyaughton Group is very complex, and is inferred by Umhoefer (1989) to be the result of thrusting followed by dextral strike-slip faulting. Details of the thrust system are in large part obscured by later deformation, but thrust faults have been defined locally. These include a southwest-dipping fault that places the lower unit of the Tyaughton Group over the upper unit east of Spruce Lake, and a presumably thrust-bound window of Last Creek formation beneath the Tyaughton Group along Tyaughton Creek (Figure 3). The Tyaughton Group is structurally overlain by the Cadwallader Group to the south, and is truncated by the Castle Pass and Fortress Ridge fault systems to the northeast.

Rusmore (1985, 1987) first described south to southeast-dipping thrust faults within the Cadwallader Terrane in the Eldorado Creek area. She mapped one set of imbricate thrusts that places the basal volcanic unit over the Hurley Formation of the Cadwallader Group (*see* Figure 6 of Rusmore, 1987), and one which separates the Cadwallader Group from the underlying Tyaughton Group. These faults were confirmed and extended during the present study, and a similar southerly dipping fault was found to mark the southern boundary of the Cadwallader Group, and to separate it from the structurally overlying Bralorne-East Liza Complex (Figure 19, Section C). The latter fault is truncated by the Eldorado fault system to the east, whereas the structurally lower faults to the north terminate against two different strands of the Castle Pass fault system. The two northern faults apparently merge to the west with the fault which juxtaposes the Tyaughton Group above the Last Creek formation. This composite fault then merges with the Spruce Lake fault, which is apparently truncated to the south by Late Cretaceous granodiorite of the Dickson - McClure batholith.

Farther southeast, rocks of the Bralorne-East Liza Complex at the highest structural level of the Gun Creek - Elbow Mountain thrust belt are juxtaposed above Bridge River Terrane. From Gun Lake northwestward to Jewel Creek, the bounding fault (Sumner Creek fault) juxtaposes serpentinite and gabbro of the Bralorne-East Liza Complex on the northeast against the Gun Lake clastic unit and, locally, an intervening sliver of chert, argillite and siltstone of Unit JBRas (Figure 3). Foliation and local shear zones within serpentinite and underlying Bridge River rocks near the fault suggest that it dips moderately to steeply northeastward. The fault is apparently truncated by the Dickson-McClure batholith west of Jewel Creek, where hornfelsed ultramafic rocks are in contact with granodiorite. It emerges again west of Roxey Creek from where it extends north-northwest to the mouth of Leckie Creek to mark the eastern boundary of hornfelsed clastic rocks, tentatively included in the Gun Lake clastic unit, invaded by lobes of granodiorite (Cairnes, 1943). Although continuity is disrupted by the batholith, the Sumner Creek fault appears to trace into the Spruce Lake fault a short distance farther to the northwest. The two faults are therefore inferred to be different parts of the same fault system, which juxtaposes imbricated Bralorne-East Liza Complex and Cadwallader Terrane above Bridge River Terrane in the south and above Tyaughton basin in the north. As discussed in Chapter 2, it is not certain whether the boundary between these two footwall tectonostratigraphic elements, which is in part hidden beneath the overlying thrust sheet and in part truncated by the Dickson - McClure batholith, is a stratigraphic contact or a fault.

A striking feature of the Gun Creek - Elbow Mountain fault system is a prominent bend in the Spruce Lake fault, which trends southeasterly from the Fortress Ridge fault to Tyaughton Creek, then swings to the south-southwest through Spruce Lake before being truncated by the Dickson - McClure batholith. If it does indeed trace into the Sumner Creek fault, then it bends again to resume its southeasterly trend beyond that point, outlining a broad Z shape in map view. The prominent swing in the fault trace north of Spruce Lake is reflected in the distribution of the Last Creek formation in the fault's immediate hangingwall, and in the orientation of stratigraphic contacts within the Relay Mountain and Taylor Creek groups in the footwall. The southern part of the northerly-trending segment of the fault system, north of the Dickson - McClure batholith, truncates a footwall anticline in the Relay Mountain Group, as well as several hangingwall thrust faults within Cadwallader Terrane and the Bralorne-East Liza Complex (Figure 3). The jog is therefore thought to reflect a major ramp in the thrust system. The prominent lobe of early Late Cretaceous granodiorite in this area suggests that the ramp may have been localized by a major footwall buttress provided by the intruding granodiorite mass.

ELDORADO FAULT SYSTEM

The Eldorado fault system includes the Eldorado fault, which has been traced for about 25 kilometres from the lower Hurley River to Eldorado Mountain, and the Steep Creek fault, an eastern splay that merges with the Eldorado fault near the head of Freiberg Creek (Figures 19 and 20). Where exposed, these faults dip at moderate to steep angles to the east or northeast, and record oblique reverse-sinistral movement. Also described in this section are two westerly-directed thrust faults, the Quarry and Sucker Lake faults, that occur between, and are truncated by, the Eldorado and Steep Creek faults. The Eldorado fault also cuts thrust faults of the Gun Creek - Elbow Mountain thrust belt in its footwall. Its reverse-sinistral sense of movement is similar to that on gold-quartz vein systems at the Bralorne and Pioneer mines, which formed between 91 and 86 Ma (Leitch *et al.*, 1991a); this may also be the time of movement on the Eldorado fault system.

ELDORADO FAULT

The northerly trending Eldorado fault zone was defined by Rusmore (1985, 1987) in the eastern part of the Eldorado Creek drainage basin; she traced it from the head of Freiberg Creek northward to the Eldorado pluton. Over this distance, she defined the fault zone to include a complex zone of serpentinite containing lenses and blocks of greenstone, chert, gabbro, limestone and clastic sedimentary rocks that separates Hurley Formation on the west from Bridge River Complex to the east. Rusmore noted that the fault zone had a well-defined western boundary, marking the western limit of coherent Hurley Formation, but that the eastern boundary was less well defined due to the presence of abundant serpentinite in the Bridge River Complex for a considerable distance to the east. She further noted that rocks of the Cadwallader Group only outcrop for 0.5 to 1 kilometre east of the western margin of the fault zone, and suggested that their disappearance eastward might mark its eastern extent.

Serpentinite and associated rocks in the western part of Rusmore's (1985) Eldorado fault zone are here assigned to the Bralorne-East Liza Complex. These include two adjacent lenses of, respectively, serpentinite and greenstone that define the fault zone for about 4 kilometres northward from the head of Freiberg Creek. These rocks separate Hurley Formation on the west from the Bridge River Complex, including local serpentinite-rich lenses, to the east. To the north, the fault zone is cut by a northwest-trending splay of the Castle Pass strike-slip fault. Directly north of the Castle Pass splay, the Hurley Formation is cut by several narrow serpentinite-bearing fault zones and is apparently thrust southward over the adjacent Bridge River Complex (Figure 3). These are thought to be relatively late structures related to the adjacent strike-slip fault. Farther north, the Eldorado fault zone is once again defined by a belt of serpentinite, several hundred metres wide, that separates Hurley Formation on the west from Bridge River Complex to the east. The fault zone is intruded by the Eldorado pluton farther to the north, but was folded into a tight south-plunging synform along the main strand of the Castle Pass fault prior to intrusion by the pluton (Figure 20). On the eastern limb of the synform the fault zone comprises serpentinite and greenstone of the Bralorne-East-Liza Complex that separates Hurley Formation on the east from Bridge River rocks to the west. These rocks extend for 3 kilometres south of the Eldorado pluton where they are truncated along the Castle Pass fault.

The Eldorado fault has been traced an additional 15 kilometres southward from where it was defined by Rusmore (1985). It truncates the thrust fault between Bralorne-East Liza Complex and Hurley Formation west of upper

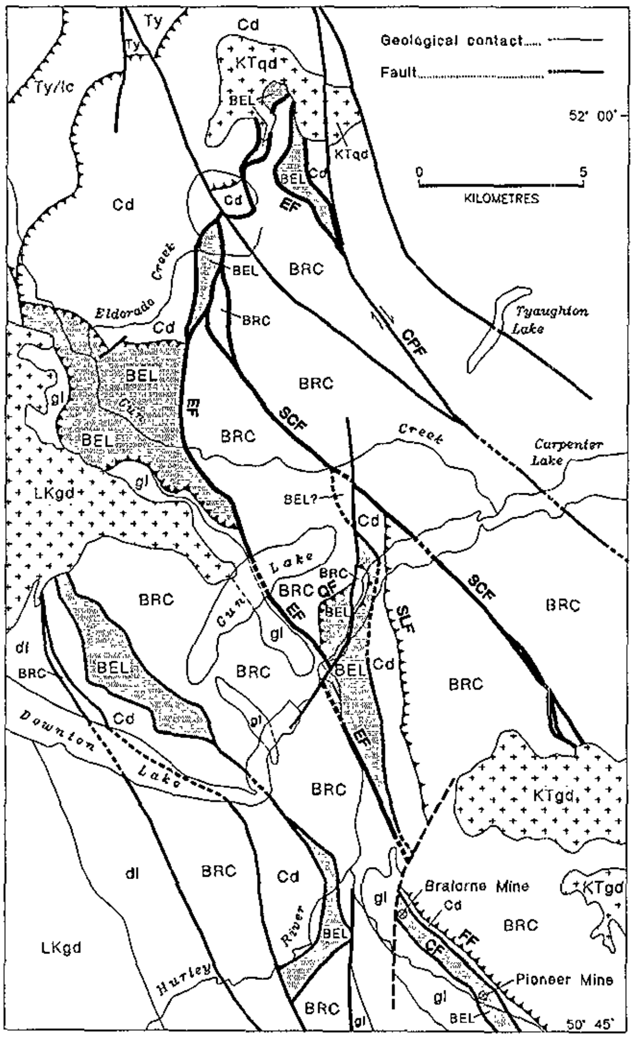

Figure 20. Simplified map of the Eldorado fault system. CF=Cadwallader fault; CPF=Castle Pass fault; EF=Eldorado fault; FF=Fergusson fault; QF=Quarry fault; SCF=Steep Creek fault; SLF=Sucker Lake thrust fault. KTgd=granodiorite of the Bendor plutonic suite; KTqd= Eldorado pluton; LKgd=Dickson-McClure batholith. Other map unit codes as in Figure 19b.

Freiberg Creek, and south of there it separates Bralorne-East Liza Complex on the west from Bridge River Complex to the east. Just north of Gun Lake it truncates the Sumner Creek fault on its west side, and just north of the Bridge River it truncates the Quarry fault to the east. Southward from there, it juxtaposes Bralorne-East Liza Complex on the east against Bridge River Complex to the west. It is apparently truncated by a north-northeast striking fault just beyond the limit of our mapping (Figure 20), but may correlate with parts of the Cadwallader fault system (Joubin, 1948), which bounds the southwestern margin of the Bralorne-Pioneer vein system still farther to the south.

The Eldorado fault is locally exposed west of upper Freiberg Creek, where the contact between Hurley Formation and adjacent serpentinite is vertical to steeply east-dipping. Mesoscopic shear zones cutting serpentinite and greenstone directly east of the Hurley Formation, however, commonly dip eastward at moderate to shallow angles; no indication of movement direction was noted in this area. Part of the Eldorado fault zone is also exposed at the south end of the Gold Bridge quarry, in a rockcut along the main road. There, serpentinite containing boudinaged dike fragments is structurally overlain by diorite of the Bralorne-East Liza Complex across a well-exposed fault that dips 50° to 60° to the east-northeast. A small outcrop of Bridge River chert and argillite 50 metres to the east is also cut by moderately northeast-dipping faults. The serpentinite directly beneath the diorite in the rockcut is cut by several discrete shear zones that are parallel to the overlying fault and are spaced several centimetres apart. These fault surfaces contain east-southeast-plunging stretching lineations and enclose domains of sigmoidally disposed foliation that indicate oblique reverse-sinistral movement.

The Eldorado fault cuts the Sumner Creek fault, which was active in early Late Cretaceous time, prior to intrusion of 92 Ma granodiorite of the Dickson-McClure batholith. The Eldorado fault is in turn cut by the Eldorado pluton, which has yielded a 67 Ma cooling age, as well as by the Castle Pass fault which was probably active before, during and after intrusion of the pluton. Within the map area, the southern segment of the Eldorado fault bounds a belt of Bralorne-style gold-quartz vein occurrences within Bralorne-East Liza Complex along the lower Hurley River, and it may be the offset extension of the fault system along the southwestern margin of the Bralorne-Pioneer vein system (Figure 20). The main gold-producing veins of the Bralorne-Pioneer camp are shear controlled and dip at moderate to steep angles to the north-northeast, recording oblique reverse-sinistral movement (Joubin, 1948; Leitch, 1989). Their spatial association and comparable sense of movement suggest that the Eldorado fault and Bralorne-style vein systems were contemporaneous. The main mineralizing episode at the Bralorne-Pioneer mine occurred between 91 and 86 Ma (Leitch, 1989; Leitch *et al.*, 1991a). This timing is consistent with the known constraints for the Eldorado fault and is considered the best estimate for the time of movement along the Eldorado fault system.

STEEP CREEK FAULT

A system of northeast dipping faults that has been mapped in the vicinity of Mount Truax, south of the map area (Turner, 1985; Journeay *et al.*, 1992), is inferred to extend northwestward along Steep Creek to Carpenter Lake, and to cross the lake to ultimately merge with the Eldorado fault in the headwaters of Freiberg and B&F creeks (Figure 20). The fault is not well defined between Carpenter Lake and Lajoie Creek, but it apparently marks the truncation of the Cadwallader Group and bounding Sucker Lake thrust fault. Farther north, the Steep Creek fault is within the Bridge River Complex, but is marked by discontinuous lenses of serpentinite that outcrop on the north bank of Gun Creek and near the lower reaches of B&F Creek. At its northern extremity, the fault is marked by a wide lens of serpentinite containing knockers of Bridge River lithologies. This belt bends to the north to merge with the Eldorado fault at the headwaters of Eldorado Creek, where it forms part of the Eldorado fault zone originally described by Rusmore (1985).

Mesoscopic faults and shear zones cutting serpentinite and greenstone along the inferred trace of the Steep Creek fault directly north of Gun Creek dip 40° to 60° northeast. One narrow northeast-dipping shear zone records oblique reverse-sinistral movement, as indicated by east-plunging striations on fault surfaces and shear bands cutting the shear zone foliation. This sense of movement is the same as that recorded on the Eldorado fault. Journeay *et al.* (1992) also note reverse-sinistral movement along northeast-dipping shears near Mount Truax at the south end of the fault zone (their Truax fault).

QUARRY FAULT

The Quarry fault, which separates the Bralorne-East Liza Complex on the east from Bridge River Complex to the west, was mapped for about 2 kilometres between the Gold Bridge quarry and Gun Lake. It is truncated to the south by the Eldorado fault, and to the north by a northerly trending fault a short distance west of the Wayside mine. The non linear trace of the Quarry fault was mapped as mainly an intrusive contact by Cairnes (1937) and as a northerly trending fault segment offset by a northeast-trending fault by Church *et al.* (1988b). However, foliation and mesoscopic faults in serpentinite along the western margin of the Bralorne-East Liza Complex commonly dip at moderate angles towards the east, suggesting that the non-linear trace may reflect intersection of a dipping structure with topography. Applying this model, it was found that the available constraints on the trace of the fault are consistent with a single fault dipping 30° to 40° to the east-southeast. This interpretation is preferred here, as it is consistent with the nature of the contact between Bralorne-East Liza Complex and Bridge River Complex elsewhere in the map area. Striations and mineral fibres on east-dipping mesoscopic faults near the inferred fault trace indicate predominantly dip-slip movement.

SUCKER LAKE THRUST FAULT

The Sucker Lake fault separates Unit uTrBRglc of the Bridge River Complex on the east from the Cadwallader Group to the west. It was traced from the Plateau Ponds area east of the north end of Gun Lake, southward across Carpenter Lake to the vicinity of Sucker Lake. The fault is exposed on the main road north of Carpenter Lake, where it is represented by 2 metres of sheared and brecciated slaty rock between Hurley sandstone on the west and Bridge River chert and slate on the east. Individual fault surfaces and cleavage domains dip moderately to steeply eastward. These include moderately east dipping fault surfaces, with down-dip striations, that are spaced several centimetres apart and enclose domains of more steeply dipping cleavage that deflects sigmoidally into bounding fault surfaces. The west-directed movement indicated by these fabrics is corroborated by folds in footwall Cadwallader Group that are overturned to the west, and asymmetric west-verging mesoscopic folds in the hangingwall Bridge River Complex.

The Sucker Lake fault is truncated by the Steep Creek fault to the north, and extends southward beyond the limit of our mapping. It is thought to be the offset equivalent of the Fergusson fault (Joubin, 1948), which places Bridge River Complex above Cadwallader Group and Bralorne-East Liza Complex northeast of the Bralorne and Pioneer mines (Figure 20).

LIZA LAKE THRUST BELT

The Liza Lake thrust belt outcrops west of Liza Lake, where it is bounded by the Relay Creek fault system to the northeast, and by a strand of the Fortress Ridge fault system to the southwest. The belt is cut by another strand of the Fortress Ridge fault system, and feathers out to the north against several anastomosing fault splays connecting the Relay Creek and Fortress Ridge systems (Figure 19). The Cadwallader Group in this belt is sandwiched between two slices of Bralorne-East Liza Complex. The lower Bralorne-East Liza slice sits structurally above an extensive belt of Bridge River rocks and in large part rests directly on blueschists imbricated in the upper part of the footwall package. The bounding faults predate the northwest-striking Relay Creek and Fortress Ridge fault systems. They dip at moderate to low angles to the northwest in the eastern part of the belt, and apparently dip to the northeast in the western part of the belt. They are presumed to be thrust faults, by analogy with adjacent belts of imbricated Cadwallader Group and Bralorne-East Liza Complex; the inferred thrust motion is supported by a single observation of a composite fault zone fabric at the base of the upper East Liza slice north of the mouth of Liza Creek.

Although the Cadwallader and Bralorne-East Liza slices of the Liza Lake thrust belt are truncated to the west by a splay of the Fortress Ridge fault system, the footwall Bridge River blueschists continue for 15 kilometres to the northwest before being truncated by the Castle Pass fault (Figure 3). The Bridge River rocks, including blueschists, within this belt are unconformably overlain by Albian rocks of the Taylor Creek Group, which in turn are unconformably overlain by the Cenomanian Silverquick formation (Garver, 1989); this entire stratigraphic succession occupies the overturned limb of a northeast-vergent syncline. Assuming that the blueschists are a reliable local marker within the Bridge River Complex, this implies one of three possible relationships between the Cadwallader - Bralorne-East Liza thrust stack and the mid-Cretaceous clastic succession: (1) the thrust stack was removed by erosion prior to deposition of the Taylor Creek Group; (2) the thrust stack ramped to the west, over the top of the Taylor Creek Group, and was then removed by erosion prior to deposition of the Silverquick formation; (3) the Cadwallader - Bralorne-East Liza thrust stack ramped to the west over both the Taylor Creek Group and Silverquick formation. The second or third interpretation is preferred because the Taylor Creek Group is nowhere seen in depositional contact with the Cadwallader Group and does not contain detritus that can be linked to the Cadwallader Group, whereas Silverquick conglomerates commonly contain abundant sandstone clasts that resemble, and may have been derived from, the Hurley Formation. The evidence is not conclusive, however, and the alternative interpretations cannot be completely dismissed. In particular, it should be noted that there are folds and faults in the Bridge

River Complex at the head of North Cinnabar Creek that may be older than the northeast-vergent structures related to the overturned syncline, and that these structures can generally be restored to a southwest-vergent orientation when the effects of northeast-vergent deformation are removed (Garver, 1991). Further, some of these early faults probably formed prior to deposition of the Albian Taylor Creek Group as it rests on different components of Bridge River basement from place to place within this area (Garver, 1989). However, these early faults are not necessarily related to the fault beneath the Cadwallader - Bralorne-East Liza thrust stack; they may have formed earlier within the demonstrably protracted Cretaceous contractional event, or be still older and related to Triassic-Jurassic subduction-accretion processes within the Bridge River Complex.

SHULAPS THRUST BELT

Thrust faults related to imbrication and emplacement of the Shulaps Ultramafic Complex are most in evidence along the southwestern margin of the complex. There, imbricate structures within and between the two mappable divisions of the complex are well displayed, as is the thrust contact between the base of the Shulaps Complex and underlying rocks of the Bralorne-East Liza Complex and Cadwallader Group. Elsewhere along its southern margin, the Shulaps Complex is in contact with Bridge River phyllites and schists across what are inferred to be later normal faults of the Brett Creek and Mission Ridge fault systems (Figure 19, Section G). The stacking order preserved in thrust belts east and west of the Shulaps Range suggests that the Bridge River Complex represents the lowest structural level within the thrust system. This is consistent with relationships in the Shulaps Range, as its relatively high metamorphic grade, and footwall position beneath the Mission Ridge normal fault, suggest that the Bridge River Complex originated at a relatively low structural level.

The southwestern margin of the Shulaps Complex consists of the harzburgite unit structurally overlying the serpentinite mélange unit. This large-scale two-fold division, comprising mantle tectonite above serpentinite mélange derived from ultramafic-mafic cumulates, reflects structural stacking of lower over higher stratigraphic elements of an original ophiolite suite. The base of the harzburgite unit is generally marked by several hundred metres of strongly foliated, moderately northeast to north-dipping serpentinite (Photo 57). Similar serpentinite zones also occur at structurally higher levels within the harzburgite, suggesting that it is internally imbricated; these imbricates, however, have not been mapped in detail.

Structures related to southwest-vergent thrust stacking are prominent within the serpentinized sole of the harzburgite unit and the underlying serpentinite mélange. The serpentinite consists mainly of serpentine and magnetite, with minor amounts of carbonate, talc or tremolite. It commonly contains a penetrative, steeply northeast-dipping S1 foliation cut by discrete, more gently northeast-dipping S2 folia-

Photo 57. Large gabbro block within the Shulaps serpentinite mélange unit, structurally overlain by sheared and serpentinized harzburgite at the base of the overlying harzburgite unit. View is to the north-northwest from upper Jim Creek.

tion planes and slip surfaces spaced several centimetres to several metres apart; sigmoidal deflection of S1 at S2 boundaries typically suggests a top-to-the-southwest sense of shear (Figure 21). Mylonite, apparently synchronous with the S2 serpentinite foliation, occurs in gabbro and serpentinite along the margins of large knockers (Photo 58), and commonly contains a rodingite-like assemblage of diopside-tremolite-chlorite (Nagel, 1979). These mylonites display a variety of kinematic indicators, including S-C foliations, shear bands and rotated mineral grains, that also indicate a top-to-the-southwest sense of shear (Calon *et al.*, 1990).

The serpentinite mélange unit is internally imbricated and is interpreted by Calon *et al.* (1990) as a large, composite, hinterland-dipping duplex structure sandwiched between the harzburgite unit above and the Bralorne-East Liza - Cadwallader slices below. Within the well-exposed northern part of the southwestern mélange belt, they map several northeast-dipping duplex structures that are focused on shingled stacks of plutonic knockers. Gently to moderately northeast-dipping zones of intensely foliated serpentinite that define the floor and roof thrust zones are congruent with the S2 serpentinite foliation. The earlier, more steeply-dipping S1 foliation wraps around the lozenge-shaped plutonic knockers and curves into the duplex boundaries (Figure 21). Farther south, the predominant S2 foliation outlines an antiformal structure within the serpentinite mélange unit. The foliation dips moderately south near the axial trace of the fold, but steepens southward to attain vertical dips along the southern margin of the mélange unit, where it is faulted against Bridge River schists (Figure 3).

Sedimentary knockers within the serpentinite mélange unit are commonly foliated and aligned with the S2 serpentinite foliation. The mappable knockers of mainly clastic sedimentary rock that outcrop along the middle reaches of Jim Creek contain the metamorphic assemblages epidote-chlorite-actinolite-sericite and actinolite-chlorite-epidote-calcite, whereas a smaller metasiltstone knocker 2.5 kilometres west of Shulaps Peak contains the assemblage biotite-chlorite-quartz. A knocker of schistose mafic volcanic breccia near the latter locality was altered to an assemblage of carbonate-biotite-quartz. The interiors of gabbro knockers within the serpentinite mélange commonly display patchy alteration to an assemblage of actinolite-epidote-chlorite, but it is not clear whether this metamorphism occurred during southwest-directed thrusting or was an earlier event, possibly related to Permian ocean-floor metamorphism.

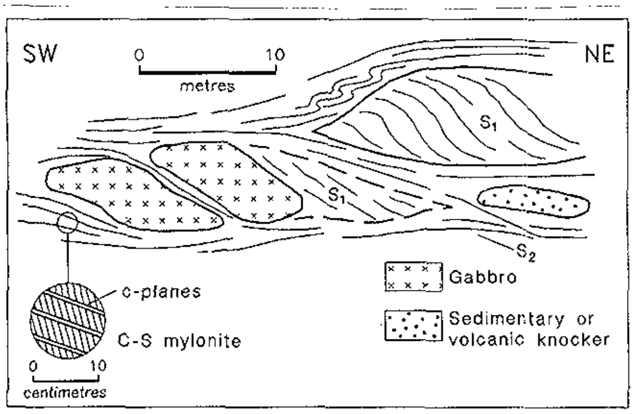

Figure 21. A schematic summary of the relationships between the main structural elements within serpentinite mélange of the Shulaps Ultramafic Complex, after Macdonald (1990a).

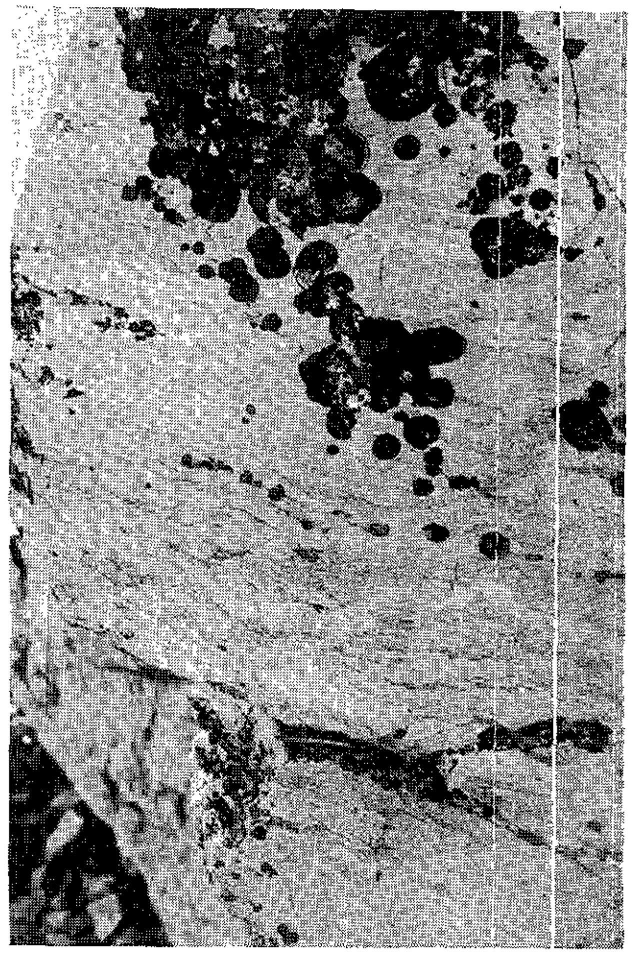

Photo 58. Mylonite at the base of a large gabbro knocker within the Shulaps serpentinite mélange unit, head of Jim Creek.

Metamorphic olivine, regenerated from serpentinite, was first noted in the Shulaps Complex by Leech (1953) and later studied in more detail by Nagel (1979) who suggested a contact metamorphic origin, but did not identify a specific heat source. The present study, together with the work of Calon *et al.* (1990), has established that this metamorphism is associated with a suite of dioritic hornblende porphyry dikes that are common in the area of Shulaps Peak and the divide between Brett and Retaskit creeks. Some contact aureoles are still attached to dike walls, but the dikes and their metamorphic products have more commonly been separated by later shearing (as noted by Nagel). Assemblages containing metamorphic olivine include: forsterite-serpentine±brucite, forsterite-serpentine±magnesite, forsterite-serpentine±talc and forsterite-talc±magnesite (Nagel, 1979; Calon *et al.*, 1990). One hornblende porphyry dike above Brett Creek is enveloped by a selvage of tremolite-serpentine-magnesite-rutile 40 centimetres wide, which passes outward into several metres of chlorite-magnesite-talc schist. Foliation within the prograde metamorphic aureoles is congruent with that of the surrounding serpentinite mélange and the dikes are commonly boudinaged within the plane of this foliation. They therefore predate some movement within the mélange. However, they caused prograde metamorphism of previously serpentinized ultramafic rock, and at one locality cut the foliation in a penetratively deformed metasedimentary knocker, so are interpreted to have been intruded relatively late in the history of contractional deformation (Archibald *et al.*, 1989; Calon *et al.*, 1990). This deformation may represent the latest stages of the mid to Late Cretaceous contractional regime, or it may relate to an early phase of transpressional deformation along the Yalakom fault.

The structural base of the Shulaps Complex is well exposed in a relatively small half window along East Liza Creek, at the western end of the antiform in the serpentinite mélange. There, serpentinite of the mélange unit lies directly above Bralorne-East Liza Complex and Hurley Formation. The contact is well exposed along the southeastern margin of the window, where serpentinite mélange overlies Bralorne-East Liza greenstone across a gently dipping mylonite zone that in part consists of pumpellyite, hornblende and minor chlorite (Nagel, 1979); excellent S-C fabrics from serpentinite mylonite at the base of the mélange unit indicate west-directed thrusting (Calon *et al.*, 1990). The Bralorne-East Liza Complex is in turn structurally underlain by the Hurley Formation across a mylonite zone that was also the locus of west to southwest-directed thrusting (Calon *et al.*, 1990; Macdonald, 1990a). This thrust contact is apparently truncated by the one at the base of the Shulaps mélange, as serpentinite mélange lies directly above Hurley Formation along the northeastern margin of the window (Figure 3).

The west-vergent thrust stack exposed in the East Liza Creek window is locally deformed by a later suite of east-vergent structures (Calon *et al.*, 1990; Macdonald, 1990a), expressed mainly as a train of folds within the Hurley formation. Fine-grained rocks display a well-developed west-dipping axial planar slaty cleavage (Photo 59), whereas sandstones preserve a relict clastic texture containing scattered grains of metamorphic chlorite, sericite, epidote and calcite. Some folds are markedly asymmetric, with overturned, steeply west-dipping short limbs. At higher structural levels these folds also deform the overlying Bralorne-East Liza Complex and Shulaps serpentinite mélange; locally they overturn the previously formed thrust contacts between the three major tectonostratigraphic units. The overturned limbs are commonly cut by west-dipping faults and shear zones with kinematic indicators, including C-S fabrics and shear bands, that show east-directed thrusting.

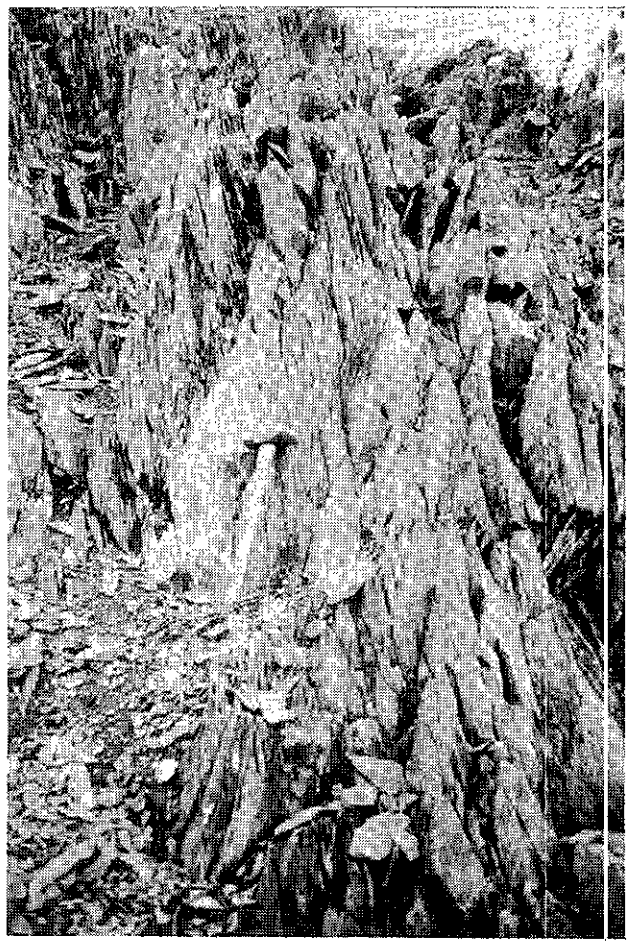

Photo 59. View to the south at east-dipping Hurley Formation cut by west-dipping cleavage near East Liza Creek; part of the east-vergent fold system that postdates the west-directed thrusts that imbricate the Hurley Formation, Bralorne-East Liza Complex and Shulaps Ultramafic Complex.

CAMELSFOOT THRUST BELT

The Camelsfoot thrust belt is a lens four kilometres wide that has been traced for 30 kilometres between the Yalakom and Camelsfoot faults (Figure 19). Stratigraphic and structural information gleaned from published reports suggests that this narrow belt may extend an additional 45 kilometres southeastward before being truncated by the Fraser fault. Because this belt occurs northeast of the Yalakom fault, it is inferred to have been displaced more than 100 kilometres southeastward relative to presently adjacent rocks southwest of the fault.

Sedimentary rocks within the Camelsfoot thrust belt include the Hurley Formation and overlying Junction Creek unit, as well as the Jura-Cretaceous Grouse Creek unit. These sedimentary rocks are deformed by southwesterly overturned folds and associated thrust faults, and are imbricated with two separate northeast-dipping fault panels of greenstone, gabbro, diabase and serpentinite assigned to the Bralorne-East Liza Complex (Figure 19, Section H). The lowest northeast-dipping thrust fault within the belt places the Hurley Formation and Junction Creek unit above the Bridge River Complex. Sparse but consistent kinematic evidence suggests that at least some of the faults record sinistral transpressional deformation. The kinematic indicators include: sinistral shear bands cutting foliated serpentinite of the Bralorne-East Liza Complex along a northeast-dipping fault contact with the Hurley Formation west of Applespring Creek; outcrop-scale fault systems with oblique east to east-northeast plunging striations preserved on northeast-dipping faults, and top-to-the-west sense of movement indicated by offset marker beds; and west to southwest-verging folds with axes locally trending more northerly than the strike of adjacent northeast-dipping faults.

The age of thrusting within the Camelsfoot belt is constrained only to be post-Valanginian, as Valanginian siltstones of Unit JKG are the youngest dated rocks involved in the thrusting. The northeast-dipping faults were first recognized by Coleman (1989, 1990), who interpreted them to be part of the Yalakom system, and suggested that the faults and associated southwest-verging folds formed in response to Eocene dextral-oblique-slip motion. We interpret these southwest-vergent structures to be part of an earlier, mid-Cretaceous contractional fault system because:

(1) They are kinematically congruent with southwest-vergent thrust faults and associated folds that occur throughout the map area, and are in some areas dated as mid-Cretaceous.
(2) The specific stacking order within the Camelsfoot thrust belt, that is imbricated Cadwallader Terrane and Bralorne-East Liza Complex thrust over Bridge River Complex, is characteristic of the Cretaceous thrust belt across the entire width of the southern part of the study area.
(3) Faults within the Camelsfoot thrust belt locally show evidence of sinistral oblique-slip motion. This is inconsistent with the Eocene dextral movement on the Yalakom fault system, but is consistent with the sinistral component of movement recognized on Cretaceous contractional faults within the map area (Bralorne-Eldorado fault system) and elsewhere in the region (Pasayten fault; Greig, 1989). There is also evidence for a sinistral component of movement on the Camelsfoot fault, which bounds the thrust belt to the northeast, but the age of movement is not well constrained.
(4) Thrust faults within the Camelsfoot thrust belt are truncated by the Yalakom fault, which we infer to follow the lower Yalakom and adjacent Bridge River valleys. This fault was not considered an important structure by Coleman (1990), who included rocks we have mapped as Shulaps serpentinite mélange within the Bridge River Complex and therefore did not identify a major tectonic boundary along the Bridge River.
(5) Riddell *et al.* (1993) identified offset counterparts of the Camelsfoot thrust belt, Camelsfoot fault and adjacent Methow Terrane on the southwest side of the Yalakom fault near Konni Lake, indicating that the entire structural succession has been offset about 115 kilometres along the Yalakom fault.

CAMELSFOOT FAULT

The Camelsfoot thrust belt is bounded on the northeast by the Camelsfoot fault, which is truncated by the Yalakom fault near the mouth of Beaverdam Creek. From there it has been traced southeastward across the wooded ridges northeast of the Yalakom and Bridge River valleys to Applespring Creek, but is not apparently exposed. It is recognized as an important structure because it marks the southwestern boundary of Methow Terrane strata over its length. The Camelsfoot fault also corresponds to a marked change in structural style, as the Methow strata to the northeast comprise a structurally simple, steeply dipping east-northeast facing belt, while the adjacent rocks of the Camelsfoot thrust belt are characterized by west to southwest-verging overturned folds and imbrication across northeast-dipping faults. Nevertheless, the fault is in places poorly constrained because of poor exposure and the difficulty in differentiating between the Methow Terrane rocks and sedimentary rocks southwest of the fault where only finer grained facies are represented. The fault was apparently the locus of igneous intrusion as quartz feldspar porphyry, hornblende feldspar porphyry, granodiorite and diorite were noted at several localities along or near its inferred trace. As mapped, the apparent surface trace of the fault suggests a moderate to steep northeast dip, but the trace is not sufficiently well constrained to be certain.

The Camelsfoot fault was not recognized by previous workers, but is inferred to extend southward to the Fraser fault as shown in Figure 22. Its projected trace occurs within the Lillooet Group of Duffell and McTaggart (1952) and Trettin (1961) which, accordingly, is inferred to comprise a northeastern belt of Middle Jurassic rocks within Methow Terrane, and a southwestern belt of Cadwallader Terrane rocks comprising the southward extension of the Camelsfoot thrust belt. Justification for this hypothesis is as follows:

(1) The northeastern part of the Lillooet Group (upper part of Duffell and McTaggart, 1952; Divisions B and C of Trettin, 1961) consists mainly of volcanic sandstone and granule to pebble conglomerate that rests stratigraphically beneath the Jackass Mountain Group, and at one locality contains a Middle Jurassic ammonite (J.W.H. Monger, personal communication 1990; Mahoney, 1992); this part of the group is therefore readily correlated with Unit lmJys of this study, which underlies the Jackass Mountain Group near Blue Creek. The southwestern part of the Lillooet Group (lower part of Duffell and McTaggart; Division A of Trettin) consists mainly of argillite, siltstone and fine-grained sandstone that, at the southern end of the belt, contains Early Cretaceous *Buchia* pelecypods (Dawson, 1896; Duffell and McTaggart, 1952) and therefore is at least in part younger than Middle Jurassic rocks of the northeastern part of the Lillooet Group. These rocks are lithologically similar to the Jurassic Last Creek formation and overlying, *Buchia*-bearing, Jura-Cretaceous Grouse Creek unit, which occur along strike in the Camelsfoot thrust belt. Furthermore, cobble conglomerate containing clasts of limestone, granitic rock and chert was noted at two localities along the western limit of the Lillooet Group belt by Duffell and McTaggart (1952; localities shown in Figure 22) and thought to possibly represent the base of the group; these conglomerates may belong to the Hurley Formation, which underlies the Last Creek formation in the Camelsfoot thrust belt.

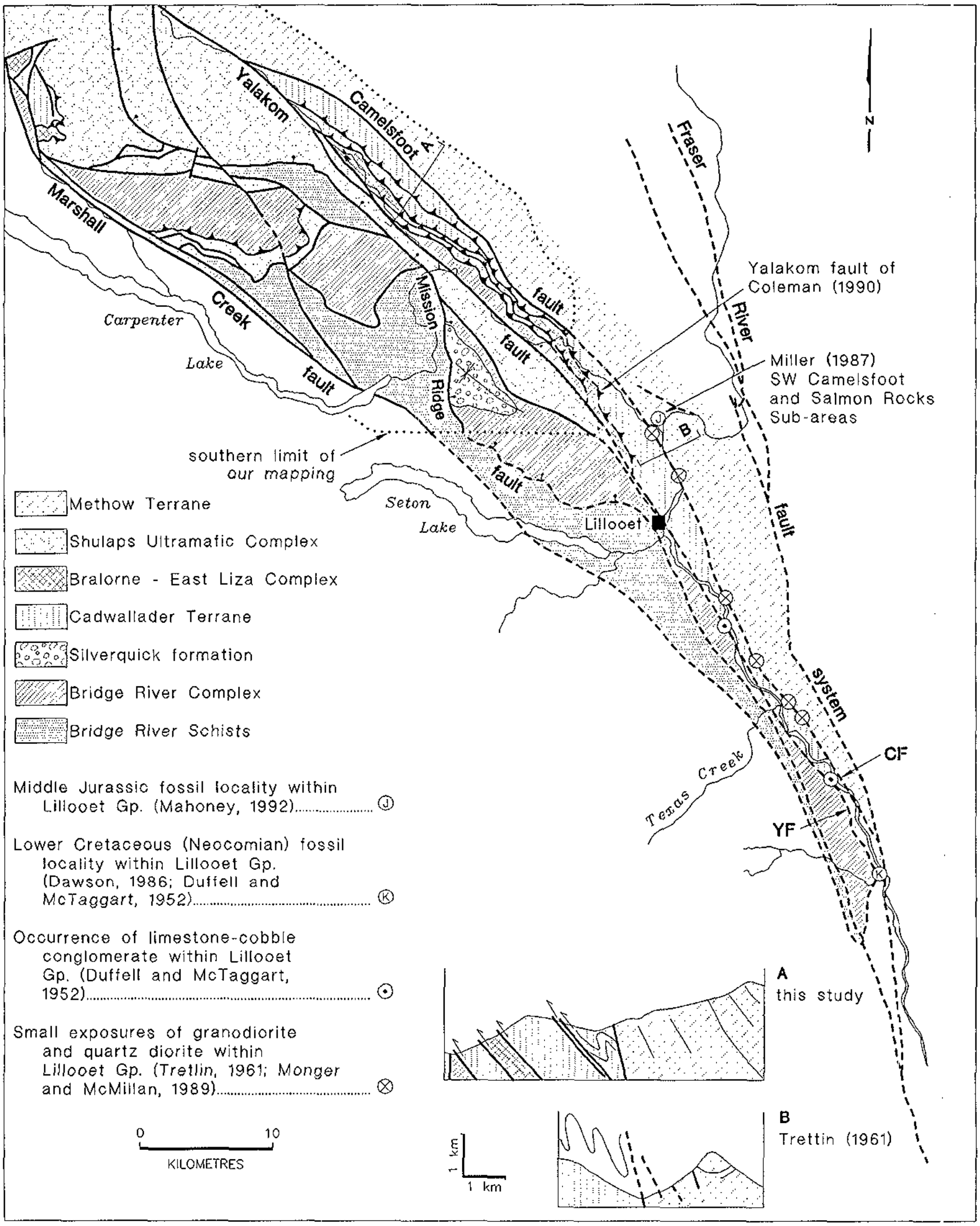

Figure 22. Postulated southeast continuation of the Camelsfoot fault. CF=Camelsfoot fault; YF=Yalakom fault.

(2) Trettin (1961) noted a contrast in structural style within the Lillooet Group; Division A is deformed by southwest-overturned folds, while Divisions B and C dip homoclinally to the northeast and locally underlie the Jackass Mountain Group in the hinge of a broad fold. A similar change in structural style is apparent in the present study area; Cadwallader Terrane rocks southwest of the Camelsfoot fault are deformed by southwest-vergent folds and thrust faults, while Methow Terrane rocks northeast of the fault occur as a northeast-dipping homocline (compare cross-sections A and B of Figure 22).

(3) Published maps (Duffell and McTaggart, 1952; Trettin, 1961; Monger and McMillan, 1989) show a linear belt of six small granodiorite, quartz diorite and dacite intrusions extending for 25 kilometres within the Lillooet Group. These intrusions are thought to be significant because similar granodiorite to quartz porphyry intrusions were noted along or near the trace of the Camelsfoot fault on four of the seven traverses that crossed it during the present study (the inferred fault trace lies within wide zones of overburden along the other three traverses). The intrusive bodies within the Lillooet Group are described as being generally elongate parallel to the strike of the belt (Duffell and McTaggart, 1952; Trettin, 1961), and the northern two lie along the contact between Divisions 1 and 2 of Trettin, which is inferred to mark the trace of the Camelsfoot fault, on both lithologic and structural grounds (points 1 and 2 above). Because Trettin's mapping covered only a part of the Lillooet Group, and it is not subdivided by other workers, the proposed trace of the Camelsfoot fault is drawn to coincide with this belt of intrusions (Figure 22).

The proposed southward extensions of the Camelsfoot and Yalakom faults shown in Figure 22 put the study of Miller (1987, 1988) into perspective. He examined the structures in a relatively small area north of the confluence of the Bridge and Fraser rivers (Southwest Camelsfoot and Salmon Rocks sub-areas, Figure 22), and concluded that they fit a strain ellipse for left-lateral slip along the Yalakom fault. As shown in the figure, his conclusions were derived from a study area immediately northeast of the Camelsfoot fault, and so presumably relate to that fault, rather than to the Yalakom which is about three kilometres across strike to the southwest. His observations are consistent with some made during this study, as east-striking sinistral faults were observed at several localities within Methow Terrane rocks directly northeast of the Camelsfoot fault, and a sinistral component of movement was also noted along some thrust faults within the Camelsfoot thrust belt directly southwest of the Camelsfoot fault. Since the Camelsfoot thrust belt is thought to be a component of a more widespread middle to early Late Cretaceous contractional fault system, and a sinistral component of motion is recognized elsewhere within this system (*e.g.* Eldorado fault zone), a middle to early Late Cretaceous age is inferred for movement along the Camelsfoot fault. A mid-Cretaceous age for sinistral movement was also suggested by Miller (1988), based mainly on analogy with the Pasayten fault system to the southeast, which was the locus of mid-Cretaceous sinistral shear with an east-side-up component (Greig, 1989).

NORTH CINNABAR FOLD-FAULT SYSTEM

Northeast-vergent structures in the North Cinnabar Creek area consist of southwest-dipping thrust faults within the Bridge River Complex and a large overturned syncline outlined by footwall rocks of the Taylor Creek Group and Silverquick formation (Garver, 1989, 1991). This belt is up to 5 kilometres wide and is bounded by the Castle Pass fault to the west and by a splay of the Fortress Ridge fault system to the east.

The footwall syncline includes a southwest-dipping overturned limb with a map width of up to 3 kilometres. This limb includes, from west to east: Bridge River Complex, comprised largely of blueschist-facies rocks; Taylor Creek Group which is in stratigraphic contact with the Bridge River Complex across an overturned unconformity; and Silverquick formation which stratigraphically overlies the Taylor Creek Group. The overturned Silverquick formation is in contact with right-way-up Silverquick formation to the northeast. This contact was mapped on the ridge north of Taylor Creek, where it is a southwest-dipping thrust fault. A thin sliver of Powell Creek volcanics lies stratigraphically above the footwall Silverquick formation in this area, whereas to the south, north of Tyaughton Lake, a thin sliver of Powell Creek formation is in stratigraphic contact with the Silverquick formation at the base of the overturned hangingwall. The thrust fault that separates overturned from upright rocks therefore has only minor displacement, and essentially marks the hinge of the overturned syncline (Figure 19, Section D). The eastern, upright limb of the syncline is only partially represented as it is truncated by a prominent north-northwest-striking fault that is part of the Fortress Ridge fault system.

Bridge River blueschists and related rocks that overlie the Taylor Creek Group across an overturned unconformity are in turn structurally overlain by Unit uTBRglc of the Bridge River Complex across a southwest-dipping fault. The fault is inferred to be a thrust because it is associated with northeast-vergent mesoscopic folds and subsidiary southwest-dipping faults that locally contain asymmetric fabrics indicative of northeast-directed thrusting (Garver, 1991). Unit UTBRglc is in turn structurally overlain by Unit JBRas across a similar southwest-dipping fault. The two thrust faults probably formed at the same time as the footwall syncline within the Taylor Creek Group and Silverquick formation; they may have significant movement across them as they separate three lithologically distinct Bridge River packages.

NORTHEAST-VERGENT FAULTS WEST OF TRUAX CREEK

Northeast-vergent structures are also recognized in a small area south of Carpenter Lake, west of lower Truax Creek (Figure 19, Section F). This area is about 12 kilometres southeast of the North Cinnabar fold-fault belt, and likewise lies between the Castle Pass fault to the west and the Fortress Ridge fault system to the east. Here, a northwesterly elongate lens of Jura-Cretaceous conglomerate, sandstone and argillite (Church and MacLean, 1987b; Truax Creek conglomerate of this study) lies between Bridge River greenstone to the west and Unit JBRas of the Bridge River Complex to the east. The western contact was observed at one place, where it is marked by several metres of sheared argillaceous rock with variably developed moderately to gently west-dipping foliation. This contact is inferred to be an east-directed thrust, as is the eastern contact which was not seen but is locally constrained to trace along or near an outcrop of serpentinite with moderately southwest-dipping foliation.

Evidence for northeast-directed deformation is seen mainly in the footwall of the Truax Creek conglomerate lens. There, sheared chert, argillite, sandstone, greenstone and serpentinite of the Bridge River Complex (Unit JBRas) passes gradationally eastward into well-bedded sandstone, siltstone and argillite of the Gun Lake unit. Bedding, foliation and mesoscopic shears within both units dip moderately to the west or southwest, but graded bedding or crosslaminations from four separate localities indicate that the Gun Lake unit is overturned. West to southwest-dipping mesoscopic faults and shear zones are common within the Bridge River Complex, and less common but nonetheless present in Unit JKGL. Shear bands in foliated shear zones and one outcrop-scale thrust duplex structure indicate a general top-to-the-east sense of shear. Where actual movement directions are indicated by striations or mineral fibres, they commonly indicate east-directed movement on both west and southwest-dipping fault surfaces. This corresponds to essentially pure reverse-slip on west-dipping faults and oblique reverse-sinistral movement along southwest-dipping faults.

SUMMARY OF CRETACEOUS CONTRACTIONAL FAULT DEVELOPMENT

The Cretaceous contractional structures in the Taseko - Bridge River area are schematically summarized in Figure 23. The southwest-vergent thrust faults exposed in different parts of the map area are thought to comprise segments of the same Cretaceous thrust belt that has been disrupted and deformed by later contractional and strike-slip related structures. The persistent stacking order that is apparent wherever these early structures are recognized suggests that, prior to this late deformation, imbricated Cadwallader Terrane and Bralorne-East Liza complex comprised a large thrust sheet that lay above footwall Bridge River Complex and Tyaughton basin across much of the map area. The faults defining this boundary include the Spruce Lake and Sumner Creek faults, and the faults between the East Liza - Cadwallader thrust stack and underlying Bridge River Complex within the Liza Lake and Camelsfoot thrust belts. Higher structural levels of this thrust system are only exposed in the Shulaps Range, where the Shulaps Complex rests above the imbricated Cadwallader Group and Bralorne-East Liza Complex.

The Eldorado fault is a northeast-dipping reverse-sinistral fault that cuts earlier structures of the southwest-vergent thrust system. It is an out-of-sequence fault, and over much of its length reverses the stacking order established during earlier thrusting by placing Bridge River Complex above Cadwallader Group and Bralorne-East Liza Complex. The Sucker Lake fault also places Bridge River Complex above Cadwallader Group and Bralorne-East Liza Complex. It is also inferred to be a relatively late, out-of-sequence structure by virtue of its spatial relationship to the Eldorado - Steep Creek fault system, and its probable correlation with the Fergusson fault, which bounds the northeastern margin of the 91-86 Ma Bralorne-Pioneer vein system. The Camelsfoot fault, which places Methow Terrane above Cadwallader Terrane, is similar to faults of the Eldorado system in that it cuts southwest-directed structures of the Camelsfoot thrust belt and shows evidence of a sinistral component of movement.

Northeast-vergent structures are only sporadically preserved in the map area, and are most common along a belt

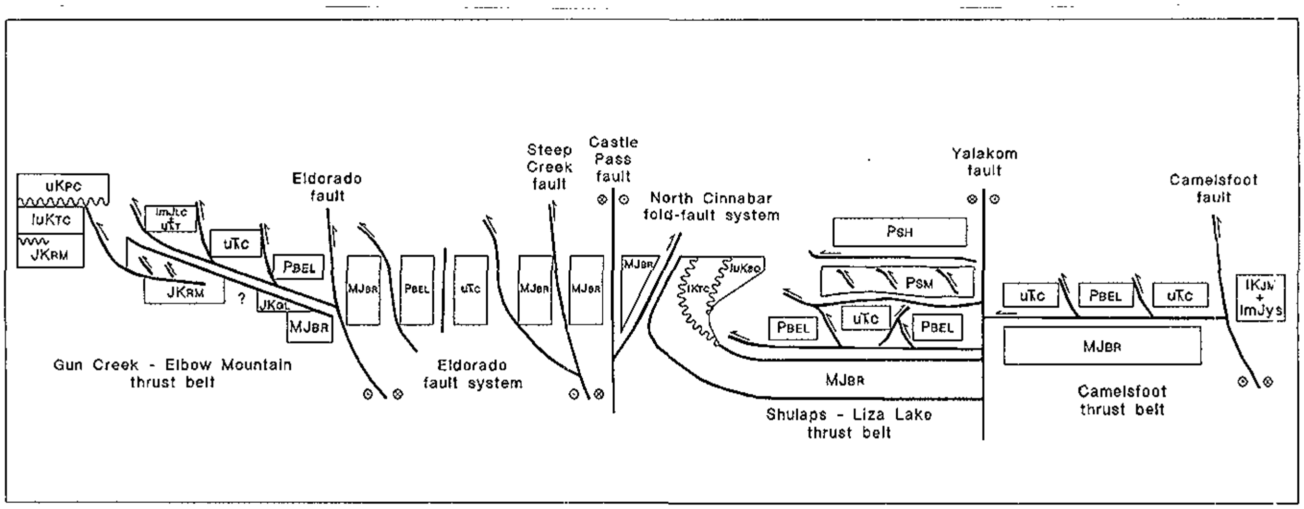

Figure 23. A schematic summary of the geometry and spatial relationships of Cretaceous contractional fault systems in the Taseko - Bridge River map area. lKTC=Dash and Lizard formations of the Taylor Creek Group. Other map unit codes as in Figure 3.

that is coincident with the younger Castle Pass dextral strike-slip fault. Northeast-vergent structures locally deform parts of the southwest-vergent thrust system, but their relationship to the Eldorado fault system is not known.

The present distribution of tectonostratigraphic elements within the map area is inferred to reflect the northwest plunge of the Bridge River Complex beneath both depositionally overlying Jura-Cretaceous clastic rocks and structurally overlying thrust slices. This pattern is modified by uplift of the Bridge River Complex along relatively young out-of-sequence faults such as the Eldorado fault, and the truncation and displacement of map units and structures along the Castle Pass and Yalakom - Marshall Creek - Relay Creek fault system to the east. The main elements of this structural pattern were recognized by Drysdale (1915) and McCann (1922) who suggested that the regional structure was essentially that of a broad northwest-plunging antiform cored by the Bridge River Complex. Our interpretation differs from theirs mainly in that we recognize Cadwallader Terrane and ophiolitic rocks on the northeast and southwest flanks of the antiform as elements of an extensive, composite thrust stack structurally emplaced above the Bridge River Complex, rather than as a volcanic-sedimentary succession deposited stratigraphically above it.

Figure 24 is a simple model summarizing the sequential development of Cretaceous contractional structures. The

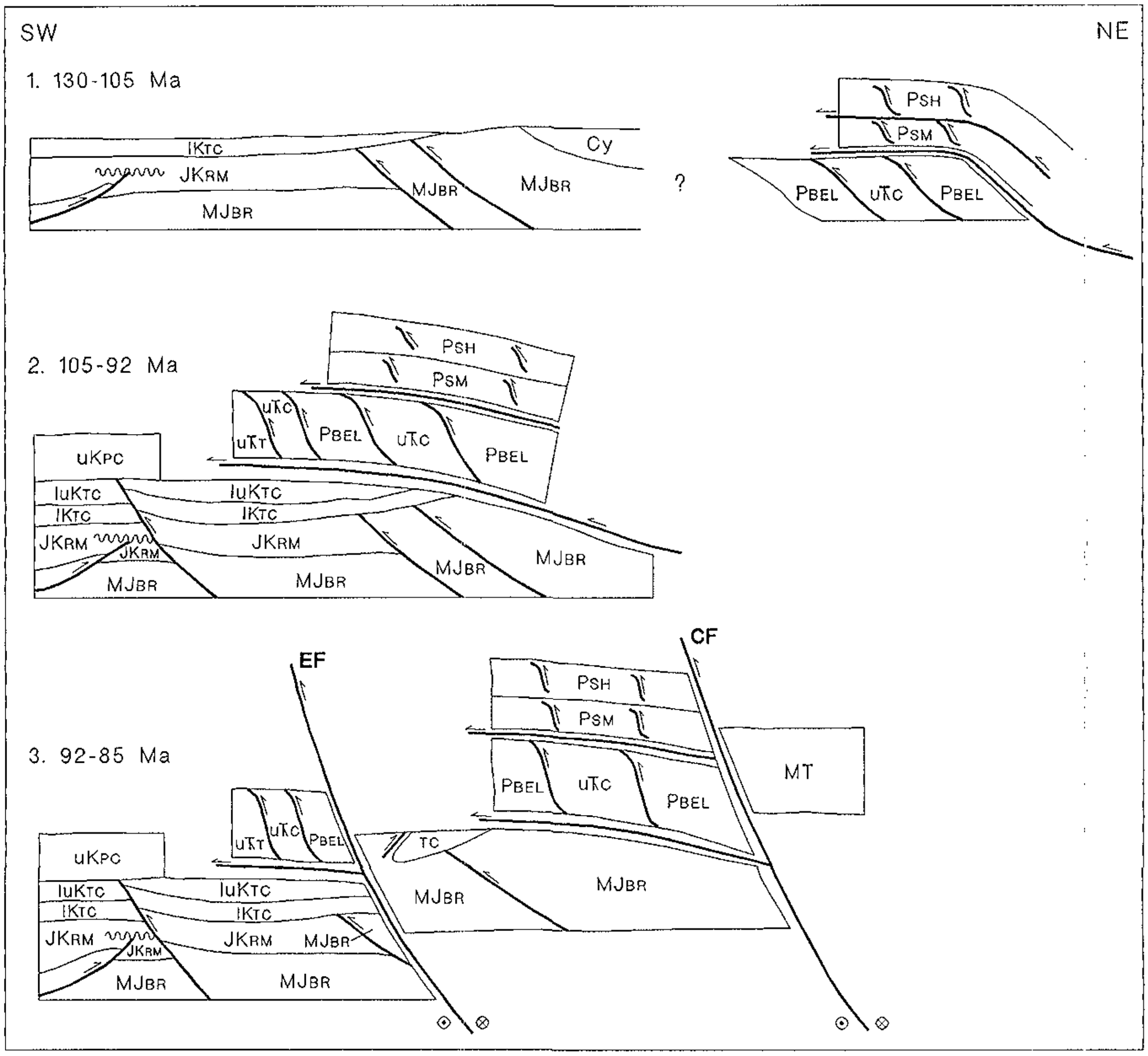

Figure 24. A schematic model showing the sequential development of Cretaceous contractional structures. CF=Camelsfoot fault; EF=Eldorado fault; Cy=Cayoosh assemblage; lKTC=Elbow Pass, Paradise, Dash and Lizard formations; luKTC=Beece Creek succession and Silverquick formation; MT=Methow Terrane; TC=undivided lKTC and luKTC. Other map unit codes as in Figure 3.

bricated Cadwallader terrane in a similar fashion farther to the east.

cene thermal and structural overprint, and neither structures

Bridge River Terrane and Tyaughton basin underwent a protracted series of deformations that culminated in the well dated structures of the Elbow Mountain thrust belt, which deform Albian and older rocks of the Relay Mountain and Taylor Creek groups, and are overlapped by the Cenomanian Powell Creek formation. Older structures are inferred, because detritus in the Taylor Creek Group records uplift and erosion of the underlying Bridge River Complex and Relay Mountain Group, as well as source terrains to the west and east (Garver, 1989; Figure 11). The angular unconformity between Hauterivian shales and underlying Jurassic rocks of the Relay Mountain Group indicates that some deformation in the Tyaughton basin is older still. It is interesting that hints of a Hauterivian or younger thermal event are also provided by a 130 Ma date from the first step of an Ar-Ar step-heating age spectrum for Bridge River blueschists, and may reflect heating due to thrust loading in Early Cretaceous time (Archibald *et al.*, 1990).

The invariable association of Bralorne-East Liza Complex imbricated with Cadwallader Terrane as a composite, widespread thrust sheet suggests that their initial imbrication occurred independently of their final emplacement above footwall Bridge River Complex and Tyaughton basin. This is corroborated by the truncation of earlier structures within both the Relay Mountain Group and the Cadwallader Terrane by the Spruce Lake fault. The assembly of the Cadwallader Terrane/Bralorne-East Liza thrust slices postdates Valanginian siltstone that is locally involved in the thrusting in the Camelsfoot Range, and predates the Spruce Lake fault, which is truncated by the 92 Ma Dickson - McClure batholith. Imbrication of Cadwallader Terrane and Bralorne-East Liza Complex is therefore broadly constrained to the same Early to mid-Cretaceous time interval as early deformational episodes documented or inferred within the Bridge River Complex and Tyaughton basin.

The actual juxtaposition of imbricated Cadwallader Terrane/Bralorne-East Liza Complex above the Bridge River Complex, Relay Mountain Group and Taylor Creek Group occurred in early Late Cretaceous time, along the Spruce Lake fault and correlative or related structures to the east. The late Albian - Cenomanian constraint on the timing of movement along the Spruce Lake fault is identical to the age constraints for the Silverquick formation, which overlies the Taylor Creek Group in Tyaughton basin. It may be significant, therefore, that abundant Hurley-like sandstone clasts in the Silverquick formation are the first detritus within the Tyaughton basin that can be linked to the Cadwallader Terrane (Garver, 1989).

Northeast-dipping reverse-sinistral faults of the Eldorado fault system apparently represent the final episode within a protracted period of southwest-directed contractional deformation. These faults were active between 91 and 86 Ma, when they cut an already assembled thrust stack comprising rocks of the Bridge River Complex and Tyaughton basin structurally overlain by Cadwallader Terrane and Bralorne-East Liza Complex. Movement along the reverse(?)-sinistral Camelsfoot fault may have accommodated juxtaposition of Methow basin against previously imbricated Cadwallader terrane in a similar fashion farther to the east.

Northeast-vergent contractional structures occur east of the Eldorado fault system. Like it, they cut earlier southwest-directed thrust faults, and locally (west of Truax Creek) have a component of sinistral movement. The two fault systems may in part be coeval, with the northeast-vergent structures comprising backthrusts in the hangingwall of the Eldorado system. The generally steep, ramp-like nature of the Eldorado fault system, the component of sinistral movement, and the association with northeast-vergent backthrusts, may all reflect accommodation to the progressive thickening of the thrust-faulted crust, perhaps buttressed by intrusion of 92 Ma granodiorite along the eastern margin of the Coast Plutonic Complex.

The timing of thrust emplacement of the Shulaps Ultramafic Complex above the Cadwallader Terrane and Bralorne-East Liza Complex, to form the highest structural level recognized in the southwest-vergent thrust stack, is not well constrained. However, if the interpretation that the Shulaps and Bralorne-East Liza complexes are related is correct, it seems most likely that emplacement of the Shulaps Complex coincided with the imbrication of the Bralorne-East Liza Complex (equivalent to crustal elements of the Shulaps ophiolite) with Cadwallader Terrane. Alternatively, it may have occurred later, during emplacement of imbricated Cadwallader Terrane/Bralorne-East Liza Complex above the Bridge River Complex at about 105-92 Ma. This is possible because at least some west-directed movement on the basal thrust of the Shulaps Complex postdates the underlying thrust that juxtaposes Bralorne-East Liza Complex and Cadwallader Group. All of these west-directed faults are deformed by east-vergent folds and thrust faults, which may correlate with early Late Cretaceous northeast-directed faults and folds that occur locally at lower structural levels outside the Shulaps Range.

The latest stages of contractional deformation documented within the southwestern part of the Shulaps Complex were synchronous with intrusion of a suite of dioritic dikes. Although the late synkinematic dikes are not dated in this area, they are lithologically similar to the Blue Creek porphyries, which outcrop extensively in the northeastern part of the complex. The Blue Creek porphyries are assigned a Late Cretaceous age based on Ar-Ar plateau dates of 77±11 Ma from a boudinaged dike near the Yalakom fault, and 70.27±5.25 from the plug that hosts the Yalakom gold-quartz vein system near upper Blue Creek (Appendix 7, Samples TL-87-11 and TL-89-6). The 77 to 70 Ma age for the latest stages of contractional deformation implied by this correlation may be supported by a 72.6±0.5 Ma Ar-Ar plateau date from an amphibolite knocker within Shulaps serpentinite mélange in the upper reaches of Hog Creek (Appendix 7, Sample TL-87-22). This date was interpreted by Archibald *et al.* (1989) to reflect Cretaceous reheating of a Permian knocker during metamorphism associated with the late synkinematic dike emplacement. This interpretation is tenuous, however, because the Hog Creek knocker occurs in the Shulaps - Mission Ridge metamorphic belt, which is separated from the main part of the Shulaps Complex by the extensional Mission Ridge and Brett Creek faults (*see* Figure 26). The metamorphic belt was affected by a strong Eocene thermal and structural overprint, and neither structures nor metamorphism can be directly related to Cretaceous southwest-directed contractional deformation within the main part of the structurally overlying Shulaps Complex. It is possible, therefore, that the Late Cretaceous date from the knocker reflects partial overprinting of Permian amphibolite during Eocene metamorphism (D. Archibald, personal communication, 1993).

The 77 to 70 Ma age for the late stages of contractional deformation within the Shulaps Complex implied by the dike correlations discussed above is significantly younger than the latest well-dated phases of Cretaceous contractional deformation outside the complex (*i.e.* 91-86 Ma movement along the Eldorado fault system). The predominantly contractional regime that was operative during mid to early Late Cretaceous time changed to one of dextral strike-slip before the end of the Cretaceous, as evidenced by pre 67 Ma dextral-slip documented along the Castle Pass fault system. If the 77 to 70 Ma correlations are valid, the implied late pulse of contractional deformation within the Shulaps Complex may relate to an early phase of transpressional deformation along the Yalakom fault rather than to the older, more regional episode of mid to early Late Cretaceous contractional deformation.

MID-CRETACEOUS FAULTS OF UNCERTAIN SENSE OF DISPLACEMENT

TCHAIKAZAN FAULT

The northwest-trending Tchaikazan fault, as mapped across the northeastern corner of the Mount Waddington map area and the contiguous southwestern corner of the Taseko Lakes map area by Tipper (1969a, 1978), has a total strike length of about 190 kilometres. Tipper (1969a) postulated 30 kilometres of right-lateral offset along the fault in the Mount Waddington map area, based on nearly horizontal slickensides observed on the steeply dipping fault surface west of Niut Mountain, and apparent offset of two potentially correlative structures, the Niut and Ottarasko faults. Recently, Mustard and van der Heyden (1994) postulated only 7 to 8 kilometres of apparent dextral displacement based on offset of a distinctive fossiliferous limestone unit within the Triassic Mount Moore formation near Bluff Lake.

The Tchaikazan fault is well delineated along the Taseko River canyon, at the western boundary of the Taseko - Bridge River map area. There, it is marked by a zone 300 metres wide containing several parallel, northwest-striking lenses of intense brecciation, silicification and pyrite alteration. From there, Tipper (1978) inferred that the fault extends along the Taseko River valley, through Warner Pass and along Gun Creek to Hummingbird Lake. However, although there are a series of pronounced topographic lineaments along this trace, there are no geological offsets documented along it. We suggest an alternative interpretation, whereby the fault continues along its well defined 135° trend in the Taseko River canyon to the east side of Amazon Creek, where it is truncated by Late Cretaceous granodiorite of the Dickson - McClure batholith (Figure 3). As thus defined, it marks the boundary between Powell Creek formation to the northeast, and altered volcanic and sedimentary rocks to the southwest that are thought to include rocks of both the Taylor Creek Group and the overlying Powell Creek formation. The fault is inferred to pass through or near a zone of intense silica, pyrite and sericite-altered volcanic rocks exposed along Amazon Creek. Between there and the Taseko River canyon, its inferred trace follows a vague topographic expression defined by several northwest-trending knolls adjacent to lower Honduras and McClure creeks; these may reflect resistant lenses of silicified rock along the fault zone.

From the study area northwestward to Chilko Lake, the Tchaikazan fault separates Upper Cretaceous Powell Creek formation on the north from older, mainly Lower Cretaceous rocks to the south (Tipper, 1978; McLaren, 1990). No sense of movement has been established on this segment of the fault zone. The fault cuts Powell Creek volcanic rocks, but is truncated by Late Cretaceous granodiorite; it was therefore active in early Late Cretaceous time. The dextral movement postulated along the Tchaikazan fault west of Chilko Lake (Tipper, 1969a; Mustard and van der Heyden, 1994) is anomalous for the present study area during this time interval, when documented structures were mainly contractional, locally with a sinistral component. Elsewhere within the region, however, dextral strike-slip faults were apparently coeval with early Late Cretaceous southwest-directed thrust imbrication. These early dextral strike-slip faults include the Harrison Lake shear zone (Journeay and Csontos, 1989; Journeay, 1990), some 100 to 200 kilometres south-southeast of the southeastern limit of the Tchaikazan fault. This suggests that the Harrison Lake and Tchaikazan faults may be coeval structures, or even part of a single system with its continuity obliterated by extensive Late Cretaceous granodiorite (*see* map of Wheeler *et al.*, 1991).

Alternatively, however, the dextral strike-slip fault mapped as the Tchaikazan fault west of Chilko Lake may be an en echelon component of the Fortress Ridge - Chita Creek fault system, which is a Tertiary dextral strike-slip system (described later in this section) that has been traced as far as the east side of Chilko Lake (McLaren, 1990). The Tchaikazan fault mapped from the present study area to the east shore of Chilko Lake might be equivalent to an older structure west of the lake, such as the Niut fault (Tipper, 1969a). The possibility of a sinistral component of displacement on the early Late Cretaceous southeastern Tchaikazan fault is suggested by the presence of a narrow fault-bounded lens of Lower Jurassic sedimentary rocks along the fault on the north side of Yohetta valley (McLaren, 1990). The nearest section of Lower Jurassic rocks from which this lens might have been derived outcrops in the Nemaia valley on the northeast side of the Tchaikazan fault. If the fault-bounded lens was derived from this belt it implies a minimum of about 20 kilometres of apparent sinistral displacement.

LAJOIE LAKE FAULT SYSTEM

A belt of rocks that includes the Cadwallader Group and Bralorne-East Liza Complex extends from near Lajoie Lake northwestward to Mount Penrose, beyond which it is truncated by Late Cretaceous granodiorite of the Dickson -

McClure batholith. Where observed southwest of Lajoie Lake, the contact between the Hurley Formation and adjacent greenstone of the Bralorne-East Liza Complex is a steeply southwest-dipping fault. Mesoscopic faults of similar orientation, some with gently southeast-plunging slickensides, were observed elsewhere within both rock units, but no clear indication of sense of movement was established. The Hurley Formation within this belt is bounded to the south by a thin sliver of Bridge River Complex, which in turn is in contact with an extensive belt of sedimentary rocks assigned to the Downton Lake unit. Neither contact was seen, but they may also be steeply southwest-dipping faults because mesoscopic faults of this orientation were observed within both the Bridge River Complex and the Downton Lake unit. The Lajoie Lake belt is also in contact with Bridge River rocks to the northeast, along an inferred fault of unknown orientation.

The Lajoie Lake belt is directly on strike with the belt of Cadwallader and Bralorne-East Liza rocks that hosts the Bralorne and Pioneer mines along Cadwallader Creek to the southeast. The two belts are not continuous, however, as they are separated by outcrops of Bridge River Complex near the confluence of the Hurley River and Cadwallader Creek (Cairnes, 1937; Church *et al.*, 1988b; Figure 20). Furthermore, faults of the Lajoie Lake system all appear to predate intrusion of the 92 Ma Dickson - McClure batholith (Parrish, 1992), whereas younger movement is inferred to have been synchronous with the 91 to 86 Ma mineralizing episode at the Bralorne and Pioneer mines. The Lajoie Lake fault system is also along strike from the Tchaikazan fault, which is truncated by the same mass of Late Cretaceous granodiorite 40 kilometres to the northwest. The relationship between these two fault systems, if any, is unclear, as the sense of movement on each is unknown, and they involve entirely different rock units.

NORTHWEST-TRENDING DEXTRAL FAULT SYSTEMS AND RELATED STRUCTURES

Most of the major through-going northwest-trending fault systems that cross the map area were the locus of dextral strike-slip movement (Figure 25). The earliest documented dextral movement occurred on the Castle Pass fault system, which was active in latest Cretaceous to early Tertiary time. This fault system is dextrally offset by the Fortress Ridge fault, which is apparently linked with the Chita Creek fault to the west across a left-stepping transfer zone. This transfer zone is marked by a broad area of uplift, and contains the Beece Creek and Lorna Lake granodiorite plutons, which occur at the terminations of the Fortress ridge and Chita Creek faults, respectively. East of the Castle Pass and Fortress Ridge-Chita Creek fault systems, the 7 to 15 kilometre-wide Yalakom - Relay Creek - Marshall Creek fault system records a complex history of contractional, extensional and strike-slip movement within an overall framework of dextral strike-slip. Deformation within this fault system was in large part Eocene, and synchronous with deformation along the Fortress Ridge-Chita Creek system. This temporal correlation is provided by the 47 Ma Mission Ridge granodiorite pluton, which was emplaced during deformation and yielded 44 Ma cooling dates that are identical

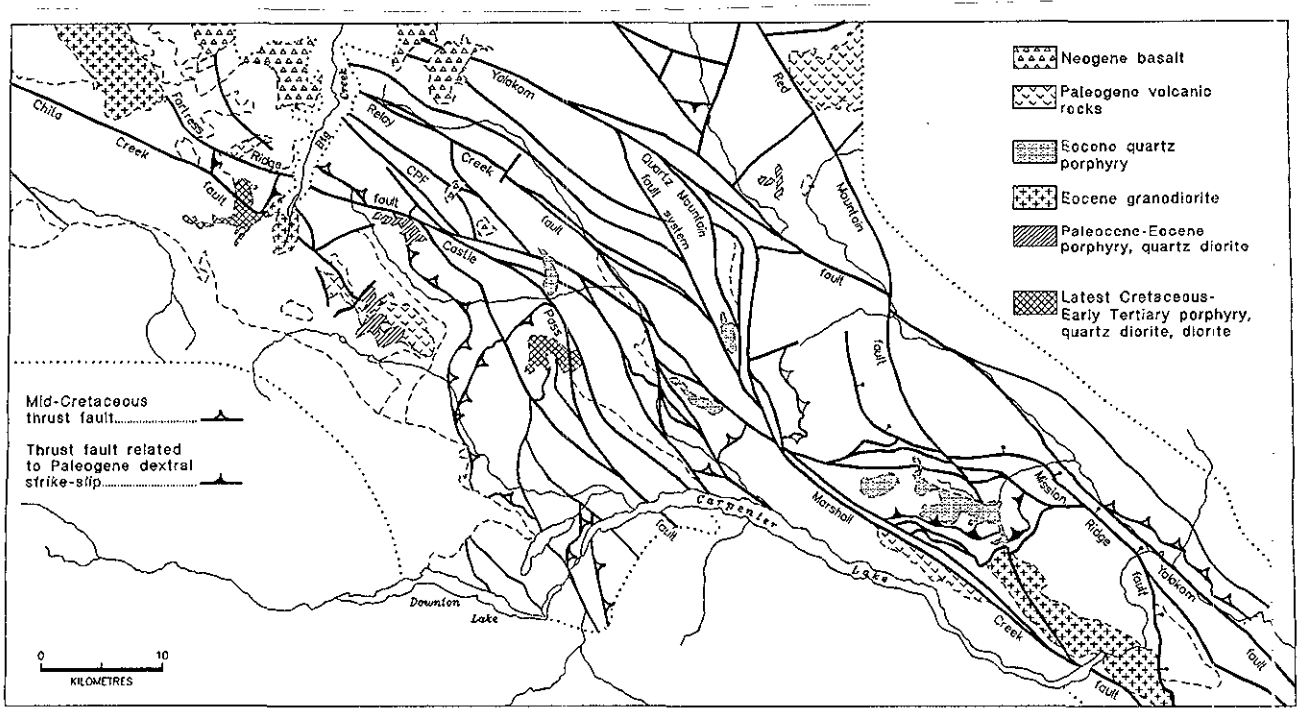

Figure 25. Late Cretaceous - Paleogene dextral strike-slip fault systems in the Taseko - Bridge River map area. CPF=offset continuation of the Castle Pass fault north of Fortress Ridge fault.

to those obtained from the Beece Creek and Lorna Lake plutons.

THE CASTLE PASS FAULT SYSTEM

The Castle Pass fault is well defined from 3 kilometres northwest of Castle Pass, where it is apparently truncated by the Fortress Ridge fault, southeastward to the Eldorado pluton. Over this distance it defines the contact between the Tyaughton and Cadwallader Groups on the southwest and younger sedimentary rocks (Relay Mountain and Taylor Creek groups and Silverquick formation) on the northeast. For 3 kilometres south of the Eldorado pluton this fault separates a sliver of Cadwallader Group on the west from the Taylor Creek Group and underlying Bridge River Complex to the east. South from there it is more difficult to define as the fault occurs within the Bridge River Complex; it is inferred to follow a discontinuous belt of serpentinite which extends southeastward to cross Carpenter Lake at the Minto mine, 8 kilometres northeast of Gold Bridge. An important subsidiary fault abuts the Fortress Ridge fault a short distance northwest of the main Castle Pass fault and has been traced southeastward through the Tyaughton Group, Cadwallader Group and Bridge River Complex to apparently merge with the main fault a short distance north of Carpenter Lake. Another splay diverges from the northeast side of the main fault a short distance north of the Eldorado pluton. This splay defines the eastern margin of the pluton, and has been traced southeastward through the Taylor Creek Group and underlying Bridge River Complex to follow a linear belt of serpentinite outcrops southeast of Tyaughton Lake.

A prominent system of faults that extends from south of Relay Mountain northwestward to the mouth of Graveyard Creek is inferred to be the northwestern continuation of the Castle Pass system. The two correlated fault systems show 1 to 2 kilometres of apparent dextral offset across the Fortress Ridge fault. The main fault within the northwestern part of the system marks the contact between Unit muJRM1 of the Relay Mountain Group on the southwest and the Taylor Creek Group to the northeast; thin slivers of younger Relay Mountain rocks outcrop locally along the southeastern segment of the fault. The Taylor Creek Group is deformed by a complex system of subparallel, presumably related, faults and folds for 1 to 2 kilometres northeast of the main fault.

Dextral movement on the Castle Pass fault is best indicated at the head of North Cinnabar Creek. There, Garver (1991) describes a system of steeply dipping, north-northwest-striking dextral strike-slip faults that extends for 2 kilometres east of the main fault. Within this zone, dextral movement along some of the north-northwest-striking faults, including the mappable northeastern splay of the Castle Pass fault, is indicated by near-horizontal slickensides and offset of local markers. Dextral movement is supported by a suite of associated structures that are of appropriate orientation and movement sense to be interpreted as synthetic dextral, antithetic sinistral and contractional faults within a dextral strike-slip strain regime (Garver, 1991). Mapping these structures northward to the Eldorado pluton is precluded by a wide belt of alluvium along Taylor Creek. However, the fault mapped as the northeastern splay of the Castle Pass fault, which has dextral offsets in the North Cinnabar Creek area, projects northward into a fault defined on the ridge 1 kilometre north of Eldorado Mountain. As thus defined, this fault marks the eastern boundary of the Eldorado pluton; although the contact is not exposed, easternmost exposures of quartz diorite display an array of northerly striking faults which have both horizontal and down-dip slickenside lineations, supporting the inference that the pluton's eastern boundary is a fault. The main strand of the Castle Pass fault is well defined, although not well exposed, both north and south of the Eldorado pluton. The fault was not observed within the pluton, but its projected trace corresponds to several hundred metres of apparent dextral offset of its northern contact. This supports both the inferred dextral movement along the Castle Pass fault and the suggestion that some of the movement occurred after emplacement of the Eldorado pluton.

Farther north, east of Castle Pass, two east-trending folds within the Tyaughton Group abut both the main Castle Pass fault and the mappable southwestern splay, respectively (Umhoefer *et al.*, 1988; Figure 3). The western fold deforms a northeast-vergent thrust fault that may be a relatively young component of the middle to Late Cretaceous contractional deformation event. The relatively young age and orientation of these folds is consistent with an interpretation that they formed during dextral strike-slip on the Castle Pass fault system. Farther south within the Tyaughton Group, several minor splays associated with the southwest-splay of the Castle Pass system change from northwest-striking faults into west-striking reverse faults before being truncated by the next northwest-striking fault to the west. These hooked faults are interpreted by Umhoefer (1989) as left-hand (contractional) step-overs within a dextral-slip system.

Local observations of sub-horizontal striations along fault surfaces associated with the Relay Pass - Graveyard Creek segment of the Castle Pass fault support strike-slip faulting along this part of the system (Umhoefer, 1989). A series of en echelon right-stepping folds within the Taylor Creek Group northeast of the fault is consistent with a dextral sense of movement. A 600-metre-wide lens of faulted rock at Relay Pass provides additional support for strike-slip deformation along this segment of the Castle Pass fault. This lens includes a number of southwest-dipping reverse faults within the Taylor Creek Group northeast of the main fault. Local relief shows that these faults begin to converge at depth, suggesting that the fault lens may be a "palm tree" structure or contractional strike-slip duplex (Naylor *et al.*, 1986; Woodcock and Fischer, 1986). An alternate interpretation, which does not preclude dextral strike-slip movement, is that the northeast-vergent reverse faults within the Taylor Creek Group are relicts of the earlier northeast-vergent contractional deformation, and the Castle Pass fault later truncated these faults on their southwest side. This is plausible as the Castle Pass fault appears to follow a belt of earlier northeast-vergent structures, such as those identified at North Cinnabar and Truax creeks.

The Castle Pass fault truncates Cenomanian or younger northeast-vergent folds and thrust faults in the North Cinnabar Creek area, and is in turn offset by the Fortress Ridge fault system, which was active during the Eocene. It also truncates the Late Cretaceous Eldorado fault, which is deformed into a major north-closing fold where it abuts the Castle Pass fault (Figure 3). This fold was apparently intruded by the 67 Ma Eldorado pluton after its formation, and the pluton, although apparently faulted, shows only minor offset compared with the major stratigraphic and structural discontinuities across the Castle Pass fault. These relationships demonstrate that most of the movement on the Castle Pass fault occurred in the latter part of the Late Cretaceous. The faults which cut the Eldorado pluton are either later structures, totally unrelated to the main phase of movement on the Castle Pass fault, as suggested by Garver (1991), or the pluton was intruded during the late stages of a single, protracted deformation. We prefer the latter interpretation, because the Castle Pass fault system seems to be the locus of latest Cretaceous igneous intrusions and associated mineral occurrences from Tyaughton Creek southward for more than 20 kilometres to Carpenter Lake. These intrusions include the Eldorado pluton, as well as dikes dated as 67 and 69 Ma at the Congress and Minto mines along Carpenter Lake (Pearson, 1977; Leitch *et al.*, 1991). Intrusion is inferred to have been synchronous with movement along the Castle Pass fault system because of its overall spatial relationship and because individual dikes and mineralized veins within this belt commonly have northerly strikes, corresponding to the extensional direction within the dextral fault system. This belt of intrusions is focused on the broad z-shaped bend within the fault system. This extensional bend in the Castle Pass dextral fault system may be the primary reason for the localization of intrusive rocks and associated mineral occurrences within this belt.

The amount of displacement on the Castle Pass fault system is not readily apparent. Although it truncates a number of earlier structures (the Eldorado fault and the thrust fault between the Cadwallader and Tyaughton groups on the southwest; the Bridge River Complex/Taylor Creek Group unconformity and associated east-vergent structures on the northeast), none of these have recognizable counterparts on the other side of the fault. Furthermore, large segments of the fault bound lithologic units that do not outcrop anywhere on the opposite side of the fault (Tyaughton Group only on the southwest; Paradise, Dash and Silverquick formations only on the northeast). The absence of obvious piercing points may be the result of significant vertical movements associated with the dextral strike-slip, as many of the truncated structures and units that they bound are relatively gently dipping. Furthermore, the Castle Pass fault system was apparently superimposed on an earlier northeast-vergent thrust and fold belt. Juxtaposition of lithologic units across segments of the fault may therefore have resulted from northeast-vergent contractional deformation followed by dextral strike-slip.

RED HILL AND TEEPEE MOUNTAIN SYNCLINES

The Red Hill syncline is a symmetric, upright, west to northwest-plunging structure within the Taylor Creek Group east of Graveyard Creek. Its southwest limb is cut by northwest-striking faults and both northeast and southwest-vergent overturned folds that are thought to be part of the Castle Pass fault system. Its northeast limb is bounded by the Relay Creek fault.

The northwest-plunging Teepee Mountain syncline occurs within the Relay Mountain Group to the southeast of the Red Hill syncline. It too is bounded by the Relay Creek fault to the northeast, and by a train of subparallel folds and northwest-striking faults to the southwest. The relationship between the upper unit of the Relay Mountain Group in the core of this syncline and the Taylor Creek Group that outlines the Red Hill syncline to the northwest is obscured by overburden along the major north-flowing tributary of Relay Creek. The contact is apparently, however, a northerly trending fault that feeds into the northwest-trending fault system east of Relay Mountain (Figure 3). Nevertheless, its spatial and geometric configuration suggest that the Teepee Mountain syncline is the deeper structural and stratigraphic expression of the Red Hill syncline, exposed up-plunge to the southeast.

The Red Hill - Teepee Mountain syncline is cored by the Beece Creek succession, and is therefore Cenomanian or younger in age. Its two limbs are truncated by the Relay Creek and Castle Pass fault systems, respectively, so the fold must predate those faults. Nevertheless, it might be related to the early stages of dextral-slip on the Castle Pass fault system. Alternatively, it might be an earlier structure that formed during the mid-Cretaceous contractional regime. Its position northeast of the Castle Pass fault indicates that it might specifically relate to the belt of northeast-vergent structures (North Cinnabar and Truax Creek fold-fault systems) directly northeast of the Castle Pass fault to the south-southeast.

THE FORTRESS RIDGE - CHITA CREEK FAULT SYSTEM

The Fortress Ridge - Chita Creek fault system comprises a pair of en echelon faults that extend from lower Tyaughton Creek northwestward to beyond the limits of the map area (Figure 25). The two faults are thought to have evolved together as part of an Eocene dextral strike-slip system linked by a left-stepping transfer zone.

The west-northwest-trending Fortress Ridge fault is well defined in the area between Fortress Ridge and Cardtable Mountain, where it truncates more northerly trending structures and stratigraphic contacts within the Relay Mountain and Taylor Creek groups on its north side and separates them from a west-northwest-trending panel of Relay Mountain Group to the south (Figure 3). The fault was not seen, but its trace is locally marked by narrow slivers of older rocks, including shale and siltstone of the Last Creek formation. The fault maintains its west-northwest trend to the Big Creek valley, and truncates the Tyaughton Group and bounding Castle Pass fault to the south, and the well-defined faults of the Elbow Mountain thrust belt to the north. The same structure is readily identified west of Big Creek, where it separates mainly Powell Creek formation and overlying Cluckata Ridge volcanics on the north from Taylor Creek Group to the south. The fault gradually assumes a more northerly trend northwest of Tosh Creek, where it separates the Tosh Creek succession and overlying Taylor Creek volcanics to the north from the Beece Creek succession to the south. North of Powell Creek it is projected north-northwestward along a pronounced lineament that extends to, and is co-linear with, the northeastern margin of the Beece Creek pluton. Intrusive contacts locally observed along this contact indicate that it is not faulted; therefore, if the Fortress Ridge fault exerted a control on the location of the pluton, it did so during, rather than after, its intrusion.

The Fortress Ridge fault is cut by a northerly trending stock of unit Ep east of Fortress Ridge, beyond which it extends southeastward to be truncated by the Relay Creek fault system north of Noaxe Creek. Two important faults with more southerly trajectories appear to merge with the main Fortress Ridge fault in this area. One passes through the Silverquick mercury mine to intersect Carpenter Lake between the mouths of Gun and Tyaughton creeks. This fault defines the western boundary of an inlier of Bridge River Complex exposed on lower North Cinnabar Creek, and to the west truncates both upright and overturned limbs of the North Cinnabar syncline. The other splay follows a prominent belt of serpentinite south-southeastward from the mouth of Taylor Creek. It bisects the Liza Lake thrust belt and follows the lower reaches of Tyaughton Creek to Carpenter Lake.

The Fortress Ridge fault is the locus of apparent dextral offsets ranging from 1.5 to 3.5 kilometres between Cardtable Mountain and the headwaters of Tyaughton Creek. The offset features include the western contact of Unit muJRM1, the Spruce Lake fault, the latest Cretaceous Castle Pass fault and late Paleocene to early Eocene porphyries of Unit PEp. The Fortress Ridge fault is cut by the late Middle Eocene Beece Creek pluton, although it may have exerted a control on localizing the intrusion. It is also cut by an undated porphyry stock east of Fortress Ridge which may correlate with the late Middle Eocene or younger Rexmount porphyries to the east. These constraints suggest that the fault was active in early Tertiary time, prior to the late Middle Eocene.

The two prominent faults that appear to splay southward from the Fortress Ridge system near its southeastern end show apparent sinistral offsets of the Bridge River blueschist unit and overlying Liza Lake thrust belt west of lower Tyaughton Creek (Figure 3). These faults may be older structures, perhaps correlative with the Eldorado and Steep Creek faults, that were truncated, or reactivated as splays to the Fortress Ridge fault during the Tertiary. Alternatively, they may have formed in the Tertiary and the apparent sinistral offsets may reflect a significant component of southwest-side-down movement along them.

The Chita Creek fault is well defined from Chita Creek, in the northwestern corner of the map area, east-southeastward to the head of Grant Creek. Over this distance it separates Powell Creek formation on the south from Taylor Creek Group to the north. The fault is not well defined between Grant Creek and the Lorna Lake stock, but is thought to correlate with a fault on the southeast side of the stock that also separates Powell Creek formation from older stratigraphic units to the north. This fault has been traced to the ridge system northwest of Mount Sheba, where it defines the northeastern margin of the Tertiary volcanics, but it does not apparently continue as a major structure beyond there.

The Chita Creek fault zone was observed at two places on the ridge south of the head of Beece Creek, where it separates the Taylor Creek volcanic unit from Powell Creek formation. There, breccia comprising pebble-sized fragments of sandstone and volcanic rock in a fine-grained sheared matrix is interleaved with more coherent lenses of grey shale, sandstone and volcanic breccia. Dikes of locally clay-altered feldspar porphyry are common in both Powell Creek formation and Taylor Creek Group adjacent to the fault. Exposures along the fault are rubbly and its orientation was not established precisely, but it is constrained to strike west-northwest and dip steeply in this area. The orientation of the fault is not well constrained elsewhere, although the segment that crosses Trail Ridge, directly east of the Lorna Lake stock, apparently dips at moderate angles to the southwest.

The Chita Creek fault cuts volcanic rocks of probable Paleocene or Eocene age northwest of Mount Sheba and is in turn cut by the Lorna Lake stock; it was therefore probably active in the Early to Middle Eocene. Stratigraphic juxtapositions across the fault indicate a component of southwest-side-down displacement along its entire length, but it is a steeply dipping, west-northwest-striking structure in the west, becomes a moderately southwest-dipping structure east of Lorna Lake, and apparently dies out farther to the east.

The following symmetries suggest that the Fortress Ridge and Chita Creek faults evolved together as part of an Eocene dextral strike-slip system: (1) the Fortress Ridge system dies out to the northwest, while the Chita Creek system dies out to the southeast; (2) in the zone of overlap, the Fortress Ridge fault shows north-side-down and the Chita Creek fault south-side-down stratigraphic separations, thus forming a zone of relative uplift between them; (3) both faults strike west-northwest over most of their lengths, but take on more northerly strikes near their terminations; (4) near their respective terminations both systems are intruded by granodiorite plutons that have yielded 44 Ma cooling dates. Dextral slip is demonstrated along the Fortress Ridge fault; it is not proven along the Chita Creek fault system, but is suggested by the presence of east-trending folds within the Powell Creek formation directly south of the fault near Battlement Ridge. The two faults are therefore interpreted to comprise a dextral strike-slip fault system and to be linked by a left-stepping transfer zone in the area between Lizard and Beece creeks. The relative uplift within the transfer zone is consistent with its left, constraining-step configuration. Tertiary contractional structures have not been documented within the zone, but it is possible that the exposures of Unit muJRM1 centred near Lorna Lake are separated from younger rocks to the southeast and northwest by thrust or reverse faults, and that the Tosh Creek succession and overlying Taylor Creek volcanics at the southwest end of Cluckata Ridge are separated from the Beece Creek succession to the northwest by a thrust fault (Figure 3). Localization of granodiorite plutons at the terminations of the faults, where they have curved into extensional orientations, suggests that faulting was broadly synchronous with plutonism and was therefore Middle Eocene in age. This is consistent with relationships established in the Yalakom - Marshall Creek - Relay Creek fault system, where dextral strike-slip was synchronous with intrusion of the Middle Eocene Mission Ridge pluton (see following section).

THE YALAKOM - MARSHALL CREEK - RELAY CREEK FAULT SYSTEM

The Yalakom - Marshall Creek - Relay Creek fault system is a complex, northwest-trending zone of faults, up to 15 kilometres wide, bounded by the Yalakom fault on the northeast and the Marshall Creek and Relay Creek faults on the southwest (Figure 25). The southeastern part of the zone is in part underlain by a belt of greenschist-facies Bridge River schists that record contractional and dextral strike-slip deformation under ductile conditions. These are bounded by the Marshall Creek fault to the southwest, and by the Mission Ridge and Brett Creek normal faults to the northeast and north. Lower grade rocks of the Bridge River and Shulaps complexes occur in the hangingwalls of these normal faults, and are bounded by the Yalakom fault zone on the northeast; they are juxtaposed directly against Methow Terrane in the north, but in the south are juxtaposed against the intervening Camelsfoot thrust belt. Farther to the northwest, northerly-trending dextral-normal faults of the Quartz Mountain fault system link the Marshall Creek and Yalakom fault systems, and separate the older rocks to the southeast from Cretaceous rocks of the Taylor Creek Group to the northwest. These younger rocks are disposed about the northwest-trending Prentice Lake syncline, and are bounded on the southwest by the Relay Creek fault system. Strike-slip, contractional and extensional structures within the Yalakom - Marshall Creek - Relay Creek fault zone are thought to have developed in concert, over a protracted period within a predominantly dextral strike-slip fault system. Deformation was at least in part Eocene in age, and overprints Cretaceous faults of the Shulaps thrust system, which are preserved locally within the zone.

YALAKOM FAULT

The northwest-striking Yalakom fault is the most prominent structural feature of the map area. It was first described by Leech (1953), who mapped it as a system of steeply dipping faults bounding the northeast margin of the Shulaps Ultramafic Complex along the Yalakom River. The fault system was traced northwestward through the Taseko Lakes and Mount Waddington map areas by Tipper (1969, 1978) who postulated that it was the locus of 80 to 190 kilometres of right-lateral displacement. It was traced southeastward through the northeastern corner of Pemberton map area by Roddick and Hutchison (1973), from where it extends into the western part of the Ashcroft map area (Duffell and McTaggart, 1952; Monger and McMillan, 1989). There, it is truncated by the more northerly trending Fraser fault system, along which it is separated by 70 to 80 kilometres from its probable offset equivalent, the Hozameen fault, to the south (Monger, 1985).

The Taseko Lakes - Bridge River map area includes a segment of the Yalakom fault 90 kilometres long (Figure 25). The northwestern part of fault marks the southwestern boundary of Methow Terrane, truncates structures and stratigraphic contacts on both northeast and southwest sides, and is commonly followed by a narrow zone of listwanite-altered ultramafic rocks. In the north, where the fault cuts across the headwaters of Dash Creek and its tributaries, it is defined by a zone of listwanite up to 300 metres wide. There, the fault separates Unit lKJMy1 of the Jackass Mountain Group on the northeast from the Taylor Creek Group to the southwest, and is overlapped by flat-lying Miocene-Pliocene plateau lavas. The listwanite belt thins or pinches out to the southeast, where the fault follows the valley of Lone Valley Creek, but a narrow belt of listwanite and serpentinite mélange marks the fault trace from the vicinity of Mud Lakes southeastward to Horse Lake. Over this interval the Yalakom fault and a splay to the northeast, the Swartz Lake fault, enclose a northeast-facing lens of Unit lmJys 20 kilometres long. On its southwest side, the Yalakom fault truncates the more northerly trending Quartz Mountain fault system at a low to moderate angle, such that the Jurassic Methow Terrane rocks are juxtaposed against southeast-facing Taylor Creek Group to the north, and against Bridge River Complex to the south. The Yalakom fault truncates the south-dipping North Shulaps fault southeast of Horse Lake, and from there to Peridotite Creek defines the northeastern boundary of the Shulaps Complex. It is well defined over most of this length, and serpentinite mélange along the margin of the Shulaps complex is commonly altered to listwanite for several tens to several hundreds of metres adjacent to the fault. On its northeast side, the Yalakom fault bounds the arkose unit of the Jackass Mountain Group near Horse Lake, and truncates a west-trending fold within the unit. From there, it cuts down-section through the Methow Terrane succession such that it juxtaposes Unit lmJys against the Shulaps Complex in the area of Blue, Peridotite and Beaverdam creeks.

At Beaverdam Creek the Yalakom fault truncates the Camelsfoot fault on its northeast side, and from there to the southeastern corner of the map area it separates serpentinite mélange of the Shulaps Complex from Cadwallader, Bralorne-East Liza and Bridge River rocks of the Camelsfoot thrust belt. The fault trace is not well constrained between Beaverdam and Junction creeks, but presumably is in or near the Yalakom River. To the southeast, the main fault crosses the low slopes southwest of the Yalakom River, but is bounded to the northeast by a zone of related splays, up to 1.5 kilometres wide, that bound slivers of Cadwallader Group, Bralorne-East Liza Complex and serpentinite mélange that outcrop on both sides of the river. Southeast of Ore Creek, the fault zone is constrained to lie in or near the lower part of the Yalakom River valley and the adjoining Bridge River valley as far south as Camoo Creek. Over this interval it truncates the basal thrust of the Camelsfoot thrust system on the northeast, such that it bounds imbricated Bralorne-East Liza and Cadwallader rocks to the north and Bridge River Complex to the south. Southeast from Camoo Creek, the fault cuts across the slopes southwest of the Bridge River to the southeast boundary of the map area. This segment of the fault was not traced in the field, but is evident on recent colour air photographs as the northeastern boundary of a belt of serpentinite and listwanite outcrops included within the Shulaps serpentinite mélange unit.

As here defined, the Yalakom fault is continuous with the Yalakom fault as mapped by Monger and McMillan (1989) to the southeast, who trace it to its termination at the Fraser fault system 30 kilometres south-southeast of Lillooet (*see* Figure 22). This interpretation differs from that of Coleman (1990, 1991), who regarded the Yalakom fault as delimiting the northeast margin of the Bridge River Complex, and mapped it as a moderately northeast-dipping fault that places clastic sedimentary rocks (her Lillooet Group) above Bridge River Complex from Applespring Creek to just north of Lillooet. Her Bridge River Complex, however, includes rocks that are here assigned to both the Bralorne-East Liza Complex and the Shulaps serpentinite mélange; consequently she did not map an important fault along the lower Yalakom and adjacent Bridge rivers. As shown in Figure 22, the northeast-dipping fault segment which she regarded as the Yalakom fault is continuous with, and here regarded as a component of, the Camelsfoot thrust belt.

The Yalakom fault appears to dip steeply throughout its length, and at several localities provides evidence for dextral strike-slip movement. On the northeast slopes of the Yalakom River, opposite the mouth of Blue Creek, the near-vertical fault separates serpentinite mélange of the Shulaps Complex from steeply dipping, locally overturned, northeast-facing sedimentary rocks of Unit lmJys. The mélange is listwanite-altered for several hundred metres immediately adjacent to the fault, and the listwanite is cut by steeply dipping, west-northwest-striking faults that parallel the Yalakom fault. The fault surfaces contain gently plunging striations and chalcedony fibres and are intersected by more northerly striking quartz and chalcedony veins, suggesting dextral strike-slip. The same outcrops locally contain relict patches of relatively unaltered foliated serpentinite that are cut by shear bands that also indicate dextral movement. These relationships suggest that dextral movement occurred both prior to and during listwanite alteration.

Dextral strike-slip indicators were also observed at the Apex mercury prospect, 18 kilometres west-northwest of Blue Creek. There, the Yalakom fault is marked by a belt of listwanite-altered serpentinite 300 metres wide that separates Unit lmJys on the northeast from the Bridge River Complex to the southwest. The listwanite locally contains steeply dipping, west-northwest-striking zones of closely spaced anastomosing shear surfaces that enclose domains of west-striking foliation that deflects sigmoidally into the bounding shear surfaces; these are interpreted as S-C mylonites, indicating dextral shear. West-northwest-striking vertical to steeply dipping faults with horizontal or gently plunging mineral fibres are also common. Associated chalcedonic quartz veins are highly variable in orientation, but most dip steeply and strike northwest to north; assuming that these reflect the extensional direction during faulting, they suggest dextral movement on the more westerly striking fault surfaces.

Indications of dextral shear were also noted in a small outcrop along the west shore of the largest of the Mud Lakes, 5 kilometres west-northwest of the Apex showing. The outcrop is constrained by adjacent lithologies to fall within or along the Yalakom fault, and comprises altered cherty and silty sedimentary rocks interspersed with rusty carbonate-altered rocks across shear surfaces that dip at moderate to steep angles to the south-southwest. Foliation in some of the silty units strikes westerly and bends sigmoidally into bounding shear surfaces, suggesting dextral movement.

Outcrops along or near the southeastern segment of the Yalakom fault, in the lower Yalakom and Bridge River valleys, commonly display a complex network of brittle faults and fractures, but were not studied in sufficient detail to allow a comprehensive kinematic interpretation. Northwest-striking faults, parallel to the general trend of the fault zone, are most common, and have gentle to steep dips and striations and mineral fibres suggesting both strike-slip and dip-slip components of movement. Also common are northeast-striking faults with generally shallow slickensides.

Miller (1988) concluded that the Yalakom fault had experienced sinistral movement on the basis of a detailed study of minor structures near the confluence of the Bridge and Fraser rivers just to the southeast of the Taseko - Bridge River map area. However, as noted in a previous section, Miller's work was concentrated in Methow Terrane rocks northeast of the Camelsfoot fault, and we conclude that his study pertains to movement along that fault rather than the Yalakom fault. He did, however, study a small, isolated outcrop southwest of the Bridge River (High rocks sub-area, Figure 22), which he thought was right along the Yalakom fault zone. The outcrop comprises serpentinite structurally above sandstone across a gently west-dipping thrust(?) fault. Miller assigned the sandstone to the Lillooet Group, and inferred that the thrust fault reflected a late stage of contractional motion along the Yalakom fault, which he suggested may have been coincident with Tertiary dextral strike-slip faulting along the Fraser fault system. Miller's "High rocks" outcrop, as shown on Figure 22, occurs within the belt of Shulaps serpentinite mélange that is bounded on the northeast by the Yalakom fault. The serpentinite mélange unit is characterized throughout by metre to kilometre-scale knockers of plutonic, volcanic and sedimentary rocks within a matrix of sheared serpentinite. Contacts are typically low-angle and related to a protracted interval of mainly Cretaceous thrusting. During the present study, traverses across the poorly exposed segment of the serpentinite mélange southwest of the Bridge River found outcrops of mainly knocker-material (including sandstone), with less resistant serpentinite as rubble and subcrop along the edges and in between knockers. We suspect, therefore, that Miller's "High rocks" outcrop is a sedimentary knocker and serpentinite matrix of the Shulaps serpentinite mélange unit; the thrust fault between them may be an earlier structure, unrelated to movement along the adjacent Yalakom fault.

MARSHALL CREEK FAULT SYSTEM

The Marshall Creek fault was defined by Potter (1983, 1986) as a northwest-striking structure that separates greenschist-facies Bridge River schists exposed in the Shulaps Range from lower grade Bridge River rocks to the southwest. It extends from Marshall Lake for about 90 kilometres to the southeast (Coleman, 1991, Monger and McMillan, 1989), where it is truncated by, or merges with, the Fraser fault system about 35 kilometres south of Lillooet. At Marshall Lake it apparently merges with, or is truncated by, the more northerly trending Quartz Mountain fault system; it is, however, approximately collinear with the Relay Creek fault system that extends from there an additional 40 kilometres to the northwest.

From Marshall Lake to Sebring Creek, the Marshall Creek fault zone comprises two steeply dipping strands. The northeastern strand truncates a belt of Hurley Formation and serpentinite mélange within the Shulaps - Mission Ridge metamorphic belt and juxtaposes it, as well as well as structurally overlying and underlying penetratively deformed greenschist-facies Bridge River schists, against prehnite-pumpellyite-grade Bridge River rocks to the southwest. A parallel strand, less than a kilometre to the southwest, is marked by the truncation of the Eocene Jones Creek volcanics, which unconformably overlie low-grade Bridge River rocks to the southwest of the fault. The two strands apparently merge to the southeast (Figure 25). South of Carpenter Lake, the fault dips 50° to 75° southwest and cuts the Eocene Mission Ridge pluton which intrudes Bridge River schists on its northeast side (Coleman, 1990). Southeastward from there, the Marshall Creek fault defines the southwestern margin of greenschist to amphibolite-facies Bridge River schists and associated Eocene intrusive rocks all the way to the Fraser fault (Coleman, 1991; Monger and McMillan, 1989). On its southwest side, it truncates a low-angle fault south of the study area, near Seton Lake, that separates the low-grade Bridge River Complex from structurally underlying Bridge River schists; this low-angle fault is interpreted by Coleman to be an offset segment of the Mission Ridge fault.

Three separate northwest-striking faults splay from the Marshall Creek fault northwest of Carpenter Lake and cause dextral offsets of older structures within the Shulaps - Mission Ridge metamorphic belt. The northern two splays diverge from the northeast strand of the Marshall Creek fault between Jones and Sebring creeks, and cause apparent dextral offsets of the belt of Hurley Formation and serpentinite mélange within the metamorphic belt. The northernmost fault was observed on the ridge west of Rex Peak, where it juxtaposes a mappable metasedimentary knocker within serpentinite mélange against Hurley Formation to the southwest. There, the fault is marked by several metres of strongly fractured rock cut by steeply dipping, northwest-striking fault surfaces containing gently plunging striations and mineral fibres. The fault to the south is closely constrained on the ridge east of Bighorn Creek, where it is followed by a narrow, apparently undeformed dike of hornblende-biotite-feldspar porphyry (Rexmount porphyry) that separates biotite-grade Bridge River schists on the southwest from serpentinite mélange to the northeast. The mélange adjacent to the fault is locally cut by steeply dipping northwest-striking faults containing gently plunging serpentine fibres; these may be related to the main fault.

The southernmost splay, referred to as the Red Mountain fault, diverges from the Marshall Creek fault directly north of Carpenter Lake. It is inferred to cut through the Mission Ridge pluton, where it is locally marked by a prominent air photo linear, and to cause the dextral offset of the northern margin of the pluton and the adjacent serpentinite mélange belt near the headwaters of LaRochelle and Holbrook creeks. To the north, the fault is plugged by the large Rexmount porphyry intrusion, but emerges north of it to cause a well-defined dextral offset of the serpentinite mélange belt and Mission Ridge fault west and northwest of Serpentine Lake. The fault was not traced through the interior of the Shulaps Complex, but is interpreted to continue as the structure which causes a well-defined dextral offset of the Yalakom fault near the mouth of Blue Creek. This fault extends to the north-northwest to dextrally offset the northeast-striking fault that separates Churn Creek and Yalakom Mountain facies of the Jackass Mountain Group, and from there to bound the Red Mountain volcanics near the northern edge of the map area. As thus defined, the Red Mountain fault has a markedly sigmoidal trace, with a major bend inferred over the most poorly defined part of its trace in the interior of the Shulaps Complex (Figure 3). This interpretation is consistent, however, with the very similar dextral offsets documented across the two well-defined fault segments at Serpentine Lake and Blue Creek. Furthermore, the pronounced sigmoidal shape of the fault matches almost exactly the shape of the Quartz Mountain fault system to the west (Figure 25), which is also a late, and presumably coeval component of the Yalakom - Relay Creek - Marshall Creek fault system.

The dextral splays that diverge from the Marshall Creek fault north of Carpenter Lake indicate that the Marshall Creek system had a component of dextral strike-slip movement. This is consistent with the interpretation that the Quartz Mountain fault system is a transfer zone linking the Marshall Creek and Yalakom faults. However, the Marshall Creek fault was also the locus of significant southwest-side-down vertical offset, as indicated by the juxtaposition of different metamorphic facies across the northeastern strand, as well as the preservation of the Eocene Jones Creek volcanics on the southwest side of the southwestern strand. Coleman (1990) estimates that vertical displacement across the Marshall Creek fault amounts to about 3.5 kilometres, based on matching the Mission Ridge fault with its counterpart on the southwest side of the Marshall Creek fault near Seton Lake.

SHULAPS - MISSION RIDGE METAMORPHIC BELT

The Shulaps - Mission Ridge metamorphic belt is characterized by greenschist facies, penetratively deformed metamorphic rocks of the Bridge River Complex that are well exposed in the southern Shulaps Range and contiguous Mission Ridge. However, the belt also includes lower grade, non-penetratively deformed Bridge River rocks, Shulaps serpentinite mélange and Cadwallader Group rocks. The metamorphic belt is bounded by the Marshall Creek fault to the southwest, by the Mission Ridge fault to the east and northeast, and by the Brett Creek fault to the north (Figure 26). These bounding faults, together with several internal faults, were the locus of Eocene transtension, and were responsible for the final unroofing of the metamorphic belt. Structural relationships within the belt indicate an earlier

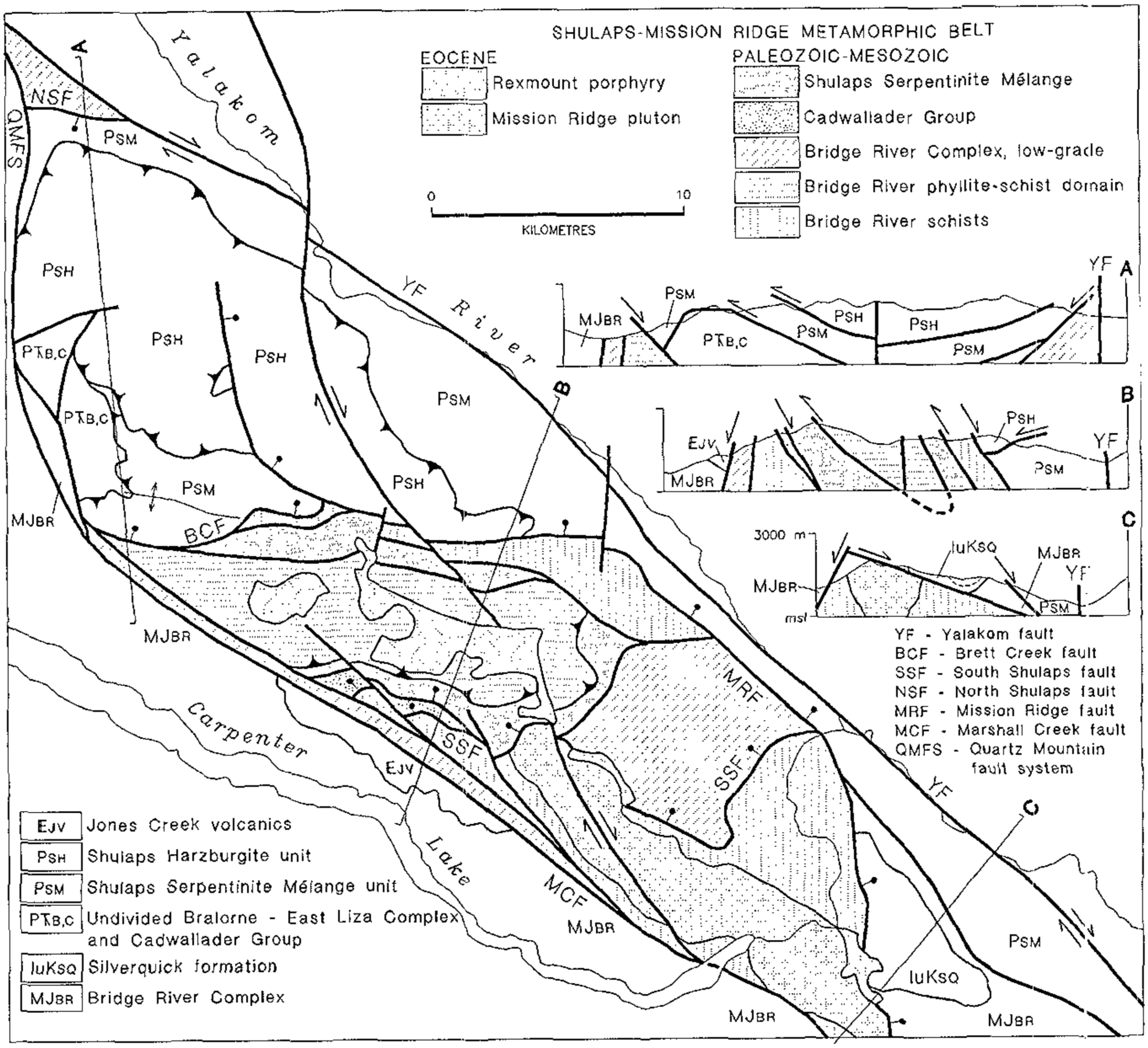

Figure 26. Simplified map showing the geology within and adjacent to the Shulaps - Mission Ridge metamorphic belt.

phase of transpressive deformation that was also Eocene in age.

Foliation and map-scale structures within the metamorphic belt dip north to northeast, and the belt will be described with reference to four lithologic-metamorphic domains arranged in ascending structural order. The structurally lowest element is the southern schist domain, consisting of upper greenschist to amphibolite facies Bridge River schists together with the Mission Ridge pluton. These rocks are overlain by the Jones-LaRochelle imbricate domain, comprising prehnite-pumpellyite to lower greenschist grade Bridge River Complex, Hurley Formation and Shulaps serpentinite mélange. These rocks are arranged in normal structural order with respect to the prevalent arrangement generated by Cretaceous thrusting, but are internally imbricated and separated from the underlying Bridge River schists by transtensional faults referred to as the South Shulaps fault system. The third domain, referred to as the phyllite-schist domain, is made up of lower greenschist facies Bridge River phyllites and schists that rest structurally above serpentinite mélange of the Jones-LaRochelle imbricate belt across a system of thrust faults related to an early phase of transpressional deformation within the metamorphic belt. The fourth element, referred to as the northern schist-mélange domain, is a relatively narrow wedge along the northern margin of the metamorphic belt, which cuts obliquely across the underlying Jones-LaRochelle and phyllite-schist domains. It includes a belt of upper greenschist facies Bridge River schists together with an underlying belt of serpentinite mélange. These rocks are correlated with similar elements in the southern schist domain and Jones-LaRochelle domain, respectively, and are inferred to have been repeated during the early transpressional phase of Eocene deformation within the metamorphic belt.

Southern Schist Domain

The southern schist domain consists of biotite-bearing Bridge River schists intruded by the Mission Ridge pluton and numerous associated syntectonic to post-tectonic granodiorite to felsic porphyry dikes and sills. These rocks are well exposed in the Bridge River canyon. From there they extend northward adjacent to the Marshall Creek fault to Jones Creek, and southward beyond the limits of the map area.

Bridge River schists of the southern schist domain are at upper greenschist to lower amphibolite-facies metamorphic grade (*see* Potter, 1983, for a detailed list of metamorphic assemblages). Metamorphic assemblages in metasedimentary rocks include quartz-biotite±chlorite±muscovite; quartz-biotite-chlorite-actinolite±garnet; and quartz-biotite-chlorite-hornblende-garnet. Mafic volcanic and intrusive rocks commonly contain the assemblage actinolite-chlorite-epidote-(albite and/or oligoclase)±biotite, but locally record the assemblages hornblende-oligoclase-chlorite-epidote, hornblende-oligoclase-epidote-biotite, and hornblende-oligoclase-chlorite-biotite, indicative of the lower amphibolite facies.

Metamorphic rocks of the southern schist domain are invariably strongly foliated, with foliation typically defined by millimetre to centimetre-scale compositional layering and oriented phyllosilicate grains. Quartz-rich rocks are most common, and comprise discontinuous lenses, generally less than 1 centimetre thick, of fine-grained quartz alternating with thinner phyllosilicate-rich lenses or partings. Stretching lineations are typically well developed, and defined by quartz rods and aligned phyllosilicate aggregates. Foliation throughout the domain has a persistent northwest to west strike, and moderate northeast to north dips; local variations do occur, particularly adjacent to faults which bound the domain. Locally the foliation is seen to be axial planar to tight to isoclinal folds outlined by compositional layering, and it is commonly folded by later folds and crenulations. Stretching and intersection lineations plunge at shallow angles to the northwest, as do the fold hinges of most early and late folds. Detailed work by Coleman (1990) indicates that the foliation is predominantly a mylonitic shear foliation. Kinematic indicators are provided by S-surfaces defined by fish-shaped quartz aggregates at an oblique angle to the predominant C-foliation, rotated garnet porphyroblasts with asymmetric pressure shadows, and shear bands that typically intersect the dominant shear foliation at 20 to 40 degrees. All of these indicators show a dextral sense of shear along the gently-northwest-plunging strectching direction (Coleman, 1990).

The Mission Ridge pluton intrudes Bridge River schists in the western part of the southern schist domain, and its northwest orientation is broadly concordant to foliation in the surrounding country rocks. The interior of the pluton is generally undeformed, whereas the margins display a variably developed mylonitic foliation. Bridge River schists throughout the domain are intruded by abundant sills and dikes of similar granodioritic composition; some of the intrusions are strongly foliated and concordant with the foliation in surrounding Bridge River schists, while others cross cut it, but are folded or have weakly foliated margins. The intrusions are therefore interpreted by Coleman (1990) to range from syntectonic to late syntectonic with respect to foliation development within the enclosing Bridge River schists. Kinematic indicators from foliated plutonic rocks are congruent with those from Bridge River schists, and indicate dextral shear along gently northwest plunging stretching lineations (Coleman, 1990). Constraints on the timing of magmatism and deformation are provided by 48.5-46.5 Ma U-Pb zircon ages from three deformed granodioritic bodies, including the Mission Ridge pluton.

Jones-Larochelle Imbricate Domain

The Jones-LaRochelle imbricate domain bounds the southern schist domain to the north, and extends continuously from the Marshall Creek fault eastward to the Mission Ridge fault. It is underlain by prehnite-pumpellyite to lower greenschist grade rocks that include, in ascending structural order, Bridge River Complex, Hurley Formation and Shulaps serpentinite mélange.

Serpentinite mélange in the upper part of the Jones-LaRochelle domain consists of northerly dipping foliated serpentinite containing knockers of gabbro, amphibolite, rodingite, metasandstone, chert and limestone. It is identical to the extensive belt of serpentinite mélange comprising the base of the Shulaps Complex, with which it is correlated. Amphibolite knockers are identical to, and presumably correlative with, the Permian knockers in the main Shulaps mélange belt to the north. Metasedimentary knockers are at sub-biotite metamorphic grade, and display a well developed foliation defined by chlorite and white mica. Serpentinite is metamorphosed to talc-carbonate schist only in the immediate vicinity of small bodies of medium-grained granodiorite that intrude it locally.

A considerable thickness of Hurley Formation underlies the serpentinite mélange adjacent to the Marshall Creek fault, but the unit thins to the east and was not recognized east of the Mission Ridge pluton. The Hurley Formation is at sub-biotite metamorphic grade, but is characterized by a well-developed sericite-chlorite foliation that dips to the north, as do strongly flattened clasts in conglomerate exposed adjacent to the Marshall Creek fault and along the contact with overlying serpentinite mélange at the head of Bighorn Creek. The conglomerate clasts near the Marshall Creek fault show a weak stretching direction, plunging gently to the northeast, but no stretching direction was recognized in the conglomerates exposed at the head of Bighorn Creek. Where seen, the contact between serpentinite mélange and Hurley Formation dips northward at moderate to steep angles, more or less parallel to foliation in overlying and underlying units. Foliation in the Hurley Formation along the contact near the head of Bighorn Creek is cut by shear bands that suggest components of dextral strike-slip and normal-sense dip-slip movement, when exposed on horizontal and vertical outcrop faces, respectively.

The Jones-LaRochelle imbricate domain also includes an area of sub-biotite-grade Bridge River rocks that are exposed east of the Mission Ridge pluton in the upper reaches of Hell, Buck, Doe and LaRochelle creeks These rocks are mainly phyllites with a moderately developed chlorite±sericite foliation that dips mainly to the northeast. The foliation is deformed by mesoscopic folds and crenulations that have variable orientations, but most commonly plunge to the northwest. Exposures on the ridge southeast of upper Buck Creek, however, include unfoliated pillowed greenstone containing amygdules and veins of pumpellyite, chlorite and calcite, as well as chert with still recognizable radiolarian tests. These observations are consistent with the more detailed work of Potter (1983), who recorded several different prehnite and pumpellyite-bearing assemblages in this area. This belt of low-grade Bridge River rocks is structurally above biotite-grade schists and, locally, the Mission Ridge pluton, of the southern schist domain. The contact, here interpreted as a fault, was interpreted by Potter (1983) as an abrupt metamorphic transition (*i.e.* a biotite isograd).

The southern boundary of the Jones-LaRochelle imbricate domain, together with the contacts between the three major components of the domain, are interpreted as components of an imbricate fault system superimposed on what may have been an intact structural succession established in the Cretaceous. The main fault, comprising the upper boundary of the southern schist domain, is referred to as the South Shulaps fault. This fault is truncated by the Marshall Creek fault northwest of Jones Creek, where it separates the Hurley Formation from underlying Bridge River schists. Eastward, the fault truncates the Hurley Formation and lower part of the serpentinite mélange in its hangingwall, and truncates the Mission Ridge pluton in its footwall. The South Shulaps fault is offset by a dextral splay from the Marshall Creek fault near the eastern margin of the pluton, and eastward from there is inferred to bifurcate into two strands that enclose the belt of low-grade Bridge River rocks exposed between LaRochelle and Hell creeks. The southern strand separates the low-grade Bridge River rocks from underlying Bridge River schists and the Mission Ridge pluton, and the northern strand separates them from overlying serpentinite mélange. Both strands are apparently truncated by the Mission Ridge fault to the east.

The sense of movement on the South Shulaps fault system is not well constrained. However, the faults are suspected to be mainly extensional to dextral-transtensional because they thin and truncate units but leave them in the typical order of superposition established during Cretaceous thrusting. Furthermore, some of the faults mark an omission of section by juxtaposing upper greenschist to amphibolite-grade rocks directly beneath sub-biotite-grade rocks. This sense of movement is corroborated by the shear bands observed along the fault contact between serpentinite mélange and Hurley Formation near the head of Bighorn Creek.

Phyllite-Schist Domain

The phyllite-schist domain consists of sub-biotite to biotite-grade Bridge River phyllites and schists that structurally overlie serpentinite mélange of the Jones-LaRochelle imbricate belt. They are truncated by the Marshall Creek fault to the west, and by the Brett Creek fault and northern schist-mélange domain to the north and northeast. They are intruded by two large bodies of Rexmount porphyry that postdate all structures mapped within the domain.

Foliation in the phyllite-schist domain dips persistently at moderate to steep angles to the north, while stretching and crenulation lineations plunge gently to the west-northwest. Lower structural levels comprise mainly sub-biotite-grade rocks that are structurally above, and locally interleaved with, serpentinite mélange of the Jones-LaRochelle belt. The metamorphic assemblage chlorite-epidote-actinolite-albite occurs in both mafic metavolcanic and metasedimentary rocks; white mica is a common additional component of metasiltstones and metacherts. Biotite-bearing rocks occur locally southeast of Rex Peak and at the head of Holbrook Creek, where they are spatially associated with substantial bodies of granodiorite similar to that of the Mission Ridge pluton (Figure 3). A thin section of a biotite-bearing metasiltstone from 1.5 kilometres southeast of Rex Peak contains the assemblage chlorite-biotite-sericite-quartz.

Higher structural levels within the phyllite-schist domain, exposed from upper Brett and Hog creeks eastward to Shulaps Creek, comprise mainly biotite-bearing rocks. Metamorphic assemblages in metasedimentary rocks within this belt include chlorite-biotite-quartz±calcite±zoisite, and biotite-actinolite-calcite-quartz. The contact with structurally underlying, sub-biotite-grade rocks is defined by a gently dipping belt of serpentinite 2.5 kilometres west of Rex Peak, where it is inferred to be a thrust fault (as suggested by Potter, 1983). The contact is not well defined elsewhere, but is tentatively inferred to be a thrust fault throughout the domain. Sub-biotite-grade rocks are also exposed in upper structural levels of the biotite-grade slice in an area of sparse outcrop south and west of Serpentine Lake. These rocks are inferred to pass down-section into the higher grade rocks across a biotite isograd.

The base of the phyllite-schist domain was observed southwest of Rex Peak, where it is separated from underlying serpentinite mélange of the Jones-LaRochelle belt by a narrow mylonitic zone that grades upward into the pervasive north-dipping foliation in overlying Bridge River phyllites. The contact is folded about later upright, gently-east plunging, south-verging asymmetric folds. The folding was apparently synchronous with intrusion of a small pod of medium-grained, weakly foliated granodiorite into the underlying serpentinite mélange, because the granodiorite localized the development of a narrow zone of talc-carbonate-magnetite schist within the serpentinite, and schistosity within this zone is axial planar to the folds that deform the contact. Farther east, the upper part of the serpentinite mélange unit bifurcates and encloses an eastward-widening lens of Bridge River phyllite similar to that which overlies it. Contacts apparently dip north at shallow to moderate angles, but no movement sense was determined across them. Nevertheless, the base of the phyllite-schist domain is inferred to be a thrust or transpressional fault as it repeats the Bridge River Complex, which to the south is structurally beneath the Jones-LaRochelle belt, and because locally it separates higher-grade from underlying lower-grade metamorphic rocks.

Northern Schist-Mélange Domain

The northern schist-mélange domain contains two main components: a belt of serpentinite mélange that extends from Serpentine Lake westward for more than 12 kilometres to the west side of Brett Creek; and a more northern belt of upper greenschist facies Bridge River schists that extends from lower LaRochelle Creek northwestward almost 20 kilometres to Brett Creek. This domain occupies the northeastern edge of the Shulaps-Mission Ridge metamorphic belt. It truncates portions of the Jones-LaRochelle and phyllite-schist domains to the southwest, and is itself truncated by the Brett Creek and Mission Ridge faults to the north and northeast.

Serpentinite mélange within the domain is moderately well exposed only west of Hog Creek, where it is characterized by serpentinite and talc-carbonate schists, dipping mainly to the north at moderate to steep angles. These contain abundant knockers of plutonic, metasedimentary and metavolcanic rock. Plutonic knockers include gabbro, clinopyroxenite and amphibolite, typical of the Shulaps serpentinite mélange elsewhere. Metasedimentary and metavolcanic rocks are mainly strongly foliated biotite-bearing schists. Metamorphic assemblages observed in thin sections of metasedimentary knockers include quartz-biotite-chlorite-calcite-rutile, and biotite-chlorite-muscovite-calcite-sphene-epidote-tourmaline (+quartz and plagioclase as mainly relict clastic grains).

The northern part of the northern schist-mélange domain consists of biotite-grade schists of the Bridge River Complex. Mafic metavolcanic rocks typically contain the assemblage chlorite-epidote-actinolite-albite±calcite, while assemblages in metasedimentary rocks include quartz-biotite-chlorite-calcite±epidote, and quartz-biotite-actinolite±calcite. Foliated, synkinematic dikes and sills of granodioritic composition (Photo 60) occur throughout the belt, but are most common in the area south and southeast of Lake La Mare. Foliation in the schists typically dips at moderate angles to the north or northeast, and stretching lineaions plunge gently northwest or southeast.

Neither the internal contact between serpentinite mélange and Bridge River schists, nor the contact defining the southern boundary of the northern schist-mélange domain were observed. However, they are inferred to comprise a system of west to northwest trending faults that merge with or are truncated by the South Shulaps fault system in the east and the Brett Creek fault to the west. This fault system apparently truncates thrust or transpressional faults within the underlying phyllite-schist domain, and is itself cross cut by a finger of Rexmount porphyry that extends into the serpentinite mélange near the head of Hog Creek. Bridge River schists of the northern domain strongly resemble those of the southern schist domain in structural style, metamorphic grade and abundance of syntectonic granodioritic intrusions. It is suspected, therefore, that they may comprise a fault repetition of the same structural level. Serpentinite

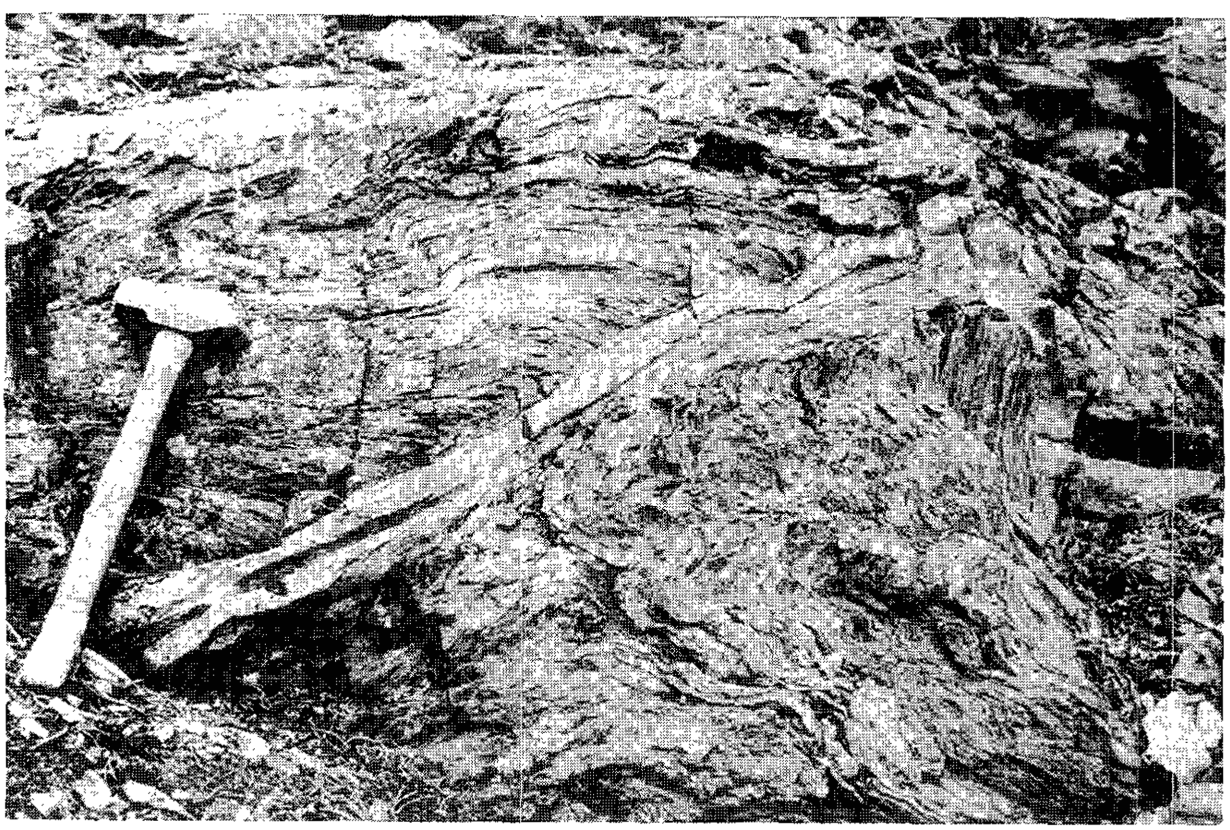

Photo 60. Felsic dike cross-cutting an east-vergent fold in the Bridge River schists north of Larochelle Creek.

mélange of the northern domain may likewise be a structural repetition of part of the Jones-LaRochelle belt, although it is at somewhat higher metamorphic grade, perhaps reflecting a deeper (down dip?) origin. It seems most likely, therefore, that the northern schist-mélange domain was juxtaposed against the more southern domains of the Shulaps-Mission Ridge metamorphic belt across transpressional structures, although these may have been reactivated or cut by normal faults during the subsequent transtensional regime.

BRETT CREEK FAULT

The westernmost exposures of Bridge River schists in the northern schist-mélange domain outcrop east of upper Brett Creek, where they are bounded on the north and west by the Brett Creek fault. This fault is truncated by the Mission Ridge fault to the east, near the head of Retaskit Creek. To the west, the Brett Creek fault truncates the fault that separates Bridge River schists from underlying serpentinite mélange just to the west of Brett Creek. Southwestward from there it juxtaposes serpentinite melange of the main part of the Shulaps complex against serpentinite melange of the northern schist-mélange belt. The fault is consequently not well defined in this area, but is projected through the serpentinite mélange so as to separate mélange containing biotite-grade metasedimentary knockers (characteristic of the northern schist-mélange belt) to the south, from mélange with mainly sub-biotite-grade knockers to the north. As thus defined, the Brett Creek fault is inferred to truncate the west end of the northern schist-mélange belt 2 to 3 kilometres east of Marshall Lake. From there it is inferred to extend westward as the contact between the main body of Shulaps serpentinite mélange to the north and the phyllite-schist domain to the south. The Brett Creek fault is truncated by the Marshall Creek fault system north of Marshall Lake.

The Brett Creek fault was not observed, but its trace from Brett Creek to the Mission Ridge fault suggests that it dips north to northeast, juxtaposing the Shulaps Complex above Bridge River schists. This fault, together with part of the Mission Ridge fault to the east, was inferred by Potter (1983, 1986) to be a Mesozoic thrust across which the Shulaps Complex was emplaced above Bridge River Complex. The Brett Creek fault, however, truncates ductile fabrics within the Bridge River schists that are now thought to be Eocene in age. Furthermore, it is very similar to the Mission Ridge normal fault in that it juxtaposes rocks of the Shulaps-Mission Ridge metamorphic belt beneath rocks of the Shulaps Ultramafic Complex that originated at a considerably higher structural level. It is therefore interpreted as a normal fault that developed somewhat earlier than the Mission Ridge fault during the Eocene extensional unroofing of the Shulaps - Mission Ridge metamorphic belt. The Brett Creek fault is, in fact, the main locus of normal displacement at the north end of the belt as the Mission Ridge fault extends northwestward into the Shulaps Complex with considerably less apparent offset north of the Brett Creek fault's truncation.

NORTH SHULAPS FAULT

The North Shulaps fault is a south-dipping fault that bounds the northern tip of the Shulaps Complex, where it separates serpentinite mélange from underlying Bridge River Complex. It is described here because it may be a northern conjugate to the Brett Creek fault (Figure 26, Section A).

The North Shulaps fault extends for about 4 kilometres between the Quartz Mountain fault system to the west and the Yalakom fault to the east. The fault was not observed, but southerly-dipping striated shear surfaces locally bounding a sigmoidal flattening(?) foliation within Bridge River rocks near the contact suggest southerly directed movement of the Shulaps Complex over the Bridge River Complex. Schiarizza *et al.* (1990a) speculated that this south-dipping fault might be a folded thrust, broadly correlative with the southwest-vergent thrusts that are well displayed beneath the Shulaps Complex in the East Liza Creek window. It is more likely, however, that it is a post-thrusting normal fault, as its present geometry indicates, that is antithetic to the north-dipping Brett Creek fault. This interpretation provides the simplest explanation for omission of the Bralorne-East Liza Complex and Cadwallader Group that are directly beneath the Shulaps Complex where the basal Shulaps thrust is actually exposed near East Liza Creek.

MISSION RIDGE FAULT

The moderately northeast-dipping Mission Ridge fault was first recognized and named by Coleman (1989, 1990) who traced it from Lillooet northwestward almost 40 kilometres to Shulaps Creek. Over this distance it separates rocks of distinctly different metamorphic grade and structural style. The footwall consists mainly of penetratively deformed greenschist-facies schists of the Bridge River Complex, together with Eocene granodiorite of the Mission Ridge pluton. The hangingwall comprises prehnite-pumpellyite grade Bridge River Complex and overlying Cretaceous sedimentary rocks (Unit luKSQ) in the south, and serpentinite mélange of the Shulaps Complex in the north.

Coleman (1990) estimates that the dip of the Mission Ridge fault ranges between 25° and 40° to the northeast on the basis of careful mapping of its surface trace southeast of the Bridge River canyon. There, the fault juxtaposes Bridge River schists and the Mission Ridge pluton in its footwall against low-grade Bridge River Complex and overlying sedimentary rocks of the Silverquick formation; the sedimentary rocks are deformed into a northwest-plunging syncline which is also truncated by the fault. The fault trace crosses the Bridge River about a kilometre west of its confluence with the Yalakom River and continues northwestward, parallel to the Yalakom, to Shulaps Creek. Over this interval it truncates structures of the South Shulaps fault system in its footwall, such that it bounds Bridge River schists of the southern schist domain and northern schist-mélange domain, together with intervening lower grade Bridge River rocks of the Jones-LaRochelle domain. These footwall Bridge River rocks are juxtaposed beneath a relatively thin sliver of Shulaps Complex serpentinite mélange that is exposed southwest of the Yalakom fault. Between the Bridge River and LaRochelle Creek the fault trace follows the base of a distinctive planar slope which dips 30° to 35° northeastward and may be the exhumed fault surface (Coleman, 1990). A northwest-striking fault that is inferred to separate the serpentinite mélange from Bridge River Complex, both in the hangingwall of the Mission Ridge fault, is apparently truncated by, or splays into, the Mission Ridge fault south of the confluence of the Yalakom and Bridge rivers.

North of Shulaps Creek, the trace of the Mission Ridge fault swings to the west and it becomes a relatively steep fault that juxtaposes Bridge River schists against the southern margin of the Shulaps Ultramafic Complex. This fault segment truncates the contact between serpentinite mélange and harzburgite in its hangingwall northeast of Serpentine Lake. Beyond the head of Burkholder Creek the trace swings to the north and extends into the Shulaps Complex. The surface trace of the serpentinite mélange-harzburgite contact is truncated in its footwall east of Shulaps Peak and again in a small half-window 3 kilometres to the north, at the head of Peridotite Creek. There, the fault is marked by a zone of outcrop-scale gently to steeply dipping east-side-down normal faults. Its trace was not established beyond this area, but it is suspected that it may connect with the northeast-striking fault that defines a prominent left-stepping jog in the western margin of the Shulaps Complex; this fault is truncated to the southwest by the easternmost strand of the Quartz Mountain fault system.

The Mission Ridge fault truncates the penetrative foliation in the Bridge River schists and cuts the 47 Ma Mission Ridge pluton (Coleman, 1990). It is inferred to be extensional because it typically juxtaposes relatively high-grade metamorphic rocks in its footwall against low-grade rocks in its hangingwall, and thus marks an omission of crust. This is confirmed by direct kinematic evidence for normal-sense displacement where the fault places Silverquick formation sedimentary rocks against Bridge River schists on the southeast side of the Bridge River canyon. There, Coleman (1990) reports down-dip slickensides within a 5 to 10-metre-wide zone of closely spaced, fault-parallel fractures superimposed on foliation of the Bridge River schists, as well as outcrop-scale normal offsets of bedding over a zone 50 metres wide parallel to the fault in hangingwall Silverquick formation. As noted above, outcrop-scale normal faults also occur along the north-striking segment of the fault within the Shulaps Complex at the head of Peridotite Creek.

Coleman (1990) calculated a pressure of 2.9-3.03 ±0.5 kilobars during the 47.5 Ma crystallization of the Mission Ridge pluton, using aluminum-in-hornblende geobarometry (Hammarstrom and Zen, 1986; Hollister *et al.*, 1987; Johnson and Rutherford, 1989). She used this constraint to estimate a depth of about 15 kilometres, and a heat flow of 90 megawatts per square metre for the Bridge River schists during synkinematic greenschist-facies metamorphism. Assuming the same value of heat flux, she estimated that the prehnite-pumpellyite-grade Bridge River rocks in the hangingwall of the Mission Ridge fault have been buried to depths of no greater than 6 to 10 kilometres. These depth calculations suggest a minimum of 5 to 9 kilometres of vertical omission south of the Bridge River canyon. Coleman assumed that all of this omission resulted from displacement on the Mission Ridge fault, which dips about 30° northeastward, and therefore translates into a minimum of 10 to 18 kilometres of down-dip displacement along the fault. Coleman, however, did not study the structural and metamorphic relationships within the Shulaps-Mission Ridge metamorphic belt, where slightly older Eocene extensional faulting may be inferred for the Brett Creek and South Shulaps fault systems, as described above. Her estimate of vertical omission may therefore represent the cumulative offset on several fault systems, and not just down-dip displacement on the Mission Ridge fault.

The Mission Ridge fault truncates the 47 Ma Mission Ridge pluton as well as ductile fabrics within the Bridge River schists that formed, at least in part, during dextral shear that was operative before, during and after intrusion of the pluton. Development of the pre-Mission Ridge fault ductile fabrics is attributed to Eocene dextral movement along the Yalakom fault system (Coleman, 1990). The west-striking segment of the Mission Ridge fault north of Serpentine Lake is itself cut by a dextral strike-slip fault that is apparently a splay from the Marshall Creek fault; this splay continues northward to also cut the Yalakom fault near the mouth of Blue Creek. The Mission Ridge fault was therefore active both before and after dextral movement along different components of the Yalakom - Marshall Creek - Relay Creek fault system, and is inferred to be an integral part of the overall dextral fault system. The Yalakom, Mission Ridge and Marshall Creek faults are all cut by the Fraser fault system, which in turn is cut by 34 Ma phases of the Chilliwack batholith (Coleman and Parrish, 1991).

EOCENE VERSUS MESOZOIC METAMORPHISM

The distribution of metamorphic facies within the Shulaps-Mission Ridge metamorphic belt presented here does not differ significantly from that of Potter (1983). However, our interpretation of the age and structural setting of the metamorphism differs dramatically from that of Potter, who inferred it to be mainly Mesozoic in age, and related to thrusting of a hot Shulaps ophiolite complex. His interpretation was based largely on inverted metamorphic gradients that he inferred within Bridge River schists beneath the Shulaps Ultramafic Complex in two separate areas: the upper reaches of Fell and Bighorn creeks; and the crest of the Shulaps Range from south of Lake La Mare westward to Brett Creek. The following paragraphs summarize the relationships observed by Potter, and place them in the context of the interpretation preferred here.

Potter (1983, 1986) mapped the southern contact of the Shulaps Ultramafic Complex from the head of Brett Creek eastward to Lake La Mare, and inferred it to be a north-dipping thrust fault across which the ultramafic rocks had been emplaced above the Bridge River Complex. He suggested that metamorphism and ductile deformation in the Bridge River schists are related to an early phase of thrusting, and that later brittle faulting resulted in mixing of serpentinite and Bridge River schists in serpentinite mélange belts that he referred to as the Hog Creek and Eastern imbricate zones. He noted a southward transition from biotite to sub-biotite-grade Bridge River schists northwest of Rex Peak, and interpreted this transition to represent an inverted metamorphic gradient beneath the Shulaps Complex.

The Bridge River schists that Potter mapped beneath his Shulaps thrust belong to the northern schist-mélange domain (Figure 26). Metamorphism and ductile deformation is thought to be Eocene in age, because this belt locally includes abundant foliated granodiorite that is correlated with middle Eocene granodioritic intrusions that were emplaced during metamorphism and associated ductile deformation in the southern schist domain (Coleman, 1990). The eastern part of the fault that Potter mapped as the Shulaps thrust is continuous with Coleman's Mission Ridge normal fault, and the western part is here mapped as the Brett Creek fault. Both faults truncate Bridge River schists and associated Eocene ductile fabrics and drop them beneath the Shulaps Ultramafic Complex. Normal, rather than thrust, movement is documented along the Mission Ridge fault farther south as it corresponds to a significant omission of crust on Mission Ridge (Coleman, 1990). Normal movement is also inferred for the Brett Creek fault, since it carries the Shulaps Complex and structurally underlying Bralorne-East Liza Complex and Cadwallader Group in its hangingwall (Figure 3, Sections I and J), and relationships beyond the Shulaps Range suggest that these assemblages were structurally above the Bridge River Complex in the structural sequence assembled by Cretaceous thrusting. Potter inferred an inverted metamorphic gradient beneath the Shulaps thrust, mainly from relationships northwest of Rex Peak where biotite-grade rocks are structurally above sub-biotite-grade rocks. These rocks are here assigned to the phyllite-schist domain, and are separated from the Bridge River schists directly beneath the Shulaps Complex by the belt of presumably fault-bounded serpentinite mélange of the northern schist-mélange domain (which Potter inferred to be a zone of brittle faulting that postdated synemplacement ductile deformation). The transition from biotite-grade to structurally lower sub-biotite-grade rocks west of Rex Peak is here interpreted to be a thrust fault that can be traced throughout the domain. Furthermore, sub-biotite-grade rocks also occur locally in the upper part of the upper thrust slice, directly beneath serpentinite mélange of the northern schist-mélange domain, so the pattern of decreasing metamorphic grade in structurally lower rocks is inconsistent. Regardless of these details, metamorphism is inferred to be Eocene in age because ductile fabrics in the phyllite-schist domain are similar to those in the southern schist domain, and higher grade metamorphism in part shows a spatial relationship with foliated granodiorite.

In the upper reaches of Fell and Bighorn creeks, Potter (1983) mapped a klippe of ultramafic rocks that is bounded on the northeast by the Mission Ridge pluton, and to the southeast is juxtaposed above Bridge River schists. He documented lower amphibolite-facies metamorphic assemblages within the schists directly below the ultramafic rocks, which pass downward (topographically and structurally) into sub-biotite-grade Bridge River rocks to the southwest. He thus inferred an inverted metamorphic gradient beneath the ultramafic rocks, and interpreted them as an outlier of the Shulaps Complex bounded by the Shulaps thrust.

We have mapped Potter's ultramafic klippe as part of the serpentinite mélange belt of the Jones-LaRochelle imbricate domain. It comprises serpentinite mélange that includes knockers of ultramafic and mafic plutonic rock, amphibolite, and metasedimentary and metavolcanic rock. The belt has been traced for about 14 kilometres, and also includes Potter's "Eastern imbricate belt". The fault beneath the ultramafic rocks is assigned to the South Shulaps fault system and is inferred to be a postmetamorphic Eocene fault because west of Bighorn Creek it bifurcates to enclose a lens of sub-biotite-grade Hurley Formation, and along the divide between Fell and Holbrook creeks it truncates the Mission Ridge pluton (rocks mapped by Potter as Mission Ridge pluton to the north are mainly younger Rexmount porphyry). Furthermore, shear bands at one locality along the Hurley/ultramafic contact suggest normal, rather than thrust movement along the fault system. The presence of lower amphibolite-facies assemblages in the Bridge River schists in upper Bighorn and Fell creeks is consistent with their position within the structurally low part of the southern schist domain, structurally beneath the Mission Ridge pluton. The transition from hornblende-oligoclase-bearing assemblages directly beneath the ultramafic rocks to slightly lower grade upper-greenschist-facies assemblages farther southwest may reflect a transition away from the local heat source provided by the pluton. The contact between biotite-grade and sub-biotite-grade rocks farther to the southwest is not transitional, however, as it occurs across the northeastern strand of the Marshall Creek fault system. This structure was not recognized by Potter, who mapped the Marshall Creek fault as a single strand that truncates the Eocene Jones Creek volcanics; he therefore inferred a metamorphic gradient from lower amphibolite facies to sub biotite-grade over a distance of about 500 metres. The northeastern strand of the Marshall Creek fault is not exposed on the ridges mapped by Potter near Bighorn Creek, but is well defined a short distance to the northwest, where it truncates the Hurley Formation and serpentinite mélange of the Jones-LaRochelle imbricate domain.

In summary, metamorphism within the Shulaps-Mission Ridge metamorphic belt is thought to be Eocene in age and unrelated to Mesozoic thrust emplacement of the Shulaps Ultramafic Complex for the following reasons:

(1) Where dated, metamorphism and associated ductile deformation are synchronous with middle Eocene granodioritic intrusions. Synmetamorphic fabrics are similar throughout the belt, and the highest grade metamorphic rocks are coincident with areas of abundant granodioritic intrusions; thus there is no rationale for inferring an earlier phase of metamorphism (note that this does not preclude an earlier phase of lower-grade metamorphism, which may have been totally overprinted by the Eocene greenschist to amphibolite facies event).

(2) The apparent inverted metamorphic gradients noted by Potter (1983, 1986) are interpreted to be the result of juxtaposition across Eocene normal, thrust, and dextral strike-slip faults of the Yalakom - Marshall Creek system.

(3) A well-exposed thrust contact is preserved at the base of the Shulaps Complex north of the Shulaps-Mission Ridge metamorphic belt, near East Liza Creek, where it is related to sub-greenschist or lower-greenschist-grade metamorphism. Furthermore, the Shulaps Complex is thrust over the Bralorne-East Liza Complex and Cadwallader Group in this area, not the Bridge River Complex. Relationships outside the Shulaps Range indicate that the Bridge River Complex is at a lower structural level, beneath the Cadwallader Group and Bralorne-East Liza complex. This structurally low position is consistent with our interpretation of relationships in the Shulaps Range, where the Bridge River schists are in contact with structurally higher rocks of the Shulaps Complex across a system of Eocene normal faults.

(4) Mid-Cretaceous clastic sequences of the upper Tyaughton basin record contraction-related uplift and erosion of older tectonostratigraphic assemblages, and include detritus derived from the Bridge River Complex, Cadwallader Group and ophiolite complexes. They do not, however, contain detritus derived from the Bridge River schists. This is inconsistent with a postulated origin for the schists as an upper-structural-level aureole directly beneath the Shulaps Complex.

EVOLUTION OF THE SHULAPS-MISSION RIDGE METAMORPHIC BELT

Figure 27 is a schematic model depicting the Eocene structural and metamorphic evolution of the Shulaps-Mission Ridge metamorphic belt. The starting configuration is inferred from the general stacking order established by Cretaceous thrusting; the Shulaps Complex is structurally above the Bralorne-East Liza Complex and Cadwallader Group, which in turn are structurally above the Bridge River Complex. Eocene metamorphism was related to structural level within this thrust stack, and was directly related to intrusion of a suite of Eocene granodioritic plutons into the Bridge River Complex at the base of the succession. This gave rise to a tract of elevated geotherms, with a surface heat flow estimated at 90 mW/m2 by Coleman and Parrish (1991). Biotite-grade rocks developed mainly or exclusively within the Bridge River Complex within and directly above the main locus of Eocene magmatism.

Eocene magmatism and metamorphism were coincident with dextral shear and foliation development within the metamorphic belt, as well as with the formation of macroscopic structures such as the north-dipping faults that imbricate the phyllite-schist domain and separate it from serpentinite mélange of the Jones-LaRochelle imbricate domain. These faults had a component of contraction because they place relatively high metamorphic grade rocks from low in the mid-Cretaceous thrust stack above lower grade rocks higher in the stack. The contractional faulting postdated some of the Eocene magmatism and metamorphism, since metamorphic isograds and bodies of granodiorite are locally truncated by the faults. Intrusion of minor amounts of granodiorite continued after this faulting, however, and generated local areas of elevated metamorphic grade within, for instance, the Jones-LaRochelle serpentinite mélange unit southwest of Rex Peak. Contractional deformation was,

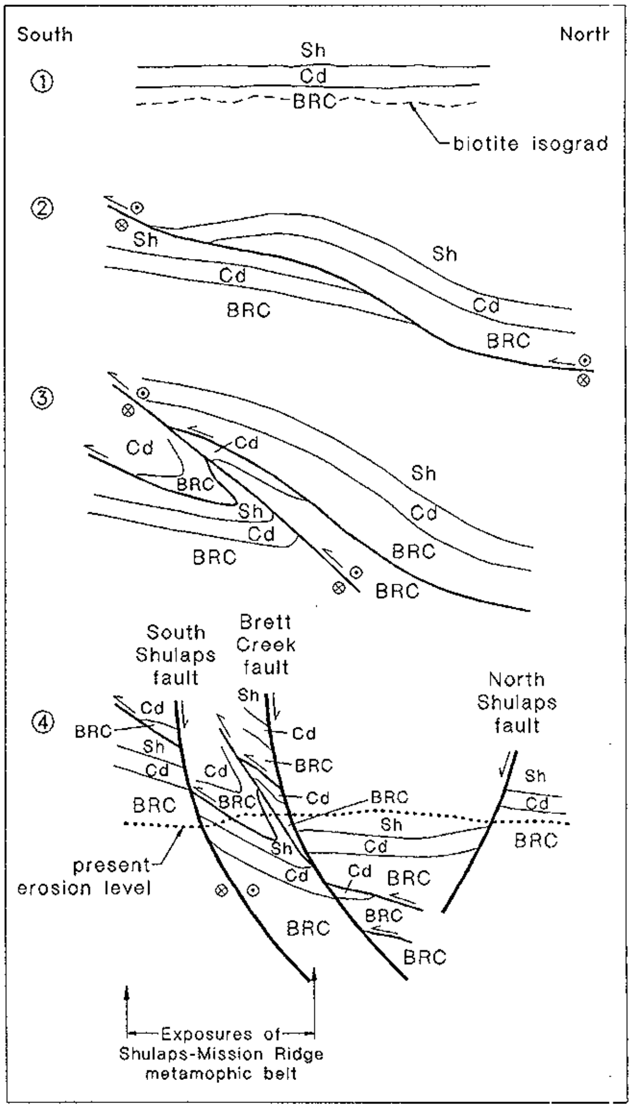

Figure 27. A schematic model depicting the Eocene structural evolution of the Shulaps - Mission Ridge metamorphic belt. BRC=Bridge River Complex; Cd=Cadwallader Group; Sh=Shulaps Ultramafic Complex. To simplify the diagram, Eocene intrusive rocks intruding the Bridge River Complex below the biotite isograd are not shown, and the biotite isograd is not shown in stages 2, 3 and 4.

therefore, broadly synchronous with Eocene granodioritic magmatism and generation of ductile fabrics in the Bridge River schists and associated rocks of the metamorphic belt. Movement along the northerly-dipping contractional faults is therefore inferred to have been parallel to the northwest-plunging stretching lineations; that is, it was markedly oblique, with a strong dextral component.

Continued deformation within the Shulaps-Mission Ridge metamorphic belt resulted in further duplication and thickening, with emplacement of the northern schist-mélange domain obliquely above the previously stacked sequence consisting of the Bridge River phyllite-schist domain over the Jones-LaRochelle imbricate belt. These structures are not well documented, but are inferred to have been transpressional since they were responsible for emplacement of biotite-bearing schists at the highest structural level in the metamorphic belt.

The final stages of deformation within the Shulaps-Mission Ridge metamorphic belt record a change from contractional to extensional deformation, presumably reflecting a change in organization of the bounding dextral fault systems. The earliest extensional structures to form were the South Shulaps fault system, which thins and truncates units that otherwise remain in their original pre-Eocene order of superposition in the lower part of the metamorphic belt, and the Brett Creek fault, which separates the upper part of the belt from the overlying Shulaps Complex. This faulting may have been ductile, in part, and may have been synchronous with extension at the north end of the Shulaps Complex, where the ophiolitic rocks are juxtaposed above low grade Bridge River Complex across the south-dipping North Shulaps fault. Continued extensional deformation gave rise to the brittle Mission Ridge normal fault, which in turn was superseded by at least some normal-component movement on the Marshall Creek fault system. Because the Mission Ridge fault is cut by a dextral splay from the Marshall Creek fault, all of the extensional faulting affecting the Shulaps-Mission Ridge metamorphic belt is inferred to have occurred within a regime of regional dextral strike-slip, and many of the faults may actually be transtensional in nature. In this regard, the preferred westerly strike of most of the early extensional faults is enigmatic with respect to the expected direction of extension within a northwest striking dextral fault system. It may be that the strong east-west anisotropy generated during the earlier phase of transpression exerted a fundamental control on the orientation of later transtensional structures.

RELAY CREEK FAULT SYSTEM

The Relay Creek fault system has been traced from the headwaters of Relay Creek southeastward about 40 kilometres to Liza Lake (Figure 25). Its continuation to the northwest is obscured by Miocene basalts capping the Dil Dil Plateau along the northern boundary of the map area. To the southeast it is truncated by the more northerly trending Quartz Mountain fault system.

The Relay Creek fault system defines the southwestern boundary of a steeply dipping, northeast-facing panel of Taylor Creek Group rocks that locally includes slivers of older Relay Mountain Group rocks immediately adjacent to the fault. This northeast-facing succession was traced from Big Creek southeastward about 35 kilometres to Noaxe Creek, where it is truncated by the Quartz Mountain fault system. Along upper Relay Creek, the panel is juxtaposed against southwest-facing Taylor Creek strata on the northeast limb of the Red Hill syncline and, locally, against a narrow fault-bounded lens of southwest-facing Relay Mountain Group. To the southeast, it is juxtaposed against southwest-facing Relay Mountain Group on the northeast limb of the Teepee Mountain syncline.

South of Paradise Creek, the Relay Creek fault bifurcates into two main strands that enclose a strongly imbricated lozenge of mainly Bridge River rocks that attains a maximum width of about 4 kilometres where it crosses Noaxe Creek. The northeastern splay separates the Bridge River rocks from the northeast-facing panel of Taylor Creek Group rocks described above. The southwestern splay of the Relay Creek fault juxtaposes the Bridge River lens against Taylor Creek Group and Silverquick formation over most of its length, but places it against Cadwallader Group, Bralorne-East Liza Complex and Bridge River Complex in the vicinity of Liza Lake, where it truncates structures of the Liza Lake thrust belt. The southwestern splay of the Relay Creek fault is marked by a narrow belt of serpentinite containing knockers of mainly Bridge River rock-types at the confluence of Relay and Tyaughton creeks, and by a sliver of listwanite-altered serpentinite northwest of Liza Lake. It is apparently truncated by the southern end of the Quartz Mountain fault system between Liza and Marshall lakes, although it is almost collinear with the Marshall Creek fault to the southeast.

The western segment of the Relay Creek fault is not well exposed, but its linear trace, and the generally steep dips of adjacent rock units, suggest that it dips steeply. Outcrops along or near the inferred trace of the northeastern splay near Mud and Noaxe creeks are commonly cut by steeply dipping, northwest-striking fault surfaces with gently plunging striations and mineral fibres, indicating predominantly strike-slip movement. Mesoscopic, northwest-striking strike-slip faults are also common within and adjacent to serpentinite defining the southwestern splay of the Relay Creek fault near the confluence of Mud, Relay and Tyaughton creeks. However, the fault system does not mark any distinct offsets that allow an estimate of displacement along it.

PRENTICE LAKE FOLD SYSTEM

The Prentice Lake fold system consists of 3 faulted folds that occur within a wide northwest trending belt of Taylor Creek Group strata that outcrops along and northeast of Relay Creek (Figure 3). This belt is bounded by the Relay Creek fault system to the southwest, the Yalakom fault to the northeast, and the Quartz Mountain fault system to the southeast.

The most conspicuous fold within the Prentice Lake system is a large doubly-plunging syncline (the Prentice Lake syncline) that is outlined by the Taylor Creek volcanic unit and cored by the Beece Creek succession. The northern limb of the syncline includes rocks of the Lizard and Dash formations that are truncated by the Yalakom fault. Its southern limb is folded through an additional anticline-syncline pair that were mapped between Dash Hill and Prentice Lake. The axial traces of these folds are truncated to the southeast by a pair of northwest-striking faults, but the fold limbs persist to the Quartz Mountain fault system as three fault-bounded panels defined by opposing facing directions within the Lizard Formation.

The folds of the Prentice Lake system might have formed during mid-Cretaceous contractional deformation, or they might be related to an early phase of transpressional deformation along the Yalakom fault system. The faults that merge with the axial traces of the folds and define the fold limbs over much of the belt are likewise not well dated.

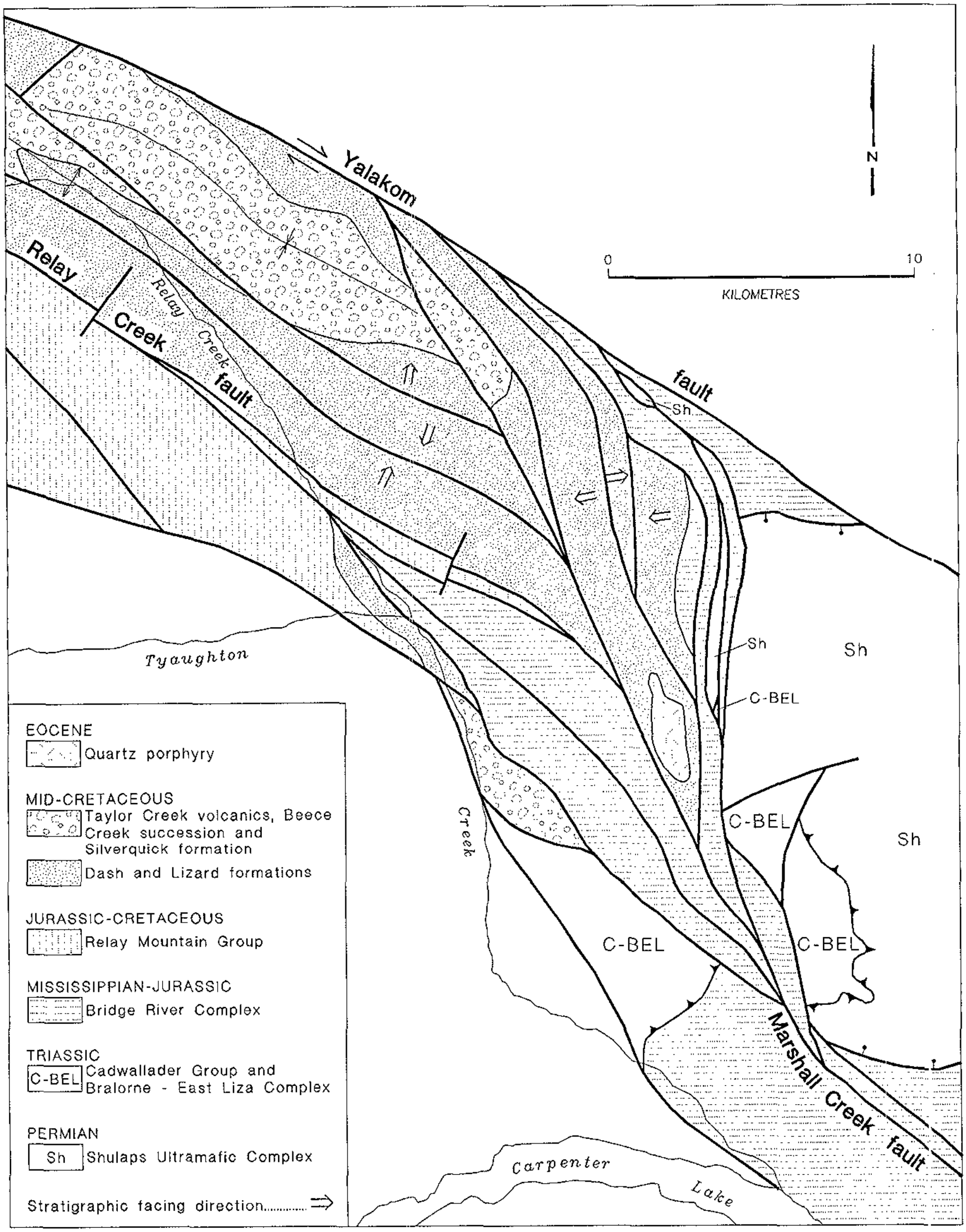

Figure 28. Simplified map of the Quartz Mountain and Relay Creek fault systems and the Prentice Lake fold belt.

Their parallelism with the Yalakom and Relay Creek fault systems suggests, however, that they may have been active during movement on the bounding systems.

QUARTZ MOUNTAIN FAULT SYSTEM

The Quartz Mountain system comprises a set of subparallel north to northwest-striking faults that emanate from the northwest end of the Marshall Creek fault at Marshall Lake, then follow a sigmoidal trace before merging with the Yalakom fault in the vicinity of Mud Lakes (Figure 28). The fault system truncates the Shulaps Complex to the east and the Relay Creek fault system and Prentice Lake fold system to the west; it attains a maximum map width of about 6 kilometres near Quartz Mountain.

Eastern strands of the Quartz Mountain fault system enclose narrow belts of Bridge River Complex, together with fault-bounded lenses of Shulaps serpentinite mélange, Bralorne-East Liza Complex, Cadwallader Group and Taylor Creek Group. Western strands cut the Taylor Creek Group and separate it into 3 main panels with opposing facing-directions. The easternmost panel includes a basal slice of Bridge River Complex that may be in stratigraphic contact with the overlying Taylor Creek Group.

Northerly-striking faults comprising the eastern part of the Quartz Mountain fault system were locally observed along the western margin of the Shulaps Complex. They are near vertical and locally contain oblique, moderately north-plunging mineral fibres. Parallel, northerly striking faults are common within the adjacent Cadwallader Group, Bralorne-East Liza Complex and Shulaps serpentinite mélange near East Liza Creek, where they record oblique movement, with components of mainly west-side-down dip-slip and dextral strike-slip (Macdonald, 1990). Dextral displacement within the Quartz Mountain system is corroborated by two different fault-bounded lenses of serpentinite mélange that were apparently displaced from the western margin of the Shulaps Complex (Figure 28). The largest, southern lens was traced from east of Big Sheep Mountain northward to Grizzly Bear Lake. Restoration of this lens southward to the corresponding serpentinite mélange cutoff along the margin of the main part of the Shulaps Complex suggests a minimum of 8 kilometres of dextral displacement. This restoration also matches a thin lens of Hurley Formation at the south end of the displaced serpentinite mélange unit with the extensive belt of Hurley Formation underlying Shulaps serpentinite mélange at East Liza Creek. The other displaced lens of serpentinite mélange outcrops one kilometre northeast of Quartz Mountain. Some translation may have occurred along the same fault that displaced the southern lens, but restoration of the northern lens to the northwestern corner of the Shulaps Complex, south of the North Shulaps fault, suggests that a minimum of 4 kilometres of additional displacement occurred along the easternmost strand of the fault system.

The map pattern (Figure 28), together with local observations indicating dextral and normal components of movement, suggest that the Quartz Mountain fault system forms an extensional transfer zone linking the dextral Marshall Creek and Yalakom faults. The western part of the Quartz Mountain system is symmetrical with the southern part of the Prentice Lake fold system in that it comprises Taylor Creek rocks divided into two west-facing panels by an intervening panel of east-facing rocks. Further symmetry is provided by the Bridge River complex, which dominates the eastern part of the Quartz Mountain system and also bounds the Prentice Lake fold system to the southwest. This suggests that the panels of opposing facing direction within the Taylor Creek Group of the Quartz Mountain fault system are relicts of the southern part of the Prentice Lake fold system. It is inferred that they were rotated into their present position by several stages of movement on progressively west-stepping strands of the eastern part of the strongly curved Quartz Mountain fault system (Figure 29), in much the same way that hangingwall anticlines form above curved normal faults (Hamblin, 1965). The space created to the southwest by this displacement and rotation may have been filled by a complimentary zone of uplift which gave rise to the adjacent lens of Bridge River Complex that occurs between the two main strands of the Relay Creek fault system. This inference is supported by the fact that the widest part of the Bridge River lens occurs adjacent to the widest part of the Quartz Mountain fault system, whereas the northwestern termination of the Quartz Mountain system along the Yalakom fault is almost directly opposite the termination of the Bridge River lens within the Relay Creek fault system.

LATE CRETACEOUS - PALEOGENE STRUCTURAL EVOLUTION

The sequential development of Late Cretaceous to Paleogene structures related to dextral strike-slip in the Taseko - Bridge River area is shown schematically in Figure 30 and summarized below in terms of 4 time periods.

LATE CRETACEOUS

The oldest dextral strike-slip faults mapped within the area comprise the Castle Pass fault system. These faults cut the mid-Cretaceous Silverquick formation as well as northeast-vergent structures of the Late Cretaceous North Cinnabar fold-fault system. The southern part of the Castle Pass fault system follows a broad z-shaped trace, and is the site of numerous latest Cretaceous intermediate to felsic intrusions which may have been localized by this extensional bend in the system. The largest of these intrusions, the 67 Ma Eldorado pluton, appears to be cut by the Castle Pass fault but shows only minor displacement and therefore is inferred to have crystallized during the latest stages of faulting. Most of the movement on the Castle Pass system occurred, therefore, in the latter part of the Late Cretaceous. Movement may also have occurred along the Yalakom fault system at this time, as indicated by late-stage movement within the Shulaps serpentinite mélange, which occurred during emplacement of synkinematic dikes that may correlate with the 77 to 70 Ma Blue Creek porphyries.

EARLY TO MIDDLE EOCENE

Early to Middle Eocene deformation involved the Yalakom, Fortress Ridge and Chita Creek fault systems. The Fortress Ridge fault cuts the Castle Pass system and is linked to the Chita Creek fault by a left-stepping transfer zone that is presently evident as a narrow zone exposing lower stratigraphic levels than adjacent areas to the northeast and south-

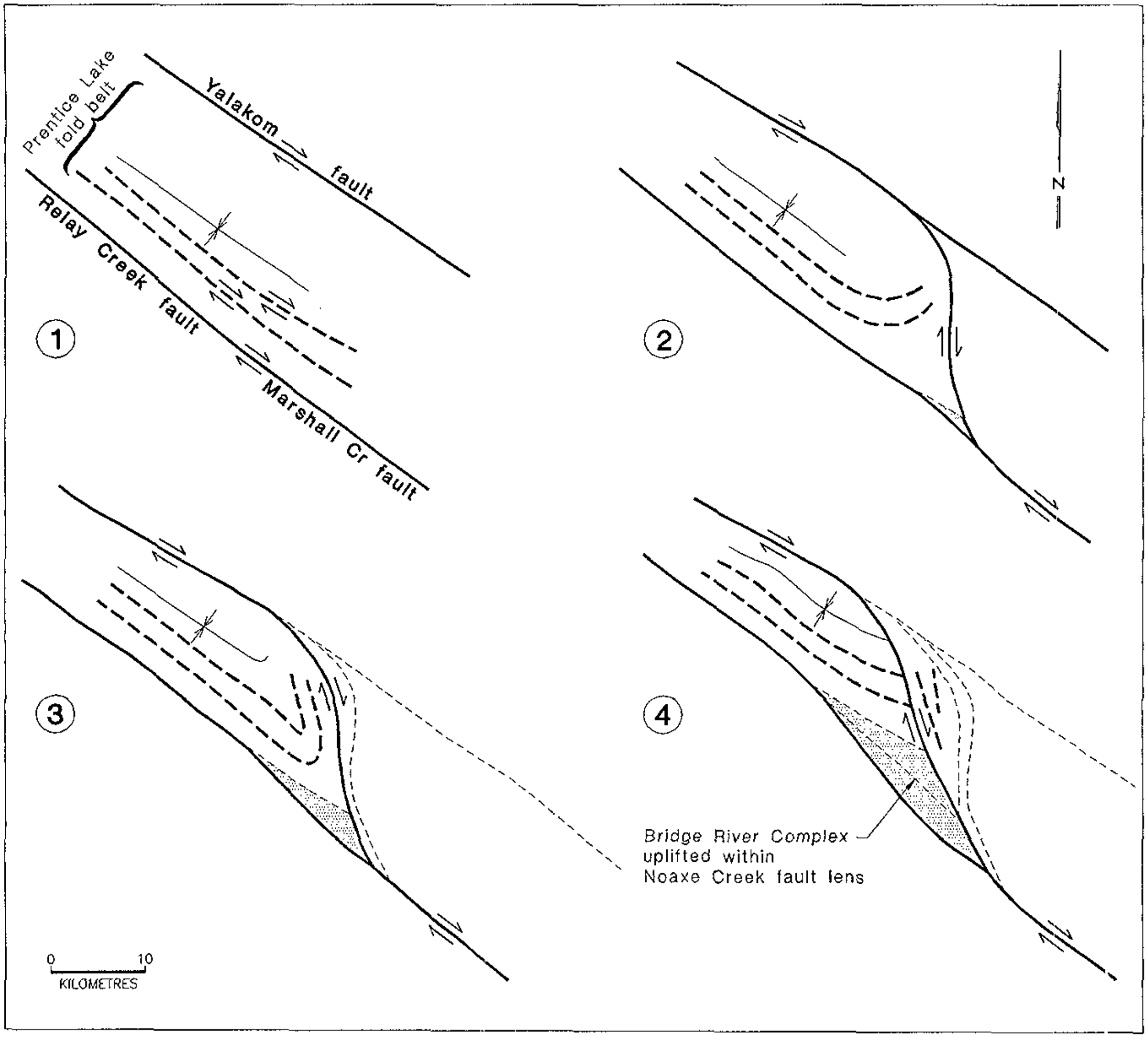

Figure 29. A schematic model depicting the structural evolution of the Quartz Mountain - Relay Creek fault system. Faults that ceased to be active in younger stages are shown as narrow dashed lines.

west. The Fortress Ridge fault may have been linked to the Yalakom fault to the southeast via the zone of transpressional deformation within the Shulaps-Mission Ridge metamorphic belt. This deformation is indicated on a mesoscopic scale by predominantly northwest to north-dipping shear foliations that contain mainly gently northwest-plunging stretching lineations; dextral shear along the stretching direction consequently has a component of north-side-up or contractional movement. On a macroscopic scale, the contractional component involved emplacement of the phyllite-schist domain above the Jones-LaRochelle imbricate domain, and elevation of the northern schist-mélange domain to the highest structural level presently exposed within the metamorphic belt. Transpressional deformation within the Shulaps-Mission Ridge metamorphic belt was in part synchronous with intrusion of the Mission Ridge pluton and associated dikes, which yield 48.5 to 46.5 Ma crystallization ages. Intrusion of the lithologically similar Beece Creek and Lorna Lake plutons occurred during coeval deformation along the Fortress Ridge - Chita Creek fault systems to the west. Both of these intrusions have yielded 44 Ma cooling ages, identical to a cooling age obtained from the Mission Ridge pluton.

Although some Eocene movement from the southern Yalakom fault was transferred to the Shulaps-Mission Ridge metamorphic belt and Fortress Ridge - Chita Creek fault systems, the northwestern part of the Yalakom fault was also active during Early to Middle Eocene time. Evidence for this comes from the Tatla Lake metamorphic complex, which is bounded on the southwest by the Yalakom fault (*see* Figure 31). Friedman and Armstrong (1988) docu-

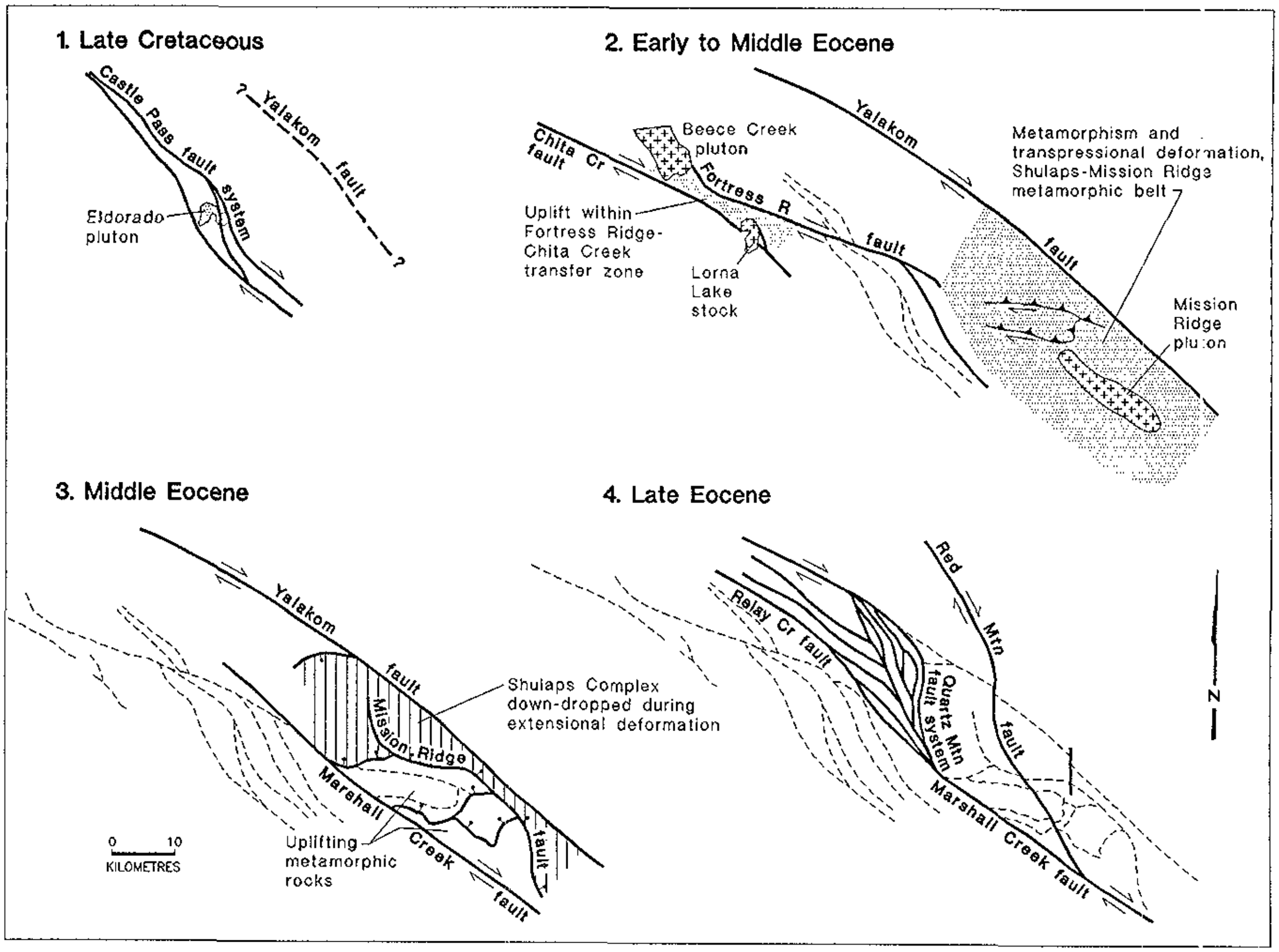

Figure 30. A model for the Late Cretaceous - Paleogene structural evolution of dextral strike-slip fault systems in the Taseko - Bridge River map area. Faults that ceased to be active in younger stages are shown as narrow dashed lines.

ment 55 to 47.5 Ma extensional shear along sub-horizontal west-northwest trending mineral lineations within the mylonite zone that comprises the upper part of the complex, followed by folding and brittle faulting during the final stages of uplift. Although they implicate the Yalakom fault only in the post-ductile deformation phase of folding and brittle faulting, the earlier ductile strain is also kinematically compatible with dextral slip along the Yalakom system. The Yalakom fault has not been mapped beyond the Tatla Lake Complex but we infer that it, or a kinematically linked extensional fault segment, extends north-northwestward from there to mark the western limit of a belt of metamorphic tectonites that are locally exposed beneath an extensive cover of Quaternary alluvium and Late Tertiary volcanics (Tipper, 1969b). As thus defined, the Yalakom fault system traces a pronounced right-stepping bend that is kinematically congruent with west-northwest-directed extensional unroofing of the Tatla Lake Metamorphic Complex and the less well studied tectonites to the north. We therefore infer that this part of the Yalakom fault was active during 55 to 47 Ma ductile extensional deformation within the Tatla Lake metamorphic complex, as also suggested by Coleman and Parrish (1991) and Struik (1993). This Early to Middle Eocene stage of deformation along the Yalakom fault may be responsible for most of the more than 100 kilometres of displacement documented along it. However, a component of Late Cretaceous or Paleocene displacement cannot be ruled out, and movement on the northwestern part of the system probably continued into the Late Eocene.

MIDDLE EOCENE

Early to Middle Eocene plutonism, metamorphism and transpressional deformation within the Shulaps-Mission Ridge metamorphic belt was followed by uplift and unroofing. The most conspicuous fault involved in this unroofing is the brittle Mission Ridge normal fault. The older Brett Creek and South Shulaps faults may, however, have played an equally or more important role that has been largely obscured by the younger faulting. The Shulaps Complex, the highest structural element of the mid-Cretaceous thrust stack, is preserved as a downdropped block bounded by this extensional fault system in the south, and by the presumably coeval south-dipping North Shulaps fault to the north. The 43.6±2.4 Ma biotite K-Ar date reported for the Mission Ridge pluton (Woodsworth, 1977; Wanless *et al.*, 1978)

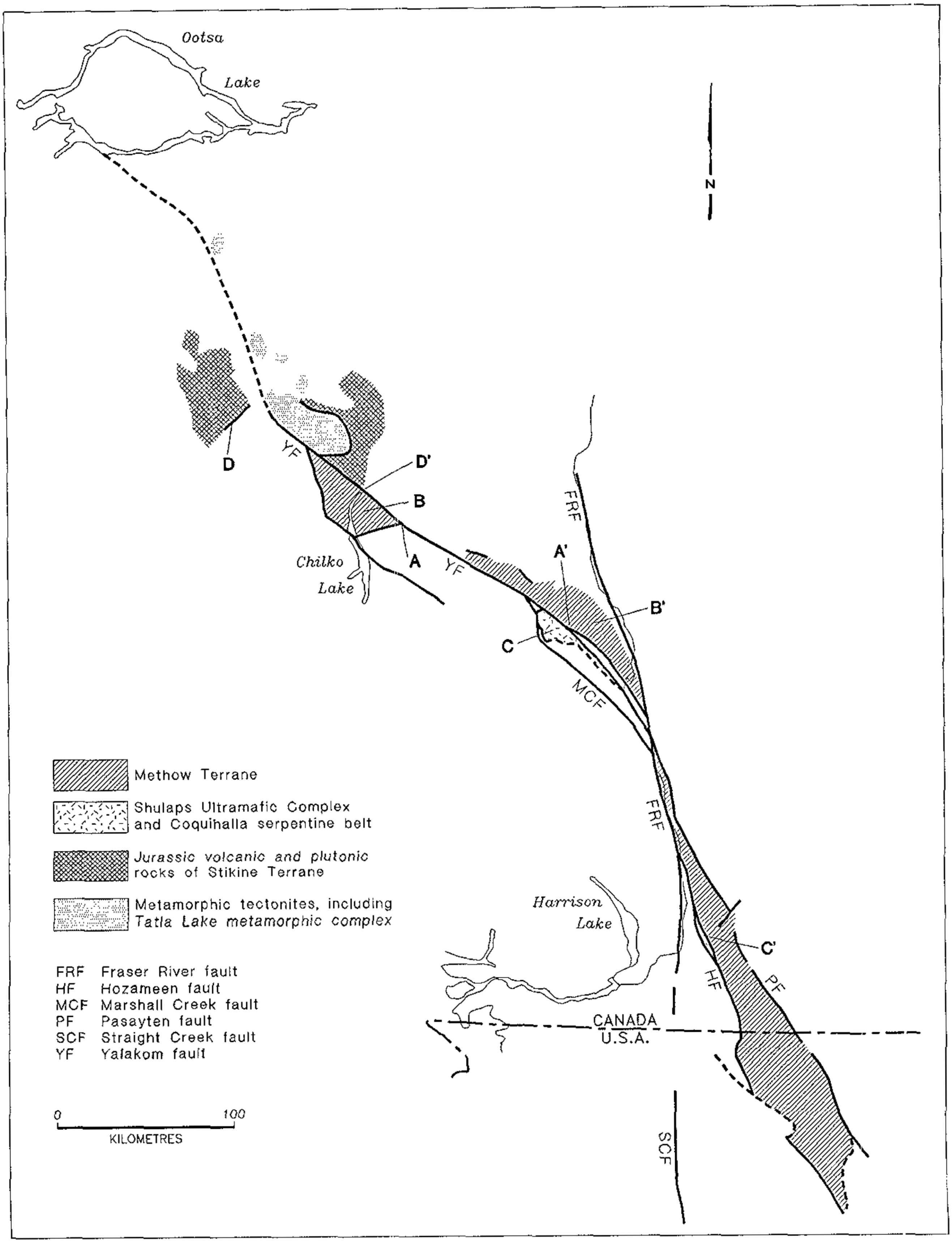

Figure 31. Map of the Yalakom - Hozameen fault system showing correlations used for estimating dextral strike-slip displacement.

suggests that extensional unroofing had been accomplished by the end of the Middle Eocene. The abrupt change from transpressional to extensional (or transtensional) deformation within the Shulaps-Mission Ridge metamorphic belt may have corresponded to a significant reorganization of the bounding strike-slip faults. We suggest that it reflects the initiation of the Marshall Creek fault as an important component of the strike-slip system, with consequent development of a right-stepping transfer zone between it and the northwestern part of the Yalakom fault. Extension was localized within this transfer zone, which just a few million years earlier had been the locus of plutonism, high heat flow and crustal thickening in a transpressional setting.

LATE EOCENE

The final stage in the evolution of the major dextral strike-slip faults in the map area involved the development of the Quartz Mountain fault system within the extensional transfer zone linking the Marshall Creek fault and the northwestern segment of the Yalakom fault. The Relay Creek fault was probably also active at this time, as indicated in Figure 30. The southeastern segment of the Yalakom fault, the Mission Ridge fault and structures within the Shulaps-Mission Ridge metamorphic belt were all inactive as they are cut by the dextral-slip Red Mountain fault. The latter fault is linked to this time interval as it also splays off the Marshall Creek fault and mimics the sigmoidal pattern of the Quartz Mountain system. Southwest-side-down displacement on the Marshall Creek system may have been synchronous with dextral strike-slip, or may reflect a later history of normal movement. The timing of this latest stage of movement along the Yalakom -Marshall Creek - Relay Creek system is not well constrained, but it post-dates 46.5 Ma deformation within the Shulaps-Mission Ridge metamorphic belt, as well as later normal movement along the Mission Ridge fault. It either predates or is synchronous with movement on the Fraser fault system (depending on whether the Marshall Creek fault merges with, or is truncated by, the Fraser fault), which is cut by the 34 Ma Chilliwack batholith.

DISPLACEMENT ON THE YALAKOM FAULT SYSTEM

The Yalakom - Hozameen fault system has been mapped for a total strike-length of about 400 kilometres (Figure 31), and dextral offset of more than 100 kilometres has been postulated by several workers, based on a number of different correlations (Tipper, 1969; Kleinspehn, 1982, 1985; Riddell *et al.*, 1993). The most compelling displacement estimate for the Yalakom fault is provided by Riddell *et al.*, who match the Methow Terrane/Cadwallader Terrane/Bridge River Complex structural succession exposed northeast of the confluence of the Yalakom and Bridge rivers with the same tripartite structural succession exposed near Konni Lake (Figure 31, points A and A'). The former area contains the only exposures of Cadwallader and Bridge River terranes known northeast of the Yalakom fault, and the latter area contains the only well documented exposures of Methow terrane southwest of the fault. In addition, internal structural and stratigraphic features within the individual elements of this three-fold structural succession provide further evidence for their correlation. These include:

(1) The internal stratigraphy of Methow Terrane, which consists of virtually identical Middle Jurassic to Lower Cretaceous rocks of the Yalakom Mountain facies.

(2) The internal stratigraphy of Cadwallader Terrane which in each area comprises Upper Triassic Hurley Formation overlain by Jurassic shale and siltstone here assigned to the Junction Creek unit.

(3) A similar abrupt change in structural style observed in both areas, comprising homoclinal Methow terrane strata juxtaposed against Cadwallader terrane rocks deformed by overturned folds and thrust faults.

In the Camelsfoot Range, Methow and Cadwallader terranes are separated by the Camelsfoot fault, and Cadwallader and Bridge River terranes are separated by the lowest thrust fault mapped within the Camelsfoot thrust belt. The faults bounding the correlative structural succession near Konni Lake were not observed, but are constrained to within one or two kilometres where they abut the Yalakom fault. The dextral offset derived from matching the Camelsfoot fault with its northern counterpart (which occurs within the valley of Konni Lake) is 113 kilometres (Figure 31, points A and A'), whereas that derived from matching the faults separating Cadwallader and Bridge River terranes is 116 kilometres. The thrust fault separating Cadwallader and Bridge River terranes in the Camelsfoot thrust belt dips moderately to the northeast, whereas the Camelsfoot fault is thought to dip steeply northeast. The close correspondence between the apparent offsets of the two different faults suggests that they provide a fairly reliable estimate of actual horizontal displacement.

Kleinspehn (1982, 1985) studied the Jackass Mountain Group in the Camelsfoot Range and at the north end of Chilko Lake. She found that the Chilko Lake exposures, southwest of the Yalakom fault, comprise an inner to mid-fan facies very similar, but perhaps slightly more distal, to those in the Camelsfoot Range. She suggested that the two belts of exposures were initially parts of one continuous fan system that was displaced by 150±25 kilometres of dextral offset along the Yalakom fault (Figure 31, points B and B'). This correlation is equivocal by itself, as less well studied exposures of Jackass Mountain Group occur along much of the northeast side of the Yalakom fault between the Camelsfoot Range and Chilko Lake, and it is possible that some of these could provide an equally compelling match for the Chilko Lake exposures. However, it is supported by the Camelsfoot fault correlation described above, because the Jackass Mountain Group is one component of the offset Methow Terrane succession.

An independent estimate of displacement along the Yalakom - Hozameen fault system is provided by correlation of the Shulaps Ultramafic Complex with the Coquihalla serpentine belt that outcrops east of Hope (Figure 31, points C and C'). This correlation is based on the lithologic similarity of Shulaps serpentinite mélange with the Coquihalla belt, which comprises serpentinite with gabbro knockers

(Ray, 1986). Furthermore, the Shulaps Complex is the most easterly-derived element of the mid-Cretaceous thrust stack exposed southwest of the Yalakom fault, and therefore has a similar pre-Yalakom structural position to the Coquihalla belt, which is inferred to represent the upthrust basement to Methow Terrane (Ray, 1986). The main part of the Coquihalla serpentine belt is a lens, 18 kilometres long and locally more than two kilometres wide, that is exposed between two strands of the Hozameen fault system. As the western strand (West Hozameen fault) is considered the regionally more significant of the two (Ray, 1986), the Coquihalla belt and Shulaps Complex are effectively on opposite sides of the Yalakom - Hozameen fault, and provide a potential measure of offset along it. As indicated by points C and C' in Figure 31, the two ultramafic complexes can be juxtaposed by restoring 90 to 125 kilometres of dextral displacement along the Yalakom-Hozameen fault, which must first be restored to a single fault strand by removing about 72 kilometres of dextral offset along the Fraser fault. Although the Shulaps-Coquihalla correlation is considered sound, the apparent dextral offset must be viewed with some reservation because thin lenses and slivers of serpentinized ultramafic rocks occur along much of the Yalakom - Hozameen fault system and there are no unequivocal piercing points (the 90 and 125 kilometre estimates are based on restoring the Coquihalla lens opposite the southern and northern portions of the 55-kilometre-long Shulaps Complex respectively). Furthermore, because relationships in the Shulaps Range suggest that the ophiolitic rocks were originally emplaced as thrust sheets on low-angle faults sub parallel to the strike-slip fault system, vertical movement along the fault system may contribute significantly to the apparent offsets. Nevertheless, the lower (90 kilometres) estimate matches closely with the expected displacement when it is taken into account that offset of the Shulaps Complex from the Coquihalla belt does not include the component of displacement that has been transferred to the northwestern segment of the Yalakom fault from the Marshall Creek fault system. Considering this, the offset should be somewhat less than that derived from the Camelsfoot - Konni Lake correlation.

Tipper (1969a) suggested correlation of Middle Jurassic sedimentary rocks near Ashcroft with those of the Taseko Lakes and Mount Waddington areas, indicating possible dextral displacements of 80 to 190 kilometres along the Yalakom fault. This correlation is based on the fact that both successions contain Middle Jurassic sedimentary rocks without interlayered volcanics, an uncommon feature in rocks of that age west of the Rocky Mountains. More recent work does not support this correlation, however, since the Ashcroft Formation was deposited on the Upper Triassic Nicola Group of Quesnel terrane while the Last Creek formation was deposited on Upper Triassic rocks of Cadwallader Terrane. Furthermore, even if they correlated, the Ashcroft Formation outcrops about 50 kilometres northeast of the Yalakom-Hozameen fault system and therefore does not provide a piercing point on which to base estimates of offset. Tipper also postulated 130 to 190 kilometres of dextral offset to match Middle Jurassic volcanic rocks northeast of the Yalakom fault in the Mount Waddington map area with similar rocks in the Anahim Lake and Bella Coola map areas. The more recent map of Wheeler and McFeely (1991) shows the southeastern limits of the respective outcrop belts of Jurassic volcanic and associated plutonic rocks (part of Stikine terrane) to be separated by 80 to 120 kilometres along the Yalakom fault (Figure 31, points D and D'). This correlation is consistent with the 115 kilometres of displacement estimated from the Camelsfoot - Konni Lake correlation, but the distribution and contact relationships of the respective belts are not well enough constrained to provide an independent estimate of offset.

STRUCTURE OF METHOW TERRANE

Structures described earlier in this chapter occur along or to the southwest of the Yalakom fault. Deformation within Methow Terrane northeast of the Yalakom fault is markedly less complex. Large areas of homoclinally disposed strata dominate, but are locally deformed by northeast-striking faults and east-trending folds, both of which may be related to dextral movement along the Yalakom fault system (Figure 32). The structural pattern also includes east-striking sinistral faults that occur adjacent to, and may be related to, the Camelsfoot fault.

EAST-STRIKING SINISTRAL FAULTS

Three separate east-striking faults cause sinistral offsets of Methow Terrane strata between Applespring and Beaverdam creeks (Figure 3). The southernmost fault was observed on the ridge west of Applespring Creek, where it is marked by more than 50 metres of rusty weathered, strongly fractured and veined, carbonate-altered rock. Mesoscopic fault surfaces within this zone strike easterly, dip steeply, and contain gently plunging carbonate fibres and striations. Calcite veins are variably oriented, but most strike northeast and dip steeply. This suggests sinistral movement on the associated faults, which is consistent with the apparent westward shift of Unit lKJMy2 on the north side of the fault zone. The fault zone was not recognized within the Camelsfoot thrust belt to the west, and is presumed to be truncated by the Camelsfoot fault.

Another east-striking fault is inferred to cause a 1 kilometre sinistral offset of the contact between the lower and upper units of the Jackass Mountain Group (Yalakom Mountain facies) between Ore and Junction creeks. The fault was not observed, but apparently passes through an area of rusty, carbonate-altered rubble on the ridge west of the head of Grouse Creek (the major creek between Ore and Junction creeks). Steeply dipping east-striking faults, commonly marked by tens of centimetres of brecciated rock, were noted at several places to the north, within 500 metres of the inferred trace of the fault. Some of the faults contain gently west-plunging striations, and rotation of bedding along one fault indicates sinistral movement.

The third east-striking sinistral fault occurs east of Beaverdam Creek. It was not observed, but occupies a prominent saddle and adjacent east and west-sloping gullies along the ridge east of the creek, where it separates Unit lKJMy2 on the north from Unit lKJMy1 to the south. Sinistral offset of the stratigraphic contact between these two units is apparently in excess of 2 kilometres, but is also dis-

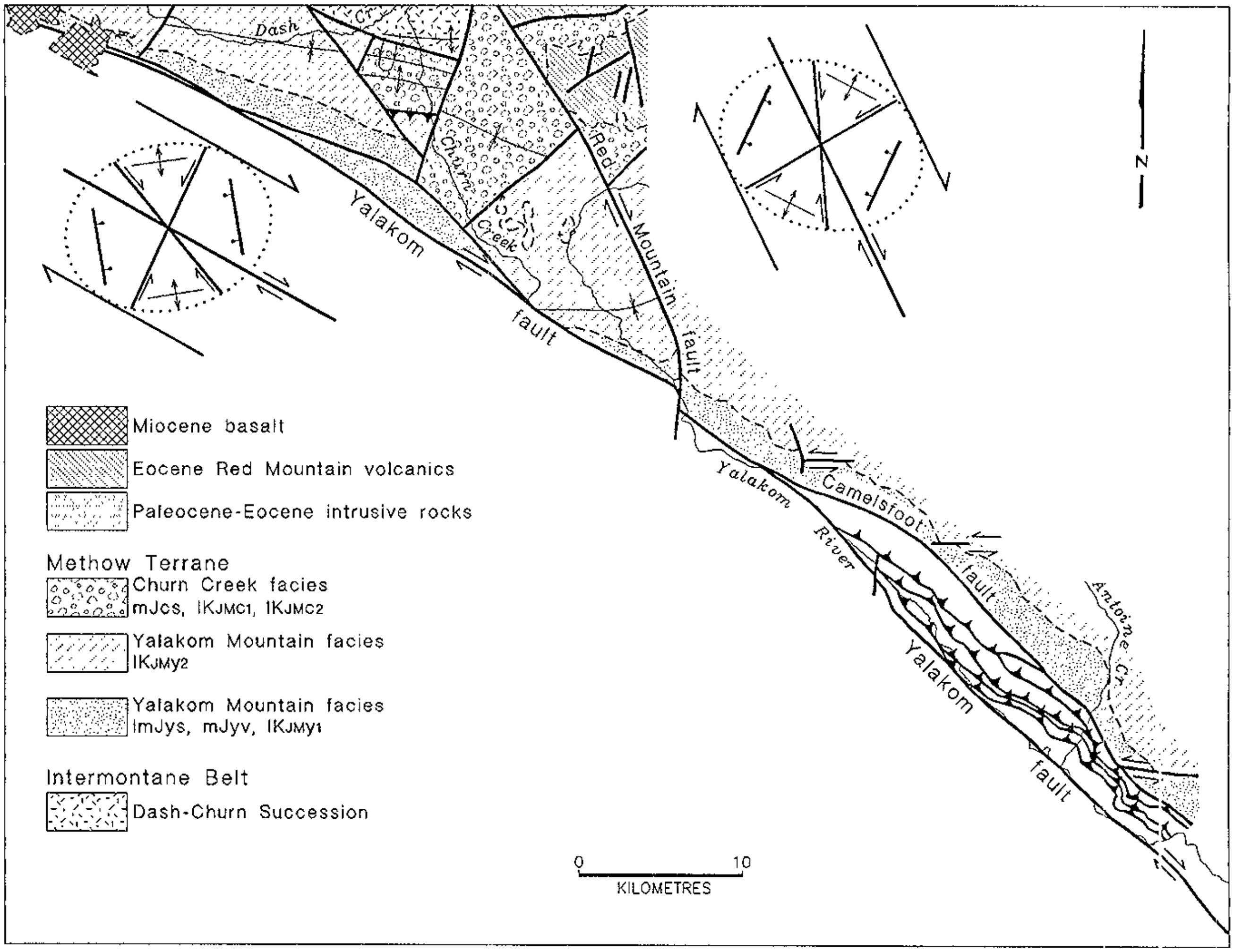

Figure 32. Simplified map summarizing the structure of Methow Terrane. Strain ellipses show the expected orientations of subsidiary structures related to dextral faulting along the Yalakom and Red Mountain faults, according to the simple shear model of Wilcox *et al.* (1973).

placed by a dextral-slip, north-striking fault along Beaverdam Creek (Figure 3).

The three east-striking sinistral faults mapped within Methow Terrane occur adjacent to the Camelsfoot fault (Figure 32); no similar structures were seen northwest of the termination of the Camelsfoot fault at Beaverdam Creek. Easterly striking sinistral faults are also documented within Methow Terrane rocks to the south, at the confluence of the Bridge and Fraser rivers. There, the sinistral faults and associated structures fit a strain ellipse suggesting left-lateral slip on the adjacent major fault, which Miller (1987, 1988) referred to as the Yalakom fault, but which we correlate with the Camelsfoot fault (*see* earlier section on Camelsfoot fault). The distribution of east-striking sinistral faults immediately adjacent to the Camelsfoot fault corroborates Miller's inference that they relate to movement along the main fault. Furthermore, a sinistral component of movement has been documented along faults within the Camelsfoot thrust belt, directly southwest of the Camelsfoot fault. These relationships suggest that the Camelsfoot fault has a component of sinistral movement, and probably formed during the middle to early Late Cretaceous contractional regime. It, together with the zone of east-striking sinistral faults on its northeast side, and the Camelsfoot thrust belt on its southwest side, is truncated by the Yalakom fault, which was the focus of Eocene dextral strike-slip displacement.

NORTHEAST AND NORTH-NORTHEAST-STRIKING FAULTS

West of Buck Mountain, the Churn Creek facies of the Jackass Mountain Group is separated from Yalakom Mountain facies to the west by a north-northeast-striking fault (Figure 3). The fault was not observed, but is apparently truncated to the south by the Swartz Lake splay of the Yalakom fault; to the north it extends into the large drift-covered area between Churn Creek and Red Mountain. The same belt of Churn Creek facies rocks is separated from the Yalakom Mountain facies to the southeast by a northeast-striking fault that to the south is also truncated by the Swartz Lake splay of the Yalakom fault. This fault is apparently offset by the Red Mountain fault in the upper reaches of the Yalakom River, beyond which it continues northeastward along a northern tributary of Davey Jones Creek. The fault was not seen in the field, but rocks near its inferred trace along Poisonmount Creek are cut by steeply dipping northeast-striking faults containing gently plunging striations, and it corresponds to about 10 kilometres of apparent left-lateral offset of the Churn Creek facies belt. Outcrop-scale strike-slip faults of similar orientation are common at the west end of Nine Mile Ridge and along the southwest-flowing tributary to the Yalakom River north of the ridge, where they typically have left-lateral offsets. Two mesoscopic faults associated with a northeast-striking fault that is defined by an abrupt change in facing direction in Yalakom Mountain facies rocks along Davey Jones Creek, however, have dextral offsets of local markers.

The Eocene Red Mountain volcanic succession overlies the Churn Creek facies of the Jackass Mountain Group in the northeastern corner of the study area. These rocks are in part bounded by the dextral-slip Red Mountain fault on the west. They are cut by several north-northeast-striking normal faults, by north-northwest-striking faults subparallel to the Red Mountain fault, and by a single prominent northeast-striking fault. The latter fault is parallel to the northeast-striking fault that marks the southeastern limit of the Churn Creek facies, and the north-northeast-striking faults are parallel to the fault that marks the western boundary of the Churn Creek facies west of Buck Mountain. This suggests that the faults bounding the Churn Creek facies may be coeval with those cutting the Red Mountain volcanics, and therefore be Eocene or younger in age. Furthermore, when compared to an ideal strain ellipse related to dextral strike-slip on the Red Mountain fault, the north-northeast-striking faults match the expected orientation of normal faults while the northeast-striking structures match the expected orientation of antithetic left-lateral strike-slip faults (Figure 32). The Red Mountain fault formed during the latter stages of development of the Yalakom - Marshall Creek - Relay Creek fault system, and was probably coeval with the Quartz Mountain system that forms a transfer zone between the Marshall Creek and Yalakom faults farther west. The north-northeast and northeast-striking faults bounding Churn Creek facies and cutting overlying Red Mountain volcanics are therefore interpreted as Middle to Late Eocene structures that formed late in the structural evolution of the Yalakom - Marshall Creek - Relay Creek fault system.

EAST-TRENDING FOLDS AND THRUST FAULTS

An east-trending syncline occurs within the Jackass Mountain Group north of the Shulaps Ultramafic Complex, where it is outlined by exposures of Unit lKJMy2 turbidites between Evelyn and Yalakom creeks. This fold is truncated by the Yalakom fault to the west and, apparently, by the Red Mountain fault to the east. Twenty-five kilometres to the northwest, an east-trending syncline is inferred from opposing dip and facing directions within Unit lKJMy2 on either side of Dash Creek. This fold is along trend from a syncline in the lower unit of the Churn Creek facies at the confluence of Lone Valley and Churn creeks. The latter syncline is bounded by a complimentary anticline to the south, and the south limb of the anticline is overlain by Yalakom Mountain facies across a moderately south-dipping thrust(?) fault that is well exposed along Churn Creek. Farther east, the hinge of an easterly trending syncline is inferred within Unit lKJMc2 in the poorly exposed area east of Churn Creek, as underlying Unit lKJMc1 is exposed to both the north and south. Farther east, Unit lKJMc2 is overlain by the Red Mountain volcanics. It dips and faces southward on the north side of the volcanics, whereas the few exposures seen south of the volcanics dip mainly to the north. This suggests that the unit is also folded through a syncline in this area; it is not known if the Red Mountain volcanics are folded into the core of this syncline, or unconformably overlie it.

The east-trending folds and thrust faults described above are post-Albian in age and may also post-date the Eocene Red Mountain volcanics. Their orientation and spatial relationship to the Yalakom fault indicate that they may comprise part of a right-handed fold set (Campbell, 1958; Wilcox *et al.*, 1973) related to dextral movement along the fault (Figure 32).

HUNGRY VALLEY FAULT

Tipper (1978) showed the northern boundary of Jackass Mountain Group exposures within and adjacent to the map area as a south-dipping thrust fault referred to as the Hungry Valley fault. North of Red Mountain, the west-trending Hungry Valley fault separates the Churn Creek facies of the Jackass Mountain Group from Eocene(?) volcanic rocks which outcrop along the northern edge of the map area (Figure 3). This probably represents a relative south-side-up vertical displacement of several hundred metres, but the fault is not exposed and its dip is unknown. The fault is apparently truncated on the west by the Red Mountain fault, which was active in Middle to Late Eocene time.

To the west, the Hungry Valley fault is a northwest-striking structure that marks the southern limit of the Dash-Churn succession. It is closely constrained by outcrops along Churn Creek, where it juxtaposes Unit KDC3 against Churn Creek facies of the Jackass Mountain Group, and along Dash Creek, where it separates Unit KDC1 from Yalakom facies of the Jackass Mountain Group. Along Churn Creek, strongly fractured rocks of the Jackass Mountain Group adjacent to the fault are cut by northwest-striking, predominantly steeply dipping fault surfaces that locally carry gently plunging slickensides. These features indicate strike-slip movement along this part of the fault zone. The sense of movement was not established, but the fault truncates an east-plunging anticline within the Dash-Churn succession to the north which, if it formed during faulting, would suggest dextral movement along the fault. The fault is apparently truncated by a north-northeast-trending fault in the drift-covered area east of Churn Creek, which in turn is cut by the Swartz Lake splay of the Yalakom fault.

NORTHEAST-STRIKING FAULTS SOUTHWEST OF THE YALAKOM FAULT

Steep faults that strike northeast, at a high angle to the well-defined structural grain, occur locally within the map area. Those northeast of the Yalakom fault were described in the previous section, and are interpreted to be related to relatively late stages in the evolution of the Yalakom fault system. Southwest of the Yalakom fault, northeast to north-northeast-striking faults were identified only as short segments that cause minor offsets of older northwest-trending structures. They are most common between Mud and Graveyard creeks, where several faults cause local offsets of the Relay Creek fault system, the Red Hill and Teepee Mountain synclines, and the Elbow Mountain thrust belt. Most of these faults have apparent dextral offsets, but nowhere was the actual sense of movement established. A zone of northeast-trending faults was also mapped northwest of Mount Sheba; they offset the Tertiary volcanics and the Chita Creek fault.

Regionally, northeast-striking faults that offset northwest-trending structures occur locally within the eastern Coast Belt both to the northwest and south of the study area. In the northwest, they are inferred to have mainly normal displacements (Tipper, 1969a; McLaren, 1990), although some are interpreted as anthithetic sinistral faults related to the Yalakom system (Schiarizza, 1996). To the south, they form prominent features along the western margin of the eastern Coast Belt between Harrison and Lillooet lakes. There, they were the locus of dextral transcurrent displacement and were in part coeval with the emplacement of a suite of Oligocene-Miocene plutonic rocks (Journeay and Csontos, 1989).

The lower unit of the Relay Mountain Group exposed between the Fortress Ridge and Chita Creek faults at Lorna Lake is in contact with the younger Taylor Creek Group to the northwest and southeast across northeast to north-northeast-trending faults (Figure 3). These structures are apparently truncated by the Fortress Ridge and Chita Creek faults, so they may be older than other northeast-striking faults in the area. They may be approximately coeval with the bounding faults, and related to uplift of the Relay Mountain block that they enclose within the left-stepping Fortress Ridge - Chita Creek transfer zone. Alternatively, they may be older transverse faults (tear faults?) within the mid-Cretaceous thrust and fold belt (Umhoefer, 1989).

THE HELL CREEK FAULT

Roddick and Hutchison (1973) mapped a northwest-trending Recent fault within the southern Shulaps Range near the head of Hell Creek. It was not examined during the present study, but was traced for about 5 kilometres (Figure 3) on aerial photographs. It occurs within Bridge River schists and adjacent granodiorite along and near the northeastern margin of the Mission Ridge pluton, where it is marked by a prominent linear trace and northeast-dipping scarp several metres high. Recent movement along the structure is indicated by its clear expression in unconsolidated Quaternary deposits and the minimal erosion of the scarp.

The Hell Creek structure was examined by Clague and Evans (1994), who argued for a gravitational rather than tectonic origin based, in part, on its close association with antislope scarps and deep-seated landslides. It was investigated in more detail during a recent paleoseismic study of the Bridge River area conducted by B.C. Hydro, due to its prominent geomorphic expression and proximity to the Terzaghi dam. On the basis of this study, Psutka (1995) concluded that it is a tectonic feature that was the locus of oblique dextral-normal displacement during two and possibly three episodes of Holocene activity. The first event occurred between 12 000 and 8600 years BP, the second between 6900 and 2400 years BP, and a third, minor event may have postdated the 2300 to 2400 year-old Bridge River ash.

CHAPTER 4
MINERAL OCCURRENCES

HISTORICAL BACKGROUND

The Taseko - Bridge River map area includes the northern part of the Bridge River mining camp, British Columbia's foremost historical gold producer. Mineral exploration dates from shortly after the first discovery of placer gold in the lower Fraser River in 1858, when prospectors on their way to the Cariboo found that Bridge River gravels yielded considerable coarse gold for several kilometres upstream from the Fraser River. The best claims were along the lower part of the Bridge River near its confluence with the Yalakom River, from which nuggets of up to 62 grams (2 ounces) were recovered (Dawson, 1889). A heightened level of prospecting up-river led to additional discoveries: gold was discovered in the gravels of Gun Creek in 1859 and shortly thereafter at Hurley River and Cadwallader Creek (McCann, 1922).

Soues (1897) first noted that the gold found in the Bridge River was unmistakably different from that found in the Fraser River bars, and had a strong resemblance to the gold found in placers at Bendigo, Victoria, Australia: the gold still had imbedded pieces of quartz matrix and had obviously not traveled very far from its lode source. Analogous to the discovery of the gold lodes of the Ballarat and Bendigo districts by placer tracing, Soues suggested careful prospecting of tributaries in the upper parts of the Bridge River watershed for the *in situ* lode sources.

The first mineral claims were located in the summer of 1896: the Forty Thieves and Ida May claim groups were staked on the east bank of the Hurley River just below the mouth of Cadwallader Creek. Word of spectacular samples taken from the veins on these claims prompted a staking rush early the next spring which included the staking of 55 claims on Tyaughton Creek, 175 claims on Cadwallader Creek, and 190 on the Bridge and Hurley rivers (Soues, 1898). By 1896, lodes containing significant concentrations of silver, lead and copper were also known, and cinnabar-bearing float had been found (Soues, 1897), initially in placers and later during surface prospecting.

Between 1897 and 1900 many of the more important properties in the Bridge River area were located, including the Lorne, Ben d'Or, Pioneer and Wayside claim groups, confined mainly to the "free-milling" belt of diorite-greenstone along the east side of Cadwallader Creek and the Hurley River. These veins were at first worked on a small scale but claims were eventually amalgamated to form more viable mining operations. Only the highest grade auriferous quartz veins were of interest at the time, owing to the region's remote location.

Significant lode gold production in the Bridge River mining camp did not begin until the late 1920s and early 1930s, when major underground operations commenced at the Bralorne and Pioneer mines, just to the south of the Taseko - Bridge River project area. Operations ceased in 1971, by which time the two mines had yielded a little more than 7 million tonnes of ore grading about 18 g/t Au and 4 g/t Ag (Harrop and Sinclair, 1986; Leitch, 1989). This accounts for most of the gold produced in the Bridge River camp, although some production occurred between 1933 and 1940 at the Minto, Wayside, Gloria Kitty and Congress mines, located in the southwestern part of the project area.

The Bridge River mining camp has also produced small quantities of mercury and tungsten, mainly from veins and disseminations along shear zones located within the lower part of the Tyaughton Creek drainage basin. Most of this production occurred in the 1930s and 1940s.

The country to the north of the Bridge River valley was less accessible, and in the late 1800s received only sporadic attention, initially focused on placer exploration at the upper reaches of the Yalakom River and Tyaughton and Gun creeks. The first recorded expeditions into these territories were by P.H. Ward and H. Gould (Soues, 1887) who set out from Big Bar in the summer of 1886 and traversed the country from Ward Creek to Red Mountain and the headwaters of the Yalakom River, and west to Castle Peak and Eldorado Mountain in search of quartz "ledges", or veins. According to their descriptions, the "ledges" that intrigued them most were probably silicic alteration zones or bedded ribbon chert which they traced for several kilometres along strike; the lack of precious metals, however, discouraged any follow-up investigations.

With increased exploration activity in the Bridge River region, access improved and new trails penetrated the little-explored terrain at the upper reaches of Gun and Tyaughton creeks and over watershed divides into the drainage basins of the Taseko River and Big Creek. The first reports of potential mineral wealth in this area described extensive surficial limonite (bog iron) deposits in the Taseko River region, staked in 1911 (Bateman, 1912). Subsequent prospecting revealed numerous base and precious metal prospects in this area. Early activity focused on precious metals, and included a small amount of gold production from the Taylor-Windfall occurrence in the mid-1930s and early 1950s. Beginning in the 1950s, however, the northern part of the project area has also been explored extensively for porphyry copper-molybdenum occurrences. The main focal points of this exploration have been the Taseko River area (McMillan, 1983; Osborne and Allen, 1995), the Poison Mountain prospect at the headwaters of Churn Creek (Seraphim and Rainboth, 1976; Brown, 1995), and the upper reaches of Relay Creek (Dawson, 1981, 1982a).

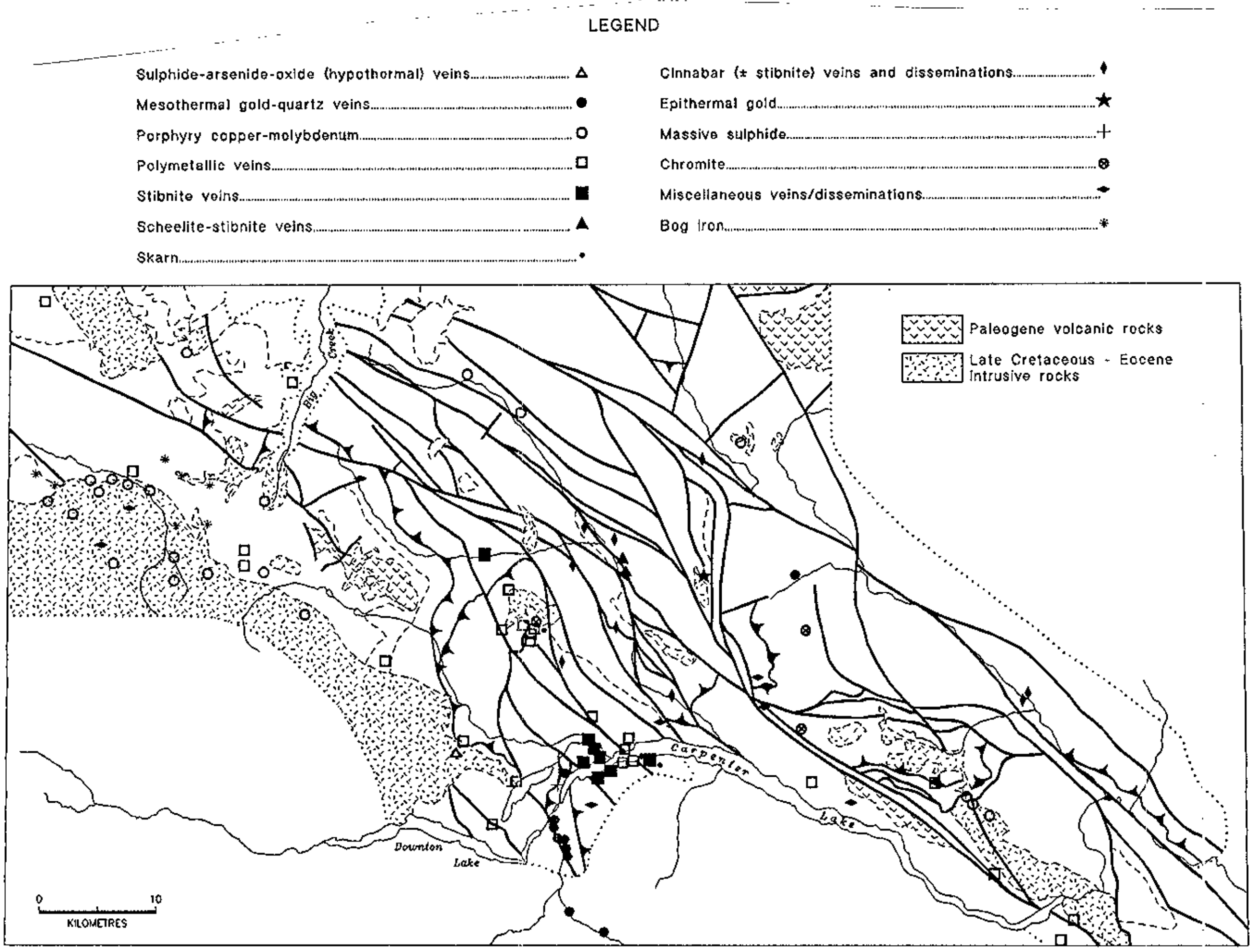

Figure 33. Metallic mineral occurrences (excluding placer gold) in the Taseko - Bridge River map area.

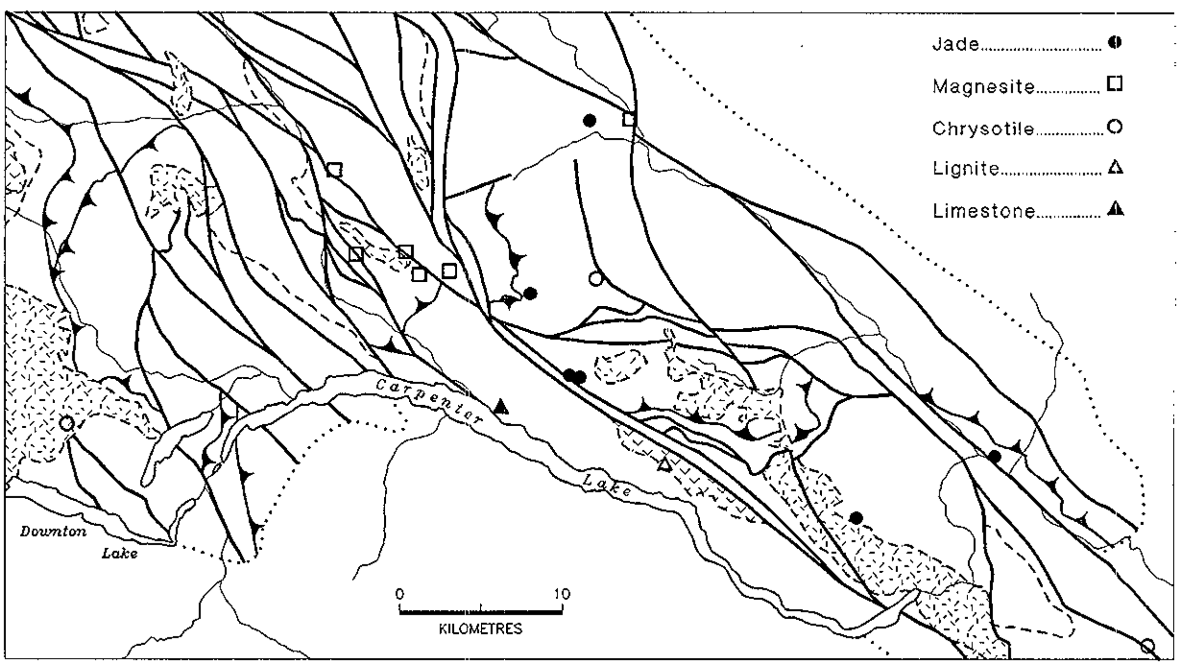

Figure 34. Nonmetallic mineral occurrences in the Taseko - Bridge River map area.

MINERAL DEPOSIT TYPES

INTRODUCTION

A wide variety of mineral deposit types are represented in the Taseko - Bridge River area; these are summarized in Table 1 and Figures 33 and 34. More precise locations of individual occurrences are shown on Figure 3 (in pocket), and the geological characteristics of all known mineral occurrences in the area are briefly outlined in Appendices 9 through 12. These data are abstracted from the British Columbia Geological Survey Branch MINFILE database, which has been revised and updated for this area during the course of the project.

Most of the gold produced in the Bridge River mining camp was from mesothermal gold-quartz veins in the Bralorne - Gold Bridge area. The principal producing veins are north-northeast-dipping shear veins that record oblique reverse-sinistral movement. These vein systems are, at least in part, bounded by faults of the Eldorado fault system that display similar reverse-sinistral movement. The vein systems and bounding faults formed in early Late Cretaceous time, during the later stages of the protracted episode of Early to Late Cretaceous contractional deformation. Texturally similar veins also comprise the Elizabeth-Yalakom prospect within Blue Creek porphyry in the Shulaps Range; these, however, are distinctly younger and are of uncertain structural affinity.

Porphyry-style mineralization is widespread in the study area, where it is associated with intrusive rocks ranging from mid-Cretaceous to mid-Eocene in age. The main belt of porphyry occurrences is along the northeastern margin of the extensive mass of Late Cretaceous granodiorite (the Dickson - McClure batholith) underlying the southwestern part of the area; this batholith also hosts the area's single occurrence of hypothermal sulphide-arsenide-oxide mineralization. To the northwest, porphyry occurrences are associated with smaller, isolated mid-Cretaceous (upper Relay Creek) to mid-Eocene (Mission Ridge pluton and Lorna Lake stock) intrusions. These include the Late Paleocene to Early Eocene Poison Mountain deposit, which is the only mineral occurrence known in the area that is northeast of the Yalakom fault.

The Taylor-Windfall vein occurrence is within an extensive belt of altered Powell Creek volcanics that occurs north of the Dickson - McClure batholith and its associated porphyry copper occurrences in the western part of the area. The alteration and metallic mineral assemblages suggest that this belt formed under conditions transitional between a porphyry and epithermal setting (Price, 1986; Panteleyev, 1992). Similar alteration and vein mineralization occurs northeast of the batholith in the Warner Creek area, 12 kilometres to the southeast

An important belt of polymetallic veins, including the Minto mine, extends from south of Carpenter Lake northwestward to beyond Eldorado Mountain. These prospects are associated with a belt of latest Cretaceous to Paleocene intrusive rocks that are thought to have been localized by an extensional bend in the Castle Pass strike-slip fault system. This belt also includes abundant stibnite vein occurrences, which may be a higher level expression of the polymetallic veins, as well as rare skarn occurrences. Polymetallic veins also occur elsewhere in the area, including the margins of the southern part of the Late Cretaceous Dickson - McClure batholith, and along the margin of the Middle Eocene Mission Ridge pluton; in each area they are inferred to be broadly contemporaneous with the associated plutonic rocks.

Cinnabar (±stibnite) veins and disseminations occur along the Fortress Ridge, Relay Creek and Yalakom dextral strike-slip faults, which were active during the Eocene. These occurrences do not have any apparent spatial relationship to intrusive rocks. Scheelite-stibnite veins are also found along the Relay Creek fault, but are restricted to an area of abundant syn-faulting feldspar porphyry dikes.

Epithermal gold-silver mineralization occurs on Big Sheep Mountain, in altered rhyolite that caps a feldspar porphyry pluton of probable Eocene or younger age.

Metallic mineral occurrences that are syngenetic with pre-Cretaceous rocks are of relatively minor importance in the Taseko - Bridge River area. These include narrow lenses of massive chromite that are known in three separate ultramafic units: the Shulaps harzburgite unit at the head of Peridotite Creek (Leech, 1953); serpentinite structurally interleaved with the Bridge River Complex east-southeast of Marshall Lake (Leech, 1953); and serpentinized peridotite of the Bralorne-East Liza Complex south of Eldorado Mountain (Drysdale, 1916). The serpentinite that hosts the latter occurrence also contains disseminated pentlandite and pyrrhotite less than a kilometre to the north (Church and MacLean, 1987c); a grab sample of this material assayed 0.32 per cent nickel, 0.28 per cent chromium and trace amounts of cobalt. Other occurrences that are of probable pre-Cretaceous age include disseminated chalcopyrite in gabbro and greenstone of the Bralorne-East Liza Complex (*e.g.* Shulaps Copper showing near East Liza Creek) and massive sulphide mineralization that is associated with the Bridge River Complex north of Gold Bridge (the New Discovery occurrence, Morris, 1985). These occurrences may indicate the potential for volcanogenic massive sulphides and related syngenetic deposits within the oceanic plutonic-volcanic successions of the area; this potential exploration target may have been largely overlooked due to the abundance of younger vein occurrences within the area.

The Taseko - Bridge River area also contains a number of nonmetallic mineral occurrences (Figure 34). Listwanite-altered ultramafic rocks are common along many of the major dextral faults of the area (Photo 61), and have been explored for their magnesite content at several places along the Yalakom, Relay Creek and Fortress Ridge fault systems (Grant, 1987). Nephrite jade occurs at several locations in the Shulaps Range, and also as boulders in Bridge River alluvium that may have been derived from the Shulaps Range. The *in situ* occurrences are in both Shulaps serpentinite mélange and in lenses of serpentinite within the Bridge River Complex. They are associated with Cretaceous-Tertiary intrusions of the Blue Creek and Rexmount porphyries. Shulaps serpentinite mélange also hosts two of the three chrysotile occurrences in the area; the other is in a

TABLE 1
SUMMARY OF MINERAL DEPOSIT TYPES, TASEKO - BRIDGE RIVER MAP AREA

DEPOSIT TYPE	DEPOSIT CHARACTER	POTENTIAL COMMODITIES	DOMINANT METALLIC MINERALS	TEXTURES & STRUCTURES	ASSOCIATED ALTERATION
Porphyry (magmatic)	stockwork, veins, disseminations, breccia infillings	Cu, Mo (Au)	ccp, py, mo; bn, cc, cv, gn, sp, mt, [apy, sch, po]	stockwork, breccia, disseminations	argillic, propylitic, biotite, sericite
Sulphide-arsenide-oxide (hypothermal) veins	veins, lenses, disseminations	Co, Au, U; Mo	dn, lo, sfl, apy; mo, ur, ery, skt [sch, native Au]	massive lenses of coarse crystalline sulphide-arsenide-oxide minerals partly intergrown with host granodiorite; disseminations	sericite, argillic
Low-sulphide (mesothermal) gold-quartz veins	quartz veins, lenses (low sulphide content)	Au, Ag; W (Pb, Zn)	py, apy; sp, gn, po, ccp, tet, sti, sch, mar, native Au [tel]	shear veins; quartz ribboned with laminations and partings of sulphidic chlorite-sericite and altered slivers of wallrock; generally massive milky quartz with very rare vugs	carbonate, silica, sericite
Polymetallic veins (upper-mesothermal)	veins, lenses (high sulphide content)	Au, Ag; Pb, Cu, Zn	apy, py, sp, ccp, gn; sti, jm, tet, ten, po, eng [native Au, native Bi, tel]	complex multiphase veins; banding defined by alternating metallic minerals and quartz-ankerite gangue; breccia textures; rare vugs; veins occupy fractures, shears, dike contacts	carbonate, silica
Scheelite-stibnite veins (meso-epithermal: telescoped?)	irregular branched veins	W (Sb, Au)	sch, sti [cn]	symmetrically banded, crustified veins with comb-textured quartz and scheelite; zoned; veins occupy branched fractures	quartz-carbonate-mariposite (listwanite)
Stibnite veins (epithermal)	irregular pods and discontinuous veins and replacements	Au, Ag, Sb (Cu)	sti, py, apy; sp, tet, cn, km [native Au]	banded veins; brecciated; comb-textured vuggy quartz, fine-grained massive to coarsely bladed stibnite; disseminations in wallrock; replacement textures	carbonate, silica, pyrite
Cinnabar veins and disseminations (epithermal)	veins, disseminations	Hg	cn; sti [native Hg]	veins, disseminations, fracture infillings, fracture coatings	quartz-carbonate-mariposite (listwanite), carbonate

DEPOSIT TYPE	DEPOSIT CHARACTER	POTENTIAL COMMODITIES	DOMINANT METALLIC MINERALS	TEXTURES & STRUCTURES	ASSOCIATED ALTERATION
Disseminated (epithermal) gold	disseminations; veinlets	Au, Ag	py; tet, lm	vuggy, breccia textured, limonitic fracture coatings; rare quartz druses and amethyst veinlets	argillic
Massive sulphide	stratiform lenses	Cu, Zn; Au (Ag)	py, ccp, sp; gn, po [Au]	disseminated to massive pods and lenses, partly layered	chlorite
Placer gold	alluvial	Au	detrital native Au	angular to well-worn and flattened gold dust and nuggets	
Placer gold	eluvial	Au	native Au	angular crystalline fragments and sponge-like particles of native gold	
Bog iron (precipitate)	surficial deposits	Fe	lm	laminated to bedded limonite, overlain by crumbly pulverulent earthy limonite	oxidation, leaching
Skarn (hydrothermal)	irregular contact - replacement bodies; stratabound	Au; Ag	po, mt, py, ccp	massive, irregular	calc-silicate, silica
Nephrite jade (hydrothermal)	tabular to podiform lodes; also as alluvial boulders	nephrite jade		massive to partly foliated, botryoidal forms	serpentinization, calc-silicate
Chrysotile	Fracture surface slip-fibres	chrysotile		fibrous strands along slip surfaces	serpentinization
Chromite (magmatic)	podiform; disseminated	Cr	chr	sheared podiform; disseminated	
Magnesite (hydrothermal)	veins, pods, lenses; irregular replacement bodies	magnesite		banded crystalline comb-textured veins, pods, lenses; massive accumulations; replacement textures	quartz-carbonate - mariposite (listwanite), carbonate
Limestone (sedimentary)	irregular lenses, pods	limestone		massive, crystalline layers and blocks	
Lignite coal (sedimentary)	narrow, discontinuous stratiform lenses	lignite coal		bedded lenses within carbonaceous shale	

Abbreviations: apy = arsenopyrite, bn = bornite, cc = chalcocite, ccp = chalcopyrite, chr = chromite, cn = cinnabar, cv = covellite, dn = danaite, ery = erythrite, eng = enargite, gn = galena, jm = jamesonite, km = kermesite, lm = limonite, lo = loellingite, mar = marcasite, mo = molybdenite, mt = magnetite, po = pyrrhotite, py = pyrite, sch = scheelite, sfl = safflorite, skt = skutterudite, sp = sphalerite, sti = stibnite, tel = telluride, ten = tenantite, tet = tetrahedrite, ur = uraninite

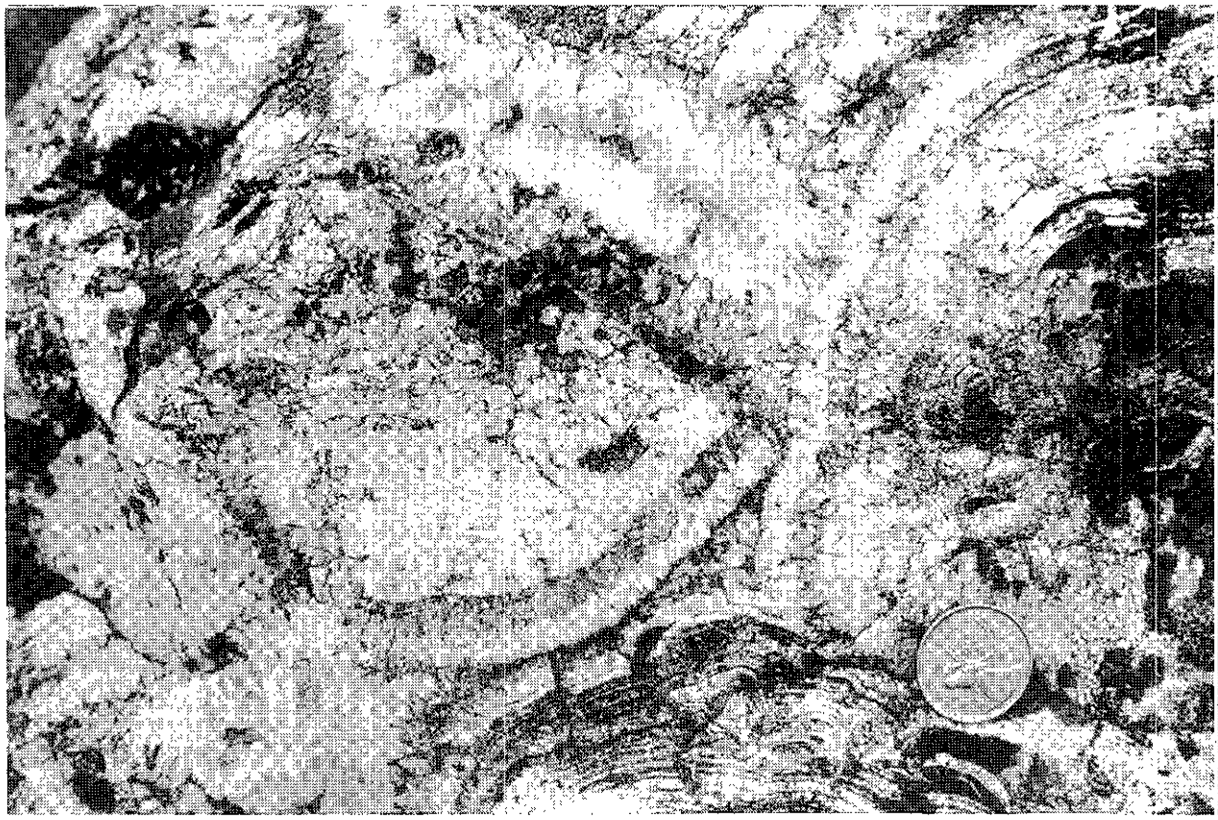

Photo 61. Magnesite-quartz-altered rock along the Yalakom fault, south of Blue Creek.

serpentinite pendant within the Dickson - McClure batholith north of Mount Penrose. Other nonmetallic occurrences that have received some attention include narrow lenses of lignite coal in Eocene sedimentary rocks of the Jones Creek succession (Robertson, 1911) and a large lens of limestone within the Bridge River Complex on the south slopes of Marshall Ridge (Drysdale, 1917).

The youngest mineral occurrences in the area are Quaternary in age, and include deposits of placer gold and bog iron. The bog iron deposits occur within and adjacent to the Taseko river valley in the western part of the study area (Figure 33), and are described in detail by MacKenzie (1921a). They comprise sheets of limonite resting above unconsolidated glacial and alluvial deposits in gently sloping areas below outcrop or talus of extensively pyritized rocks of the Taseko River alteration belt (Figure 3). As noted by MacKenzie, the iron was oxidized and leached from the finely disseminated pyrite and transported in solution to favourable sites of deposition down-slope. Placer gold occurs in the Bridge River and many of its tributaries, although there are official production records from only a few occurrences, and the total gold produced from placer operations is small when compared to that from lode deposits of the Bridge River camp. Minor amounts of placer gold were also produced from Poisonmount Creek to the north, and close to 3500 grams of gold were recovered from an eluvial placer at the Taylor-Windfall deposit near Battlement Creek.

MAIN CRETACEOUS AND TERTIARY MINERAL DEPOSIT TYPES

LOW SULPHIDE (MESOTHERMAL) GOLD-QUARTZ VEINS

Bralorne Area

Most of the gold produced in the Bridge River mining camp was from quartz veins that contain only a few per cent sulphide minerals. These veins occupy shears and tension fractures within diorite and greenstone of the Bralorne-East Liza Complex. Most of the camp's production came from the Bralorne-Pioneer mine south of the map area, but gold has also been produced from the Wayside mine (Gaba and Church, 1988) and a belt of similar deposits east of the lower Hurley River. Vein quartz is milky and contains variable amounts of calcite, ankerite and disseminated metallic minerals. Much of the quartz is ribboned with laminations and stylolitic partings of chlorite-sericite and inclusions of carbonate-sericite-mariposite-altered wallrock. Metallic minerals are mostly pyrite and arsenopyrite, with lesser sphalerite, galena, pyrrhotite, chalcopyrite, tetrahedrite, stibnite, scheelite, marcasite, molybdenite, native gold and gold tellurides. Sulphide concentrations and native gold tend to coincide along ribboned structures, although both are also found within vein quartz. The ratio of gold to silver is generally between 4 and 8.

Dated pre-mineral and intra-mineral to post-mineral dikes suggest that the main mineralizing event at the

Bralorne-Pioneer deposit occurred between 86 and 91 Ma (Leitch, 1989). The major gold-bearing veins at Bralorne dip steeply to the north-northeast and record reverse-sinistral movement (Joubin, 1948; Leitch, 1989). Leitch suggests that these veins occupy riedel shears within a reverse-sinistral fault system, and invokes a fault-valve model (Sibson *et al.*, 1988) to explain the ribboned, yet euhedral, coarsely crystalline milky quartz veins. These timing and kinematic constraints are consistent with the mesothermal vein systems being associated with reverse-sinistral faults of the Eldorado - Steep Creek fault system. These faults control the distribution of Bralorne-East Liza Complex where it hosts mesothermal gold-quartz veins at Wayside and along the lower Hurley River, and may be part of the offset extension of the Bralorne fault system to the south (*see* Figure 20).

Leitch (1989, 1990) and Leitch *et al.*(1989, 1991a) stress that the ore formation at Bralorne is strongly tied to the Coast Plutonic Complex (represented by dikes of Late Cretaceous age) which presumably was the heat source that drove the ore fluids in the development of the auriferous vein system. A metamorphic fluid source has also been favoured (Leitch *et al.*, 1991b) to account for characteristics, such as strong enrichment of ^{18}O in wallrocks and abundant and widespread carbonate alteration commonly attributed to a fluid-dominated system. The structural setting is also favourable for the concentration of fluids derived from large volumes of rock undergoing devolatilization reactions at the amphibolite-greenschist facies transition. Leitch and his colleagues postulate that the vein system developed near the roots of a high-angle reverse fault above an actively prograding metamorphic pile, with the bulk of mineralization probably post-dating peak-metamorphism (Leitch, 1990, Leitch *et al.* 1991b). Leitch (op. cit.) does not, however, rule out the possibility of contributions from deeply circulated, highly evolved meteoric water (*cf.* Nesbitt, 1988).

Blue Creek Area

Veins at the Elizabeth-Yalakom prospect, in the heart of the Shulaps Ultramafic Complex, are mineralogically and texturally similar to those of the Bralorne area (Gaba *et al.*, 1988). The important gold-bearing veins occupy north-trending shears in porphyritic quartz diorite that intrudes Shulaps harzburgite, although some minor veins are along or adjacent to contacts with the harzburgite country rocks. Narrow zones of propylitic alteration occur within the diorite along some vein margins. The diorite is crosscut by various aplitic to porphyritic dikes; those observed, however, are not spatially coincident with auriferous veins. The diorite body exposed on the Yalakom claims has a hydrothermally altered zone along its western contact; harzburgite within this zone has been altered to an assemblage of quartz-carbonate-mariposite (listwanite). A hornblende separate from the diorite yielded a 70.27±5.25 Ma Ar-Ar plateau date (Appendix 7, Sample TL-89-6), which may be a more reliable estimate of the cooling age than the 58.4±2.0 Ma whole-rock K-Ar date reported by Church and Pettipas (1989).

The Elizabeth-Yalakom veins comprise ribboned lenses of milky white, massive quartz separated by dark partings (Photo 62). The partings are composed of chlorite,

Photo 62. Ribboned quartz vein from the Elizabeth - Yalakom prospect, Shulaps Range.

carbonaceous material and sulphide minerals, and locally contain fragments of slightly to intensely altered quartz diorite wallrock. The total content of metallic minerals rarely exceeds a few per cent. Arsenopyrite, pyrite and chalcopyrite are the dominant minerals, with lesser galena, sphalerite, pyrrhotite, magnetite and molybdenite. Native gold occurs as microscopic to visible blebs and smears within the partings, and only rarely as isolated visible grains within massive quartz. The mean composition of native gold grains, based on electron microprobe investigations (16 analyses), is: 81 per cent gold, 18 per cent silver, 0.71 per cent copper and 0.01 per cent mercury; the fineness ranges from 813 to 823 (J. Knight, written communication, 1989), typical for mesothermal gold deposits (Boyle, 1979).

The ribboned structure of the quartz veins suggest repeated fracturing during emplacement and vein growth; bands of inclusions parallel to the vein walls are evidence for successive episodes of vein accretion by a crack-seal process localized at the vein wall. In addition, complex stylolitic banding may have formed by tectonically induced pressure solution and recrystallization of the vein after emplacement. These structures, like those of the older vein systems near Bralorne and Gold Bridge, are characteristic of syntectonic mesothermal veins emplaced along high angle reverse and transpressional faults (Sibson *et al.*, 1988). The macroscopic structural control of the Elizabeth-Yalakom vein system is not well established, but the general location of the system suggests that the veins may have formed during latest Cretaceous to Early Tertiary transpressional deformation that is documented within the Shulaps-Mission Ridge metamorphic belt on the southwest side of the Yalakom fault (Chapter 3).

SULPHIDE-ARSENIDE-OXIDE (HYPOTHERMAL) VEINS

Sulphide-arsenide-oxide veins at the Little Gem prospect are composed of an uncommon, high-temperature (hypothermal) assemblage of cobalt and gold-bearing sulphides and arsenides, with minor amounts of uraninite. This prospect is within granodiorite and quartz diorite of the Late Cretaceous (92 Ma) Dickson - McClure batholith. The principal metallic minerals form coarse crystalline masses as well as dense disseminations within wallrocks; the latter are reported to be partly intergrown with relatively fresh quartz diorite and granodiorite, suggesting a common magmatic origin (Cairnes, 1943; Stevenson, 1951).

PORPHYRY COPPER - MOLYBDENUM PROSPECTS

Porphyry copper and molybdenum prospects and deposits are associated with mid-Cretaceous to mid-Eocene intrusions. Many are within or adjacent to the Late Cretaceous Dickson - McClure batholith. To the north and east, others are associated with isolated plutons and dike swarms that cut a variety of Cretaceous and older country rocks (Figure 33). A few have considerable reserves of copper and/or molybdenum, and many have important associated gold, but none are presently economic.

Upper Relay Creek

Altered and mineralized zones along upper Relay Creek are associated with a swarm of hornblende-feldspar porphyry sills, dikes and small plugs that intrude volcanic and sedimentary rocks of the Taylor Creek Group. Interest in the area dates from 1970 when it was explored for porphyry copper-molybdenum deposits. More recent exploration by Consolidated Barrier Reef Resources Ltd. (now Minven Gold Corporation) and Esso Minerals Canada has concentrated on the area's gold potential. Carbonate alteration is widespread in both intrusive and country rocks; it is locally accompanied by chlorite-epidote alteration, silicification and minor clay alteration. Disseminated pyrite and pyrrhotite are common within and adjacent to the porphyries, and are locally accompanied by minor amounts of chalcopyrite, molybdenite, arsenopyrite and sphalerite. More intense pyritization is commonly associated with zones of silicification. Recent interest is focused on the northwestern end of the altered belt, where gold values of 1 to 10 g/t have been obtained from narrow quartz-carbonate and chalcedony veins which occur within broader zones of elevated gold values (in the range of 50 to 300 parts per billion) that also have anomalously high values of arsenic (Dawson, 1981, 1982a).

Hornblende from one of the intrusive plugs along upper Relay Creek has yielded an Ar-Ar plateau date of 104.5±16.6 Ma (Appendix 7, Sample TL-87-14). Despite the large error, this date suggests that the intrusions may be cogenetic with the spatially associated Taylor Creek volcanics. The mineralization may also be of this age, as the associated alteration is widespread in the Taylor Creek volcanics and underlying Lizard formation, but is absent in the overlying Beece Creek succession.

Dickson - McClure Batholith

A total of 13 known porphyry copper prospects occur within or immediately adjacent to the northeast margin of the Late Cretaceous Dickson - McClure batholith, in a belt extending from Copper Mountain 25 kilometres northwest to Mount McClure (Figure 33). Most occurrences are hosted by granodiorite to quartz diorite typical of the main mass of the batholith (McMillan, 1983; Osborne and Allen, 1995), although some (*e.g.* Copper Mountain; Camsell, 1919) are spatially associated with younger phases, typically hornblende-feldspar porphyries, that intrude the granodiorite. The Empress occurrence is within volcanic rocks of the Powell Creek formation immediately adjacent to the batholith contact at the north end of the belt, and the Porphyry (Warner 4) showing is hosted by a hornblende-feldspar porphyry stock and adjacent Powell Creek volcanics about 1 kilometre north of the batholith contact near Warner Lake.

Metallic minerals typically occur as disseminations, stockworks, veins and fracture fillings that are concentrated in fractured and brecciated zones within propylitized or weakly sericitized host rock. At the Buzzer showing, they are disseminated within vugs and mariolitic cavities in the host granodiorite. Silicification may be significant, and is particularly pronounced within Powell Creek volcanics at the Empress prospect. Chalcopyrite and pyrite are the most abundant sulphide minerals, and are commonly accompanied by significant amounts of molybdenite. Bornite, sphalerite, galena, arsenopyrite, scheelite and magnetite also occur, and gold and silver in accessory concentrations commonly accompany the base metals.

Porphyry mineralization associated with the Dickson - McClure batholith is inferred to be broadly synchronous with emplacement of the batholith. At the Mohawk prospect (92O 001), K-Ar radiometric ages of biotite from granodiorite, sericite from an alteration zone, and biotite from a postmineralization dike are essentially identical, within limits of analytical precision (86.7±2.6, 84.9±2.5 and 84.7±2.5 Ma respectively; McMillan, 1983). These cooling dates are 5 to 7 Ma younger than a 92 Ma crystallization age obtained by U-Pb dating of zircons from granodiorite near Dickson Peak, 36 kilometres to the southeast (Parrish, 1992).

Poison Mountain

The Poison Mountain porphyry copper-molybdenum-gold deposit occurs on the southwest slopes of Poison Mountain, 3 kilometres northeast of the Yalakom fault. The first lode claims were staked in 1935, after placer gold had been discovered along Poisonmount Creek in 1932. Diamond drilling and trenching, carried out by various companies between 1956 and 1971, delineated a mineral inventory in the order of 175 million tonnes with an average grade of 0.33% Cu, 0.015% Mo and 0.3 g/t Au (Seraphim and Rainboth, 1976). Additional work was carried out by Lac Minerals Ltd. and Bethlehem Resources Corp. between 1979 and 1993, resulting in updated reserves totalling 808 526 000 tonnes, at a 0.15% Cu cutoff (Brown, 1995). These include 768 315 000 tonnes grading 0.232% Cu, 0.122 g/t Au and 0.007% Mo within the main sulphide zone, together with an additional 40 211 000 tonnes grading 0.228% Cu (sulphide), 0.15% Cu (oxide), 0.127 g/t Au and 0.007% Mo within a near-surface zone of oxidation.

Mineralization at Poison Mountain is associated with two granodiorite to quartz diorite stocks which intrude Jackass Mountain Group sedimentary rocks of Unit lKJMy2. The stocks comprise relatively unaltered cores of hornblende granodiorite which pass outwards into biotite-hornblende quartz diorite containing secondary biotite as an alteration product of primary hornblende and biotite. The highest grade mineralization occurs within the biotite-altered border phases and adjacent biotite hornfels. It consists mainly of pyrite, chalcopyrite, molybdenite and bornite, which occur as disseminations, fracture fillings and in quartz veins (Seraphim and Rainboth, 1976). Calcite and gypsum also occur as hydrothermal minerals, and pyrite, together with magnetite and hematite, forms an irregular halo around the ore zone. Sulphide minerals are accompanied by azurite, malachite, native copper and cuprite down to depths of 10 to 40 metres, but there is no significant supergene copper enrichment (Brown, 1995). Chlorite-epidote alteration occurs sporadically within Jackass Mountain Group rocks for several kilometres around the deposit, but is not distinctly concentrated around the mineralized porphyries.

K-Ar dates reported by Brown (1995), indicate that intrusion, potassic alteration and mineralization at Poison Mountain is Late Paleocene to Early Eocene in age. He reports a date of 59.3±2.7 Ma for primary hornblende from the core granodiorite, and dates of 61.4±2.1 and 57.3±2.0 Ma on primary hornblende and primary biotite, respectively, from biotite-altered quartz diorite. In addition, a sample of mixed biotite and hornblende from hornfelsed Jackass Mountain Group in the outer part of the deposit yielded a date of 55.5±2.0 Ma.

Mission Ridge Pluton and Lorna Lake Stock

A porphyry molybdenum prospect was discovered in granodiorite of the Middle Eocene Mission Ridge pluton in 1989 (Gaba, 1990). Molybdenite is present in veins, stockworks and disseminations in foliated granodiorite adjacent to the contact with younger porphyritic dacite (Rexmount porphyry) along the northeast margin of the pluton. Large ribboned quartz veins mark the contact zone between porphyry and granodiorite, and contain significant molybdenum and copper, with erratic anomalous gold and silver contents. Pervasive silicification accompanies the metallic mineral concentrations: At higher elevations the character of the granodiorite has been mostly obliterated by diffuse silica flooding and brecciation and is now a banded blue-grey cherty textured and partly vuggy mylonitic rock with only finely disseminated sulphides present, whereas at lower elevations, molybdenite and pyrite are associated with quartz stockworks cutting massive to foliated granodiorite. Overall, there is a rough zonation from a high-level brecciated silicic cap with generally low but sporadic metal content to a deeper level of coarse stockwork quartz-molybdenite-pyrite mineralization (Gaba, 1990).

The Lorna Lake stock is a granodiorite to quartz monzonite intrusion that is similar to the Mission Ridge pluton in composition, age and structural setting, as outlined in Chapter 3. Copper and molybdenum showings are common along the margin of the stock, within both the intrusive mass and adjacent Powell Creek volcanics (Figure 53; Freeze and Allen, 1972). These metal occurrences are coincident with zones of propylitic and argillic alteration that rim the stock.

VEINS ASSOCIATED WITH ALTERATION SYSTEMS NORTHEAST OF THE DICKSON - McCLURE BATHOLITH

Taylor-Windfall

The Taylor-Windfall occurrence, within Powell Creek volcanic rocks along lower Battlement Creek, produced 13 405 grams of gold from both surface and underground workings during the mid-1930s. Most of this came from a narrow, northeast-striking shear zone containing pyrite, tennantite, chalcopyrite and minor sphalerite in a chlorite-sericite gangue. Further underground mining in 1941, 1953 and 1954 resulted in the recovery of an additional 1120 grams of gold and 156 grams of silver, mainly from a narrow flat-lying pyroclastic bed. Renewed exploration of the Taylor-Windfall property and surrounding area in the 1980s, by Westmin Resources Ltd. and Esso Minerals Canada, focused on siliceous zones with associated argillic and phyllic alteration. A limited amount of diamond drilling was undertaken in conjunction with detailed geological mapping and geochemical sampling, but no reserves have been published.

Taylor-Windfall occurs near the east end of a broad alteration zone situated along the north margin of the Dickson - McClure batholith (Figure 3). The zone extends 10 kilometres westward from Taylor-Windfall to Honduras Creek, and includes argillic, advanced argillic, phyllic, propylitic and high temperature andalusite-bearing alteration assemblages (Lane, 1983; Bradford, 1985; Price, 1986). Massive flows and sills typically display chlorite-epidote alteration. The more abundant fragmental volcanic and volcaniclastic rocks are commonly silicified, and in addition contain a variety of alteration assemblages that include pyrite, kaolinite, dickite, pyrophyllite, alunite, sericite and specularite. Tourmaline occurs locally, while andalusite and corundum are reported from the Taylor-Windfall deposit and the upper part of the Empress prospects; andalusite also occurs in the Amazon Creek area. The geometry of these alteration zones and the minerals contained within them indicate a transition from an epithermal setting to that of a deeper porphyry system (Price, 1986).

A belt of alteration also extends for about 7 kilometres to the east of Taylor Windfall, but here it is less extensive and comprises silicification, pyritization and local clay alteration that is largely restricted to a specific stratigraphic level within the Powell Creek volcanics. This alteration is apparently truncated by the Paleocene Dorrie Peak stock (Figure 3). Farther east, however, an apparently younger belt of alteration affects the Dorrie Peak stock as well as adjacent volcanic rocks of the Powell Creek formation and Taylor Creek Group. This belt includes an extensive zone of chlorite-epidote alteration along Denain Spur and Warner Ridge, as well as a zone of silicification and clay alteration that is exposed along the slopes northwest of Sluice Creek. Some samples collected from the latter zone contain anomalously high concentrations of mercury and arsenic, and one sample contained anomalous gold (Appendix 12).

A belt of alteration also occurs along the Tchaikazan fault, where it is located in the Taseko River canyon at the western margin of the map sheet. It includes a group of bright yellow to orange-weathering en echelon zones of silicified and sericitized volcanic rocks, which are cut by northwest-trending carbonate veins, and locally contain up to 10 per cent disseminated fine-grained pyrite. Samples taken from this area have high geochemical values in mercury and arsenic, and one sample taken from immediately west of the map sheet, along the north side of the canyon, was anomalous with respect to gold (Appendix 12).

Alunite from the Taylor-Windfall property has yielded an Ar-Ar total fusion date of 73.7±0.5 Ma (Archibald *et al.*, 1988; Appendix 7, Sample DDH-87-163.3), and muscovite from the property, collected by G. Price, has yielded an Ar-Ar plateau age of 86.3±0.3 Ma (R. Britten, written communication 1986). More recently, alunite and sericite collected by Andre Panteleyev from the alteration zone at several places between Honduras Creek and Taylor-Windfall have yielded Ar-Ar plateau and total fusion dates that range from 67 to 87 Ma (A. Panteleyev, personal communication 1994). The older dates from the alteration zone confirm its relationship to the Dickson - McClure batholith, with which it is spatially associated. The younger dates may reflect overprints, related to the protracted nature of the plutonism, alteration and mineralization that is clearly documented in the Taseko - Bridge River area.

Warner Creek

Alteration northeast of the Dickson - McClure batholith near Warner Creek (Figure 3) is similar to that observed in the Taylor-Windfall area. A prominent, steeply dipping north-trending zone of intense silicification and sericitization, that locally contains up to 10 per cent finely disseminated pyrite, crosscuts and partly replaces Powell Creek volcanic rocks that dip gently to the north. Clay alteration was observed locally along the ridge at the south end. The exposed strike-length of the zone is 1.7 kilometres and its maximum width is about 300 metres. The Warner Creek showing, at the north end of the zone, comprises a silver-rich quartz vein containing blebs and disseminations of tetrahedrite, along with minor amounts of sphalerite, malachite, stibnite and cinnabar. The BK showing, just to the east of the main alteration zone, comprises disseminated sphalerite, galena and pyrite within silica flooded sericitic shear zones.

Sericite from the main alteration zone south of Warner Creek yielded an Ar-Ar total fusion date of 78.1±0.6 Ma (Archibald *et al.*, 1988; Appendix 7, Sample TL-87-3a). This is younger than most dates from the Dickson - McClure batholith and suggests that the alteration may be related to a slightly later event. This event may have coincided with emplacement of the Warner Lake stock, a relatively large body of pervasively chlorite-epidote altered hornblende-plagioclase porphyry located 1.5 kilometres west of the alteration zone. This relationship is suggested by angular float of malachite-stained epidote-altered tuff located along the eastern margin of the stock. The mineralized float contains disseminated sphalerite, pyrite and tetrahedrite, and 3 separate analyses yielded values of 331 to 377 ppm Ag (Appendix 12, Samples L86026, L86027 and L86028).

POLYMETALLIC VEINS

Gold-silver-bearing polymetallic veins occur mainly in a northwest-trending belt extending from south of Carpenter Lake to Eldorado Mountain, where they are associated with numerous latest Cretaceous-Paleocene dikes and stocks that are broadly coincident with the trace of the Castle Pass fault. This belt also contains abundant stibnite veins and a few skarn and cinnabar occurrences. The polymetallic veins near Carpenter Lake, including the past-producing Minto mine, occupy shears within greenstone, argillite, chert and serpentinite of the Bridge River Complex, and are commonly associated with feldspar porphyry and aplite dikes. Veins contain coarsely crystalline arsenopyrite, pyrite, sphalerite, galena and chalcopyrite together with accessory tetrahedrite, jamesonite, pyrrhotite and bornite (Photo 63). The veins are complex and multiphase; banding is defined by alternating metallic mineral concentrations and quartz-ankerite gangue. Brecciated veins are commonly richer in precious metals. Wallrock alteration is characterized by rare to abundant ankerite and calcite, with lesser sericite, chlorite and mariposite. Gold is closely associated with arsenopyrite and only rarely present as native metal. The ratio of gold to silver is generally between 0.1 and 0.3. The close spatial association of veins and dikes suggests a possible genetic

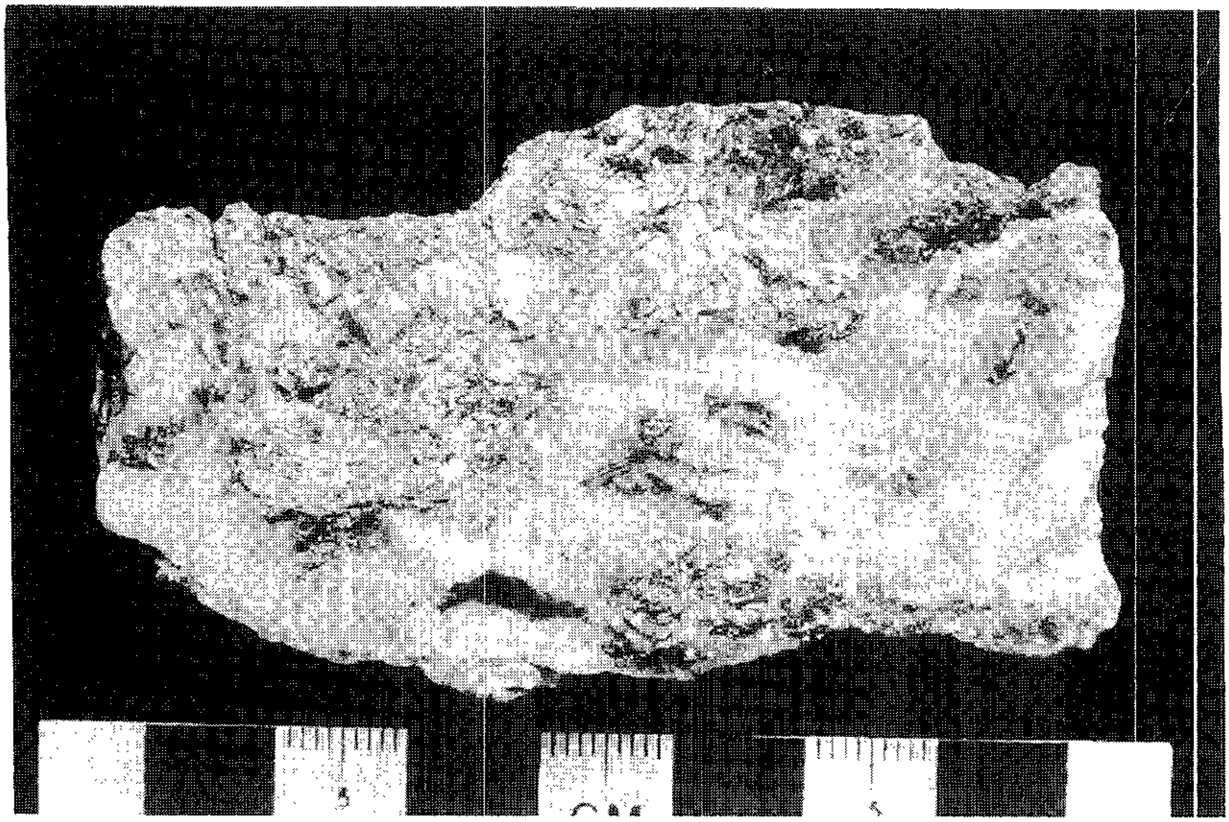

Photo 63. Sample from the Minto polymetallic vein system, Carpenter Lake.

relationship. This is probably the case at least for the Minto vein, as it parallels the margin of the 69 Ma "Minto dike" which is apparently auriferous (J. Miller-Tait, personal communication 1988).

Farther north within the same belt, veins composed dominantly of arsenopyrite and pyrite, with lesser sphalerite, chalcopyrite, jamesonite, pyrrhotite and only minor quartz, occupy shears that may be radial extension fractures peripheral to the 67 Ma Eldorado pluton. A local metal zonation about the pluton is represented by the abundance of arsenopyrite in veins closest to the contact (Pearson, Lucky Jem, Northern Lights 1 and 6) and by base metal sulphide and sulphosalt minerals in veins farther from the pluton (Robson, Lucky Strike).

Polymetallic veins also occur peripheral to the margin of the southern part of the Dickson - McClure batholith (Native Son, Jewel), along the margins of the Mission Ridge pluton (Spokane, Broken Hill), and in association with dikes and small plugs of unknown age elsewhere in the area (Figure 33). They are inferred to be related to hydrothermal activity peripheral to the associated intrusive bodies.

STIBNITE VEINS

Stibnite veins, including the past-producing Congress mine, are confined to the belt of intrusions and mineral occurrences that follows the Castle Pass fault. These veins occupy shears within foliated greenstone, sedimentary rock and gabbro of the Bridge River Complex. Feldspar-porphyritic dikes both parallel and crosscut vein structures; dikes range from unaltered to completely altered. Veins consist of quartz, ankerite and stibnite, with lesser pyrite and arsenopyrite (Photo 64). They are banded with comb-textured vuggy quartz, commonly brecciated and discontinuous. Stibnite, pyrite and arsenopyrite are accompanied by sphalerite, tetrahedrite, limonite, marcasite and cinnabar as irregular and lenticular concentrations that partly replace carbonate-altered wallrock and adjacent dike rock. Wallrocks are altered for as much as 5 metres away from veins; arsenopyrite and associated gold concentrations are most abundant within these alteration envelopes. The ratio of gold to silver is variable.

Geological relationships at the Congress mine suggest a connection between the stibnite veins and the spatially associated polymetallic veins. Altered greenstones contain diffuse concentrations, aggregates (uncommonly crystalline in some spots) and hairline streaks and films of pyrite, arsenopyrite and minor sphalerite (a typical polymetallic assemblage) as "replacement deposits" adjacent to the main shear that hosts the bulk of the stibnite "vein" mineralization. The stibnite occurs as both fine-grained compact to banded, and coarsely columnar masses. Both megascopic and microscopic examination reveals the discordant relationship of the stibnite to the altered wallrock charged with pyrite and arsenopyrite. Gold is typically associated with the arsenopyrite in the replacement zones and the abundance of gold increases with depth: According to mine management

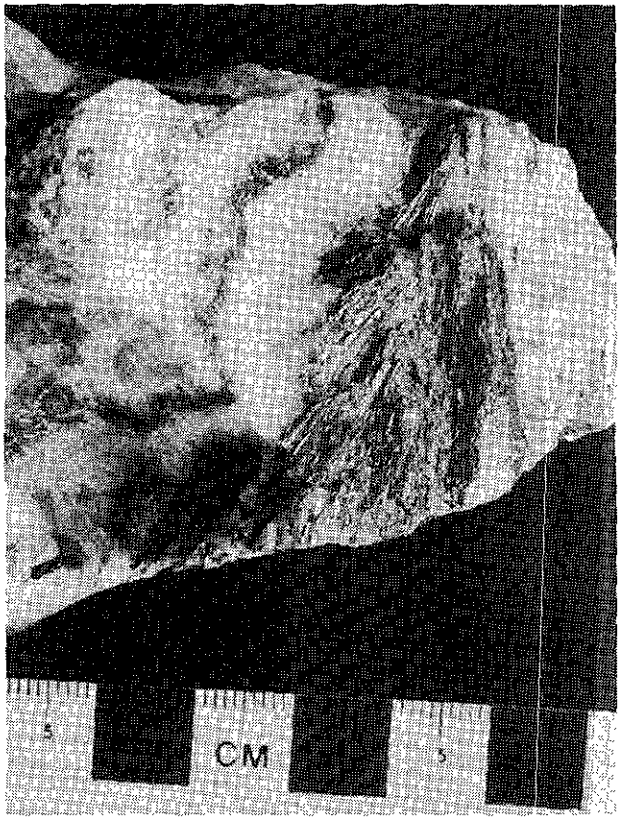

Photo 64. Sample from the Congress (Howard Zone) stibnite vein system, Carpenter Lake.

in 1936, the stibnite concentration peaked on the 2nd level, whereas on the 3rd level there was apparently more arsenopyrite and associated gold. In addition, small occurrences of cinnabar were recognized in the upper two levels of the mine (O'Grady, 1937) and, at the Howard stibnite prospect to the west, native gold occurs in brecciated and comb-textured quartz veins characteristic of a high-level environment of deposition. Overall, the Congress mine (and the Howard prospect) seem to provide a section through a transition from auriferous polymetallic mineralization at depth, through abundant coarse stibnite veins and stibnite with minor cinnabar (a typical epithermal vein association), to native gold as at the Howard prospect. The stibnite veins may, therefore, represent essentially epithermal, or higher level extensions of the polymetallic veins with which they are spatially associated along the Castle Pass fault system. This inferred temporal relationship is supported by available dates, as the 67 Ma K-Ar date from a dike associated with mineralization at the Congress Mine (Pearson, 1977; Leitch *et al.*, 1991a) compares closely to the 67 Ma Eldorado pluton and the 69 Ma Minto dike, which are associated with polymetallic vein systems.

SKARNS

Skarn occurrences are not common in the Taseko - Bridge River area but occur locally, mainly along the belt of intrusions associated with the Castle Pass fault system. This belt also hosts abundant polymetallic and stibnite vein occurrences.

On the south side of Carpenter Lake, two skarn zones are exposed east of the main polymetallic veins on the Olympic property, in an area underlain by the Bridge River Complex and abundant mafic to felsic dikes and small plugs. At the Billyo zone, calcsilicate rocks, including garnet-diopside skarn, enclose a lens of massive pyrrhotite, pyrite, chalcopyrite and magnetite that has yielded analyses of up to 545 ppb gold (Price, 1983). The Manners zone, 500 metres to the east, includes garnet-magnetite-quartz skarn with small amounts of molybdenite and chalcopyrite, and contains up to 200 ppb gold (Price, 1983).

The Wide West showing occurs along upper Taylor Creek, where it is hosted by a limestone lens within the Hurley Formation along the southern contact of the Eldorado pluton. The limestone, which has an exposed width of about 9 metres, is wholly to partly replaced by pyrrhotite together with minor amounts of chalcopyrite and quartz (Bateman, 1914b; Brewer, 1914).

Quartz-stibnite veins at the Eva showing are hosted by skarn-altered rocks of the Tyaughton Group and Last Creek formation. The altered rocks are exposed for several hundred metres along the north bank of Tyaughton Creek, where they are cut by steeply dipping, north-northwest-striking, carbonate-altered hornblende plagioclase porphyry dikes and pyritized shear zones (Croft *et al.*, 1986). Skarn assemblages reported by Macfarlane (1988) include: wollastonite-diopside-andradite-plagioclase, calcite-diopside-epidote-quartz-pyrite and calcite-andradite-epidote-hornblende-chlorite-plagioclase. Significant gold values are reported in the associated quartz-stibnite veins, but the skarn-altered rocks have thus far not yielded significant base or precious metal values.

Calcsilicate-altered Tyaughton Group rocks also occur near the Castle Pass fault north of Castle Peak, where they are associated with dikes and sills of pyritized and carbonate-altered hornblende feldspar porphyry. Samples of dikes and hostrocks were analysed but did not yield significant base or precious metal values.

CINNABAR VEINS AND DISSEMINATIONS

Cinnabar veins and disseminations, locally with associated stibnite, show a clear spatial association with major Eocene dextral strike-slip faults; the main occurrences are along the Yalakom, Relay Creek and Fortress Ridge fault systems. Most of the occurrences are associated with subsidiary structures adjacent to the main fault zones; an exception is the Apex showing, which is within the main strand of the Yalakom fault. There is no indication that intrusive rocks are spatially associated with cinnabar mineralization.

Mercury mineralization at the Apex prospect occurs within a lens of listwanite, about 300 metres wide, that defines the Yalakom fault northeast of Quartz Mountain. Cinnabar typically occurs as specs, blebs and fine veinlets within chalcedonic quartz that forms part of the listwanite alteration assemblage. The Eagle and Red Eagle prospects are 36 kilometres to the southeast, on either side of the Yalakom River near the mouth of Shulaps Creek. The main strand of the Yalakom fault is about a kilometre to the west, but a subsidiary fault is mapped along the Yalakom River between the two occurrences. Mineralization is hosted by greenstone and greenstone breccia of the Bralorne-East Liza Complex. It comprises cinnabar veinlets and disseminations that are generally within or adjacent to narrow stringers of white dolomite that occur within broader zones of brownish-weathering ankeritic carbonate alteration (Stevenson, 1940).

The Manitou occurrence is on the slopes directly northwest of lower Mud Creek, within the Bridge River Complex near the north end of the lens enclosed by the Relay Creek fault system. The property produced 543 kilograms of mercury from 141 tonnes of ore in 1938 and 1939. Stevenson (1940) reports that the best mineralization is within 2 northwest-striking shear zones, where cinnabar occurs mainly along foliation and shear surfaces cutting Bridge River greenstone. It also occurs within calcite veins and amygdules, and as disseminated grains within greenstone. The Mugwump prospect is located about 3 kilometres northwest of the Manitou. Here cinnabar and stibnite occur mainly within conglomerates of the Dash formation along the southwest side of the southern strand of the Relay Creek fault system. Cinnabar and stibnite occur together in quartz veinlets, and also as disseminated grains and thin smears on fracture surfaces (Lammle, 1974). Wallrock alteration is characterized by abundant quartz, carbonate and pyrite, and less common hematite, limonite and clay minerals.

The Silverquick mine, which produced 3241 kilograms of mercury between 1955 and 1965 (McCammon, 1965; Robinson, 1966), is on the south side of Tyaughton Creek, 4 kilometres northeast of Eldorado Mountain. Cinnabar mineralization is hosted by highly fractured and faulted conglomerates of the Silverquick formation on the west side of a strand of the Fortress Ridge fault system. The cinnabar is accompanied by quartz, calcite, limonite and clay; it occurs as disseminated grains, streaks and small lenses within brecciated conglomerate, as smears on faults, and in the mud of gouge seams (McCammon, 1965).

SCHEELITE-STIBNITE VEINS

Scheelite-stibnite veins occur at the Tungsten King and Tungsten Queen prospects, which are located just east of Tyaughton Creek along a major strand of the Relay Creek fault system. The Tungsten Queen produced 7896 kilograms of tungsten from 55 tonnes of ore in 1953. The veins occupy branched fractures within listwanite-altered ultramafic rocks comprising chalcedonic quartz, ankerite, mariposite and relict serpentinite. The veins are up to 8 centimetres wide and well banded: scheelite is followed inward from vein walls by chalcedonic quartz, coarse crystalline comb-quartz and finally by a central band of stibnite (Stevenson, 1943). There are no obvious alteration selvages along vein margins. Feldspar porphyry dikes are common within this part of the fault zone, but are not directly adjacent to the veins. Diamond drilling on the Tungsten Queen prospect (Sadlier-Brown and Nevin, 1977) sampled scheelite and stibnite concentrations carrying up to 480 ppb gold within altered ultramafic rocks. These rocks also contain up to 133 ppm arsenic and 17 ppm mercury (Appendix 11).

The symmetric mineral banding, the comb-textured quartz and the branching veins suggest a moderate to high level environment of emplacement. Scheelite is typically indicative of a high-temperature hydrothermal environment, but stibnite is characteristically a low-temperature mineral. Their presence together in the same veins, but in a zonal arrangement that indicates different times of formation, suggests that the veins formed in a rapidly changing temperature regime. Abundant syn-faulting feldspar porphyry dikes intruded along this segment of the Relay Creek fault may have provided a short-lived heat source.

DISSEMINATED (EPITHERMAL) GOLD

At Big Sheep Mountain gold and silver values are associated with vuggy quartz seams with rare disseminated to massive tetrahedrite, and with limonitic pitch-coated fractures within and adjacent to argillically-altered feldspar and quartz-porphyritic rhyolite that caps a feldspar porphyry pluton (Dawson, 1982b). Disseminated pyrite and pyrrhotite are widespread throughout the pluton. Rare amethyst veinlets are reported in altered rhyolite. The limited amount of information regarding the style of mineralization at Big Sheep Mountain suggests a high level or epithermal environment.

METALLOGENY OF THE TASEKO LAKES-BRIDGE RIVER AREA

INTRODUCTION

Woodsworth *et al.* (1977) noted an asymmetric metal and mineral zoning pattern within the Bridge River mining camp, comprising two northwesterly-trending belts of gold-bearing vein deposits (Bralorne and Minto) within a larger zone of antimony minerals, which is succeeded to the northeast by a mercury zone. They suggested that the pattern resulted from mineral deposition under a regional thermal gradient decreasing outward from the eastern margin of the Coast Plutonic Complex. Implicit in their model is the assumption that most mineral deposits formed during a single period of mineralization that coincided with the latest cooling of the northeastern side of the Coast Complex, which they thought occurred at about 50 Ma.

The model of Woodsworth *et al.* (1977) predated most of the geochronologic database presently available for the Taseko - Bridge River area (*e.g.* McMillan, 1983; Archibald *et al.*, 1989, 1990, 1991a,b; Leitch *et al.*, 1991a; Coleman and Parrish, 1991; Parrish, 1992). It also predated development of a regional tectonostratigraphic framework, and an understanding of the kinematics and timing of the complex system of faults in the area. These issues have been the focus of the present study; this allows a more comprehensive understanding of regional metallogeny in the context of the area's complex structural and magmatic evolution. The major metallic mineral deposits in the Taseko - Bridge River area are schematically summarized in Figure 35. They formed over a protracted interval during mid-Cretaceous to mid-Tertiary time, coincident with several pulses of igneous activity within an evolving structural regime that generated

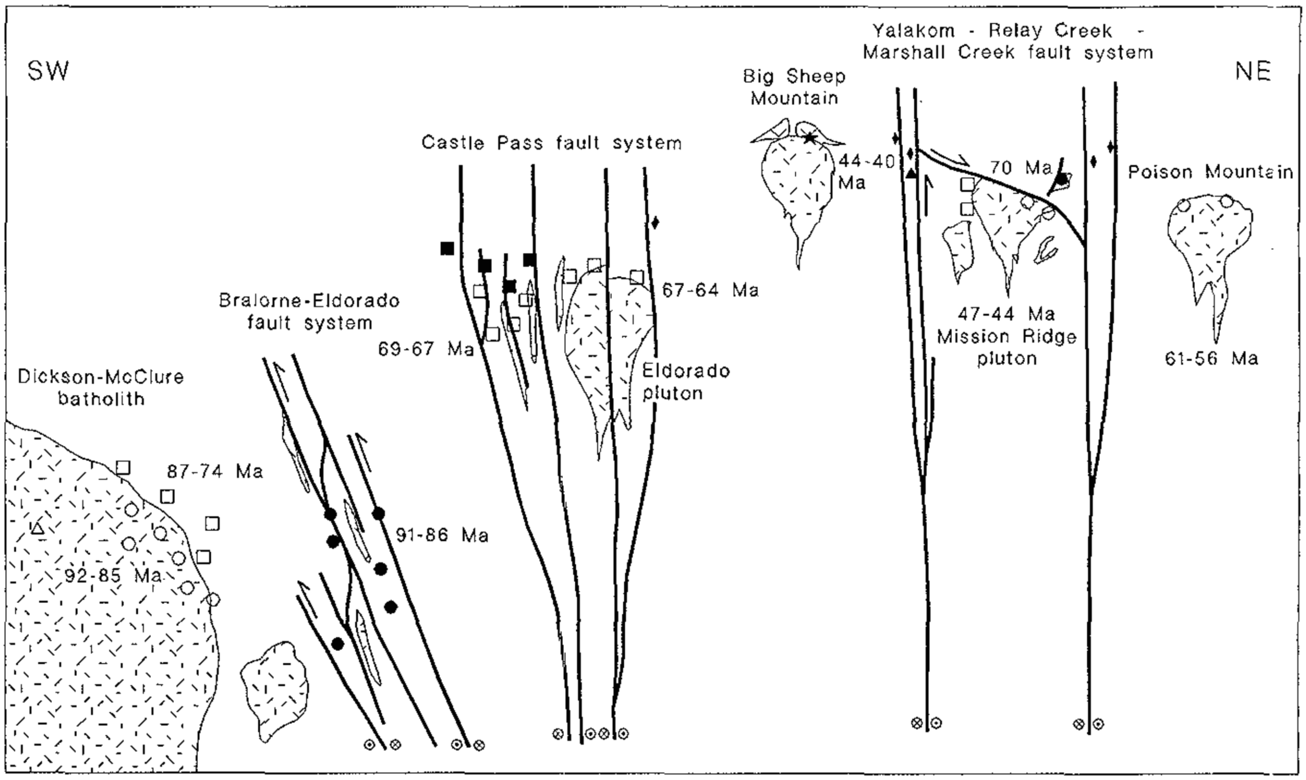

Figure 35. A schematic summary of the distribution and structural and plutonic controls of metallic mineral occurrences along a southwest - northeast transect from the Dickson - McClure batholith to the northeast side of the Yalakom fault. Symbols as in Figure 33.

contractional, transpressional, transcurrent and transtensional structures. The zonal pattern noted by Woodsworth *et al.* (1977) is in part expressed by a general easterly progression from mesothermal to epithermal mineralization within vein deposits. It is supported by the trend of decreasing fluid-inclusion homogenization temperatures in vein quartz (Maheux *et al.*, 1987), indicating a general trend toward higher level metal deposits to the east. This trend is coincident with a general eastward-younging in the age of mineralization, although there are major inconsistencies, particularly when porphyry occurrences are considered (*e.g.* the upper Relay Creek porphyry occurrences, in the northeastern part of the map area, are apparently the oldest deposits in the region). Leitch *et al.* (1989) interpreted the mineralization in terms of a single protracted but episodic mineralizing event coinciding with emplacement of granitic rocks during early Late Cretaceous to Early Tertiary time, and related the eastward-younging to movement of the magmatic front of the Coast Plutonic Complex eastward with time. The present study corroborates this general pattern, but emphasizes the role of faults in localizing both intrusive rocks and mineral deposits. The structural regime evolved from mainly compression and sinistral transpression in the early Late Cretaceous, to dextral strike-slip and local transtension and transpression in latest Cretaceous through Eocene time.

METALLOGENIC EVOLUTION

MID TO EARLY LATE CRETACEOUS

Mineral occurrences of probable mid-Cretaceous age are known only in the vicinity of upper Relay Creek, where they occur within and adjacent to a swarm of hornblende feldspar porphyry dikes and small plugs. The intrusions are spatially associated with the Taylor Creek volcanics, and a single Ar-Ar date suggests that they may be cogenetic. The porphyry-style mineralization includes disseminations of chalcopyrite and molybdenite, as well as disseminations and blebs of pyrite, pyrrhotite and sphalerite that contain low-grade gold. Carbonate alteration is widespread throughout both intrusive and country rocks, and is locally accompanied by propylitic, argillic and quartz-pyrite alteration. Similar hornblende feldspar porphyry intrusions occur near Dash Hill, about 10 kilometres east of the upper Relay Creek occurrences (Figure 36). Carbonate alteration is common in both the intrusions and the adjacent Taylor Creek Group, suggesting that there may also be potential for mineralization in this area.

The early Late Cretaceous was very important in the metallogenic evolution of the Taseko - Bridge River area, as this time period saw the deposition of mesothermal gold-quartz veins of the Bralorne-Pioneer system, as well as mineral deposits within and peripheral to the Dickson - McClure batholith (Figure 36).

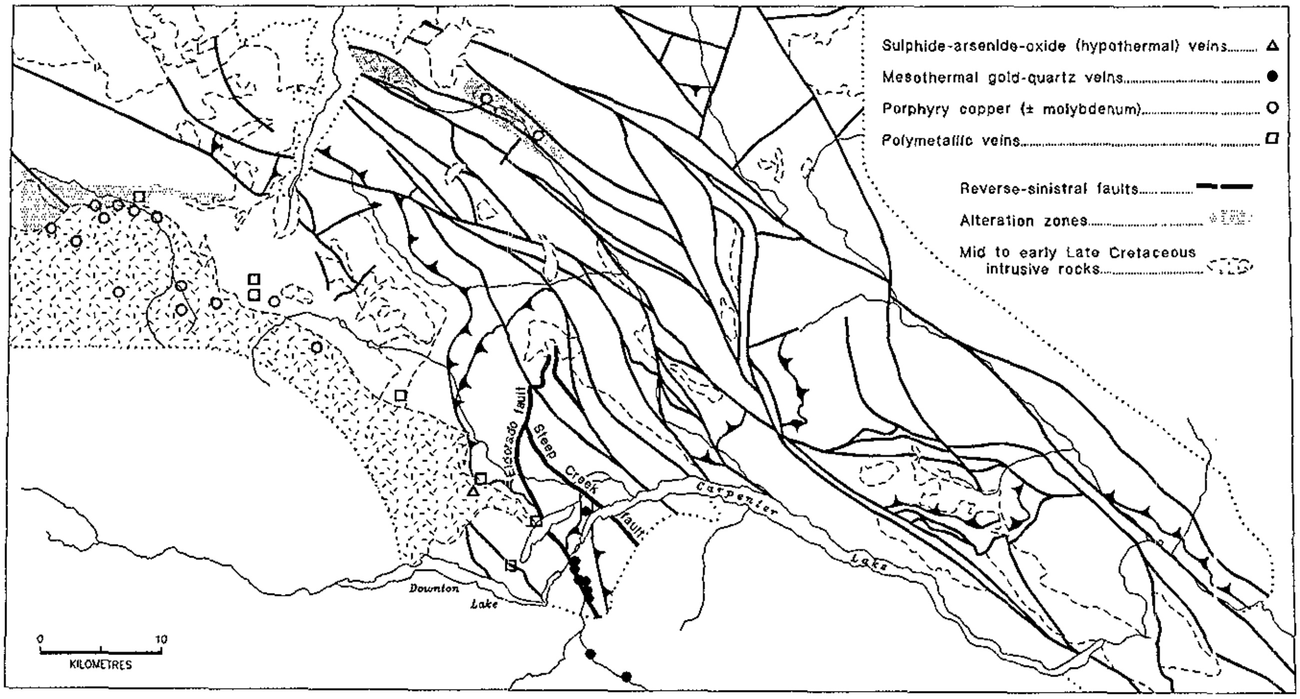

Figure 36. Map showing the distribution of mid to early Late Cretaceous mineral occurrences, along with associated structures and plutonic rocks.

Bralorne-style gold-quartz veins are associated with early late Cretaceous reverse-sinistral faults related to the Eldorado fault system. These faults formed late in the protracted period of Cretaceous contractional deformation that caused imbrication and juxtaposition of the diverse Paleozoic-Mesozoic tectonic elements of the area. All of the major Bralorne-style vein systems cut diorite and greenstone of the Bralorne-East Liza Complex; thus the Bralorne diorite has traditionally been the focus of exploration activity in the region. Recent dating indicates that the diorite is much older than the mineralization and was simply a suitable host for vein formation. A shift in exploration focus to the Late Cretaceous transpressional fault systems that control the mineralization might be fruitful. It is suspected, for instance, that the Camelsfoot fault is a similar structure; it may be an offset extension of the East Hozameen fault system, which controls mesothermal vein mineralization in the Coquihalla River area (Ray, 1986).

The available dating indicates that intrusion, cooling and mineralization associated with the Dickson - McClure batholith was essentially coincident with the Bralorne-style mesothermal veins. The batholith itself contains numerous porphyry occurrences, and a single hypothermal sulphide-arsenide-oxide vein occurrence. The porphyry occurrences pass outward into vein occurrences in the adjacent country rock that are known for 40 kilometres along the northeastern contact of the pluton. In the Battlement Creek area, mineral assemblages in an extensive alteration zone directly north of the batholith suggest conditions transitional between porphyry and epithermal environments.

LATEST CRETACEOUS TO PALEOCENE

Latest Cretaceous to Paleocene intrusions and associated mineral occurrences are concentrated along the dextral-slip Castle Pass fault system between Carpenter Lake and Tyaughton Creek, and may in part have been controlled by a prominent extensional bend in the fault system (Figure 37). Mineral occurrences are mainly polymetallic and stibnite veins, including the past-producing Minto and Congress mines, but the belt also includes skarn and mercury showings. Polymetallic vein and porphyry occurrences that occur along the general strike of the belt west of Big Creek are also associated with porphyry intrusions that may be of this age.

Ribboned gold-quartz veins at the Elizabeth-Yalakom prospect are in Late Cretaceous Blue Creek porphyry, and may also have formed during this time period. The textures of the veins suggest that they developed in a compressional or transpressional regime, similar to that operative during deposition of the older Bralorne-Pioneer vein system. The structural setting of the Elizabeth-Yalakom prospect has not been established, but it is speculated that the mineralization may have been coincident with the early stages of transpressional deformation associated with the Yalakom fault system.

LATE PALEOCENE AND EOCENE

The Eocene structural history of the area was one of dominantly dextral strike-slip, with transpressive and transtensional regimes developed locally along fault bends and steps. The strike-slip faults were the focus of major hydrothermal activity, as evidenced by the abundant listwanite and carbonate alteration along them. Most of the listwanites

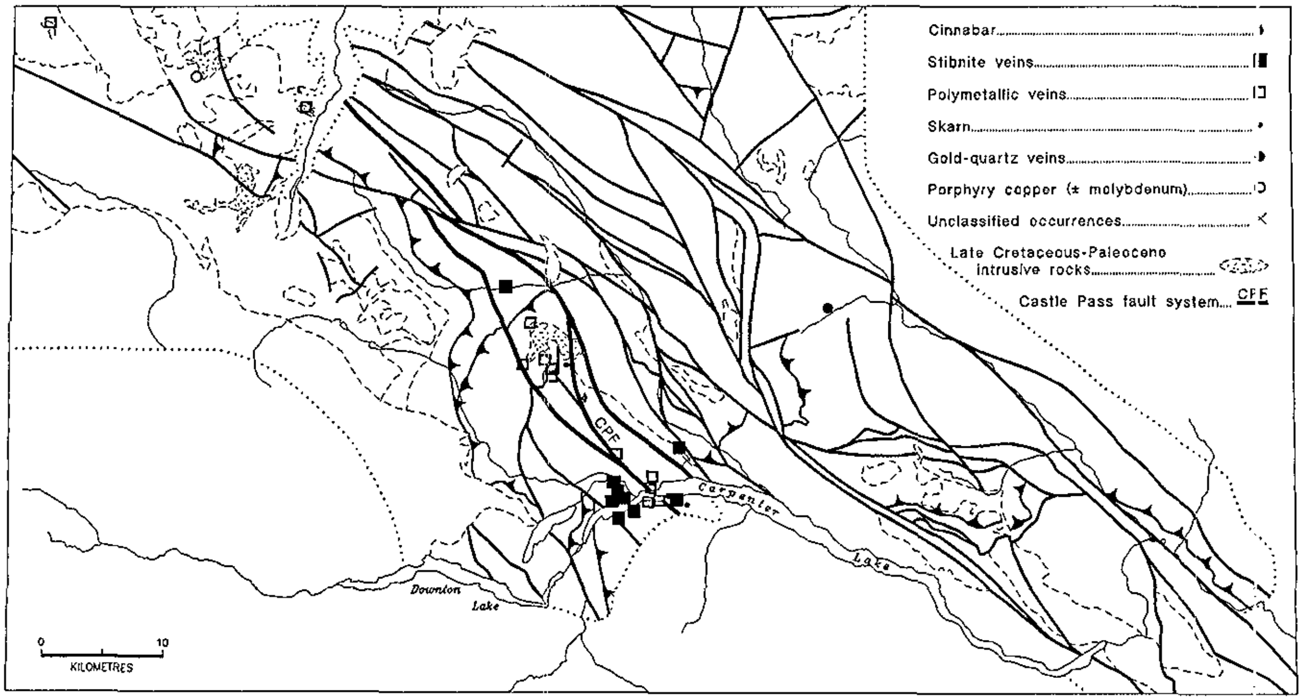

Figure 37. Map showing the distribution of Late Cretaceous to Paleocene mineral occurrences, along with associated structures and plutonic rocks.

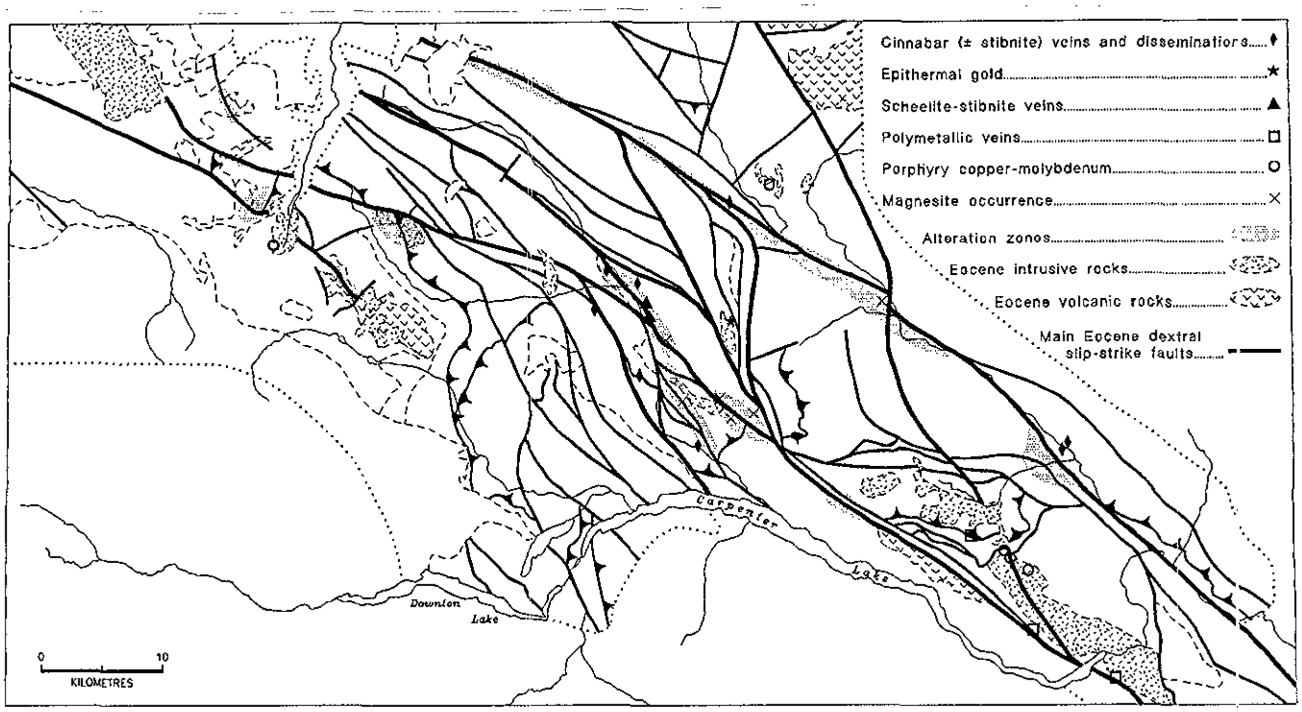

Figure 38. Map showing the distribution of late Paleocene to Eocene mineral occurrences, along with associated structures and plutonic rocks.

are anomalous in mercury and antimony, and a number of cinnabar±stibnite mineral occurrences, some with past production, occur along strands of the Yalakom, Relay Creek and Fortress Ridge fault systems (Figure 38). Higher temperature scheelite-stibnite veins along the Relay Creek fault system may have been localized in an area of synchronous intrusions.

Intrusion and associated porphyry mineralization at Poison Mountain was late Paleocene to early Eocene in age. This is the only mineral occurrence in the area northeast of the Yalakom fault, and as it predates much of the Eocene dextral strike-slip on the fault, may have originated a considerable distance northwest of the mineral occurrences on the other side of the fault.

Porphyry intrusions associated with the Mount Sheba volcanic complex are apparently of early Eocene age (Archibald *et al.*, 1989; Appendix 7). One of these, which intrudes the Relay Mountain Group and Last Creek formation on the north side of Tyaughton Creek, is largely carbonate-clay-altered and, together with associated rhyolite, contains local zones of silicification and pyrite-arsenopyrite mineralization. The alteration and sulphide concentrations may be broadly coeval with the plutonic-volcanic complex or, alternatively, may relate to the younger Fortress Ridge fault system.

Three Middle Eocene granodioritic plutons were localized within the Yalakom - Fortress Ridge - Chita Creek dextral fault system. The Lorna Lake and Mission Ridge plutons have associated porphyry mineralization, and the Mission Ridge pluton is also associated with peripheral polymetallic veins. An extensive alteration zone west of the Lorna Lake stock may also be of this age but; alternatively, may be related to the 64 Ma Dorrie Peak stock. The largest of the three Middle Eocene intrusions, the Beece Creek pluton, contains no known mineral occurrences but is locally altered and may warrant further exploration.

Epithermal-style mineralization at Big Sheep Mountain is associated with a plutonic-volcanic stock that was intruded into a large extensional transfer zone between the Marshall Creek and Yalakom faults. This zone is a major dilational jog that may have considerable potential for additional epithermal mineralization.

CHAPTER 5
TECTONIC IMPLICATIONS

REGIONAL CORRELATION AND SIGNIFICANCE OF MAIN LITHOTECTONIC ASSEMBLAGES

BRIDGE RIVER TERRANE

The Bridge River Terrane is represented mainly by the Bridge River Complex, which includes Mississippian to Middle Jurassic chert, pillowed and massive greenstone, limestone, clastic rocks and blueschist. The Taseko - Bridge River map area encompasses the northwestern end of the main outcrop belt of the Bridge River Complex. Along strike to the northwest is the main exposure belt of Jura-Cretaceous clastic sedimentary rocks of the Tyaughton basin, which extends continuously along the southwest side of the Yalakom fault for 80 kilometres to Chilko Lake (Figure 39). At the southeast end of this belt, within the Taseko - Bridge River map area, this clastic succession is inferred to have been deposited above the Bridge River Complex (*see* Chapter 2). The Tyaughton basin belt is also bounded on its northwest side by sparse exposures of the Bridge River Complex (Riddell *et al.*, 1993a,b), indicating that the Bridge River Complex probably underlies, in the subsurface, the entire belt of clastic sedimentary rocks. The exposures at the northwest end of the belt, east of Chilko Lake, are bounded to the north by fault-bounded panels of Cadwallader and Methow terranes, and are the northernmost known exposures of the Bridge River Complex.

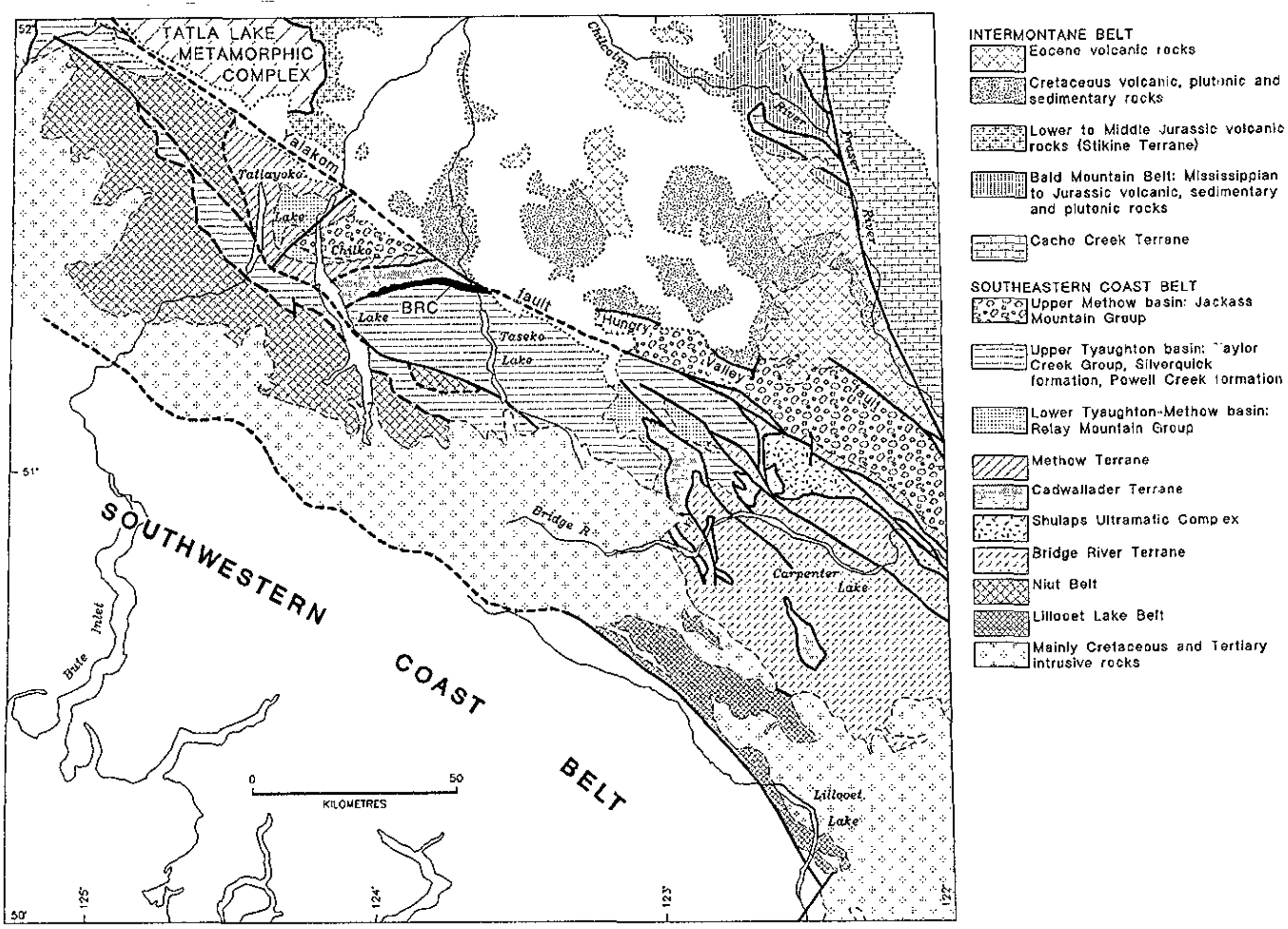

Figure 39. Map showing the distribution of major tectonostratigraphic elements of the southeastern Coast Belt in the Pemberton, Taseko Lakes and Mount Waddington map sheets. BRC=narrow lens of Bridge River Complex east of Chilko Lake. Map is based on the compilations of Schiarizza *et al.* (1994) and Monger and Journeay (1994).

The Bridge River Terrane also includes local exposures of clastic sedimentary rocks assigned to the Gun Lake and Downton Lake units in the southern part of the Taseko - Bridge River map area. These undated rocks rest stratigraphically above the Bridge River Complex, and are correlated with the Cayoosh assemblage, a thick succession of Jura-Cretaceous clastic sedimentary rocks that conformably overlies the Bridge River Complex farther to the south (Journeay and Northcote, 1992; Mahoney and Journeay, 1993; Journeay and Mahoney, 1994). Parts of the Cayoosh assemblage, including the Gun Lake unit, may correlate with the basal unit of the Relay Mountain Group, which is also inferred to have been deposited directly above the Bridge River Complex. Parts of the Cayoosh assemblage are probably older, however, as basal turbidites of the assemblage locally overlie, with apparent conformity, limestone-bearing portions of the Bridge River Complex which have yielded Upper Triassic (Norian) conodonts (Journeay and Mahoney, 1994). This suggests that the onset of sustained clastic sedimentation was markedly diachronous within the Bridge River basin.

The Bridge River Complex and overlying Cayoosh assemblage outcrop in a belt that extends for about 150 kilometres southeastward from the Bridge River area, where it is truncated by the Fraser River fault. Rocks correlative with the Bridge River Complex on the east side of the fault comprise Permian to Jurassic chert, greenstone and pelite of the Hozameen Group, which outcrops within the eastern Cascade foldbelt of southern British Columbia and adjacent Washington state (Haugerud, 1985; Monger, 1989). The metachert and metabasite-bearing Napeequa unit (Mad River Terrane) and Twisp valley schists of the Cascade Metamorphic Core may also correlate with the Bridge River Complex (McGroder, 1991; Miller *et al.*, 1993b). Other potentially correlative assemblages include the Cogburn Group within the metamorphic culmination of the southeastern Coast Belt east if Harrison Lake, and the Elbow Lake Formation within the northwest Cascade system to the south (Monger and Journeay, 1994). Structurally higher levels within this part of the orogen may correlate with the Cayoosh assemblage; these include the Settler schist of the southeastern Coast Belt, (Monger and Journeay, 1994), the Chiwaukum schist of Nason Terrane within the Cascade Metamorphic Core (McGroder, 1991) and the Darrington phyllite and Shuksan greenschist-blueschist of the Northwest Cascades Thrust System (Monger, 1991b).

The Bridge River Complex may also correlate with chert, basalt and limestone of the Deadman Bay Terrane (including Deadman Bay volcanics and Orcas chert, Brandon *et al.*, 1988), which is a component of the San Juan thrust system (*see* Figure 42). This correlation is based on a very close correspondence in the known ages of chert, as those in the Deadman Bay Terrane are mainly Permian to Lower Jurassic, but also include a single Mississippian locality (Whetten *et al.*, 1978), as well as comparable geochemistry of basalts, which resemble tholeiitic and alkalic basalts of modern ocean islands (Potter, 1983, 1986, Brandon *et al.*, 1988; Macdonald, 1990a,b). The Deadman Bay Terrane also includes Upper Triassic limestone, comparable to most limestone bodies in the Bridge River Complex, but also includes Permian limestone containing Tethyan fusilinids (Brandon *et al.*, 1988).

The Bridge River Complex in the Taseko - Bridge River area is thought to have accumulated as an accretion-subduction complex on the basis of its wide age range, the apparent lack of an internal stratigraphy, commonly observed outcrop-scale tectonic disruption, and presence of Middle to Late Triassic blueschist. Accretionary tectonics, presumably related to subduction, apparently continued until at least latest Middle Jurassic time, as cherts of this age are known to be imbricated within the complex (Cordey and Schiarizza, 1993) whereas clastic rocks which overlie the complex (Gun Lake unit and Relay Mountain Group) display a coherent stratigraphy. The continuous sedimentation recorded across the contact between more coherent sections of Bridge River Complex and the overlying Jura-Cretaceous Cayoosh assemblage farther to the south indicates that the early to mid Mesozoic phase of accretionary tectonics did not effect all parts of the complex or completely close the Bridge River ocean basin. However, by late Middle Jurassic time the basin had narrowed to the extent that younger sedimentation was dominated by clastic deposits, perhaps derived from flanking arc terranes (Mahoney and Journeay, 1993; Journeay and Mahoney, 1994). A later pulse of subduction-related deformation within Bridge River Terrane may be recorded by Early Cretaceous blueschists of the Shuksan Terrane of the North Cascade Mountains, which have been correlated with the Settler schist and Cayoosh assemblage of the southeastern Coast Belt (Monger. 1991b; Monger and Journeay, 1994). This episode may have led to final closure of the Bridge River basin, and culminated in the mid to early Late Cretaceous contractional deformation that characterizes the southeastern Coast - north Cascade orogen. Mid-Cretaceous clastic sedimentary rocks deposited in the Tyaughton - Methow basin during this contractional deformation contain detritus derived from the Bridge River Complex and provide the first record of uplift and erosion of Bridge River Terrane (Garver, 1989, 1992).

Some workers (*e.g.* Rusmore *et al.*, 1988; Rusmore and Woodsworth, 1991a) have correlated the Bridge River Complex with parts of the Cache Creek Terrane, which outcrops between Quesnel and Stikine terranes in the Intermontane Belt. Although the two assemblages are broadly similar in structural style and lithologic components, including Triassic blueschists, there are also important differences that argue against their correlation. The first is a significant disparity in the youngest known radiolarian cherts, which are late Middle Jurassic in the Bridge River Complex and Late Triassic in southern Cache Creek Terrane; Early or Middle Jurassic radiolarians extracted from the western Cache Creek are in tuffaceous argillite, and therefore record a different type of sedimentation (Cordey *et al.*, 1987; Cordey and Schiarizza, 1993). A second important difference is based on the structural relationships exposed in the Taseko - Bridge River map area (Chapter 3), which suggest that Bridge River Terrane originated west of Cadwallader Terrane. This does not support the proposed reconstructions of Rusmore and Woodsworth (1991a) which suggest that the Cache Creek - Bridge River basin lay east of a system of arcs represented by Stikine and Cadwallader terranes. Finally, relationships in the southeastern Coast Belt indicate that the Bridge River ocean basin remained open well into the latter part of the Mesozoic (Journeay and Mahoney, 1994), and that its final collapse, coupled with uplift and erosion of its contents, did not occur until mid-Cretaceous time (Garver, 1989, 1992). This contrasts markedly with the history of Cache Creek Terrane, which was uplifted and eroded following its amalgamation with adjacent terranes in Early Jurassic time (Monger *et al.*, 1982).

The above differences indicate that the Bridge River and Cache Creek terranes had distinctly different mid to late Mesozoic histories. They do not preclude the possibility that Cache Creek and Bridge River terranes contain remnants of the same late Paleozoic - early Mesozoic ocean basin, or that the Triassic component of accretion within the Bridge River Complex may have somehow been linked to that of Cache Creek Terrane. A late Paleozoic link between the two terranes is supported by some faunal data, as Permian limestones within both the Cache Creek Terrane and the Bridge River - correlative(?) Deadman Bay Terrane of the San Juan Islands contain Tethyan fusilinids (Monger and Ross, 1971).

CADWALLADER TERRANE

The Taseko - Bridge River map area includes the type area of Cadwallader Terrane (Rusmore, 1987; Umhoefer, 1990), which includes the Upper Triassic Cadwallader and Tyaughton groups together with Lower to Middle Jurassic rocks of the Last Creek formation and Junction Creek unit. The chemical characteristics of the volcanic rocks, together with the compositions of associated clastic rocks, suggest that Cadwallader Terrane represents part of a Late Triassic volcanic arc and associated Late Triassic to Middle Jurassic fringing sedimentary apron (Rusmore *et al.*, 1988). The rocks of Cadwallader Terrane are imbricated with Permian ophiolitic rocks of the Bralorne-East Liza Complex throughout the Taseko - Bridge River map area. Together, these two assemblages comprise a widespread composite thrust sheet that typically occurs structurally above the Bridge River Complex and Tyaughton basin across southwest-directed thrust faults. The Cadwallader Terrane - Bralorne-East Liza thrust sheet is in turn structurally overlain by the Shulaps Ultramafic Complex in the Shulaps Range.

Rocks that are readily correlated with Cadwallader Terrane extend for about 35 kilometres south of the Taseko - Bridge River map area, where the Cadwallader Group and Bralorne-East Liza Complex are imbricated with Bridge River Complex and Cayoosh assemblage in the southeastern continuation of the Eldorado - Bralorne fault system northwest of Anderson Lake (Figure 39; Journeay, 1993). A separate belt of Cadwallader Terrane rocks outcrops east of Chilko Lake, about 100 kilometres northwest of Gold Bridge (Figure 39). This belt consists of the Hurley Formation and overlying Junction Creek unit, and is in fault contact with Methow Terrane to the north and Bridge River Complex and Tyaughton basin to the south (Riddell *et al.*, 1993a.b). It is interpreted as an offset continuation of the Cadwallader Terrane exposed in the Camelsfoot Range of the Taseko - Bridge River map area, which has been displaced about 115 kilometres along the Yalakom fault.

Cadwallader Terrane is inferred to have originated east of Bridge River Terrane because it typically occurs structurally above the Bridge River Complex across southwest-directed thrust faults (Chapter 3). This relative paleogeographic positioning is consistent with the present distribution of terranes along the northeastern margin of the southeastern Coast Belt in the Camelsfoot Range and its offset counterpart east of Chilko Lake, comprising, from northeast to southwest, Methow, Cadwallader and Bridge River (Figure 39). It is also consistent with the invariable structural association of Cadwallader Terrane with ophiolitic rocks of the Bralorne-East Liza Complex, as these rocks may correlate with the Spider Peak Formation and Coquihalla serpentine belt, which comprise the basement to Methow Terrane in the East Cascade fold belt to the southeast (Ray, 1986). The Cadwallader and Bridge River terranes are overlapped by Jura-Cretaceous clastic sedimentary rocks of the Tyaughton - Methow basin (see later section), whereas older arc-related volcanism and sedimentation within Cadwallader Terrane overlapped in time with subduction-related deformation and metamorphism within Bridge River Terrane. It is reasonable to infer, therefore, that the two terranes may have been linked by Middle to Late Triassic time, with the Cadwallader arc forming on an overriding plate above the Bridge River subduction zone.

A separate belt containing Upper Triassic arc-related rocks that have been assigned to the Cadwallader Group outcrops in the Lillooet Lake area, to the southwest of Bridge River Terrane (Figure 39). The Triassic rocks of this belt contain a more varied assemblage of mafic to felsic volcanic rocks than are found in the type area of the Cadwallader Group (Riddell, 1992), and they do not include thick sedimentary intervals that can be unequivocally correlated with the Hurley Formation, which dominates exposures of the Cadwallader Group in the vicinity of its type area. Furthermore, the Triassic rocks of the Lillooet Lake belt are locally overlain by Lower to Middle Jurassic arc-like volcanic rocks correlated with Harrison Lake Formation (Figure 40; Journeay and Mahoney, 1994), which contrast markedly with the Lower to Middle Jurassic shales of Cadwallader Terrane in its type area to the northeast (Umhoefer, 1990; Riddell *et al.*, 1993a; this report). Along strike to the northwest of the Lillooet Lake belt is another sequence of Triassic arc volcanics (Niut belt of Figures 39 and 40), which has been correlated with Stikine Terrane (Mount Moore and Mosley formations, Rusmore and Woodsworth, 1991a). These rocks may correlate with those of the Lillooet Lake belt on the basis of general lithologic similarity, their along strike position, and the presence of Triassic quartz dioritic intrusive rocks within both belts (Riddell, 1992; Mustard and van der Heyden, 1994). Furthermore, the Triassic successions within both belts are associated with younger sequences of volcanic and sedimentary rocks that may correlate with the Lower Cretaceous Gambier Group (Cerulean Lake unit of the Lillooet Lake belt, Riddell, 1992; Ottarasko and Cloud Drifter formations of the Niut belt, Rusmore and Woodsworth, 1989). The relationship of the Lillooet Lake and Niut belts to the type Cadwallader Group is uncertain, as they are presently on opposite sides of Bridge River Terrane. Their present distribution (Figure 39) sug-

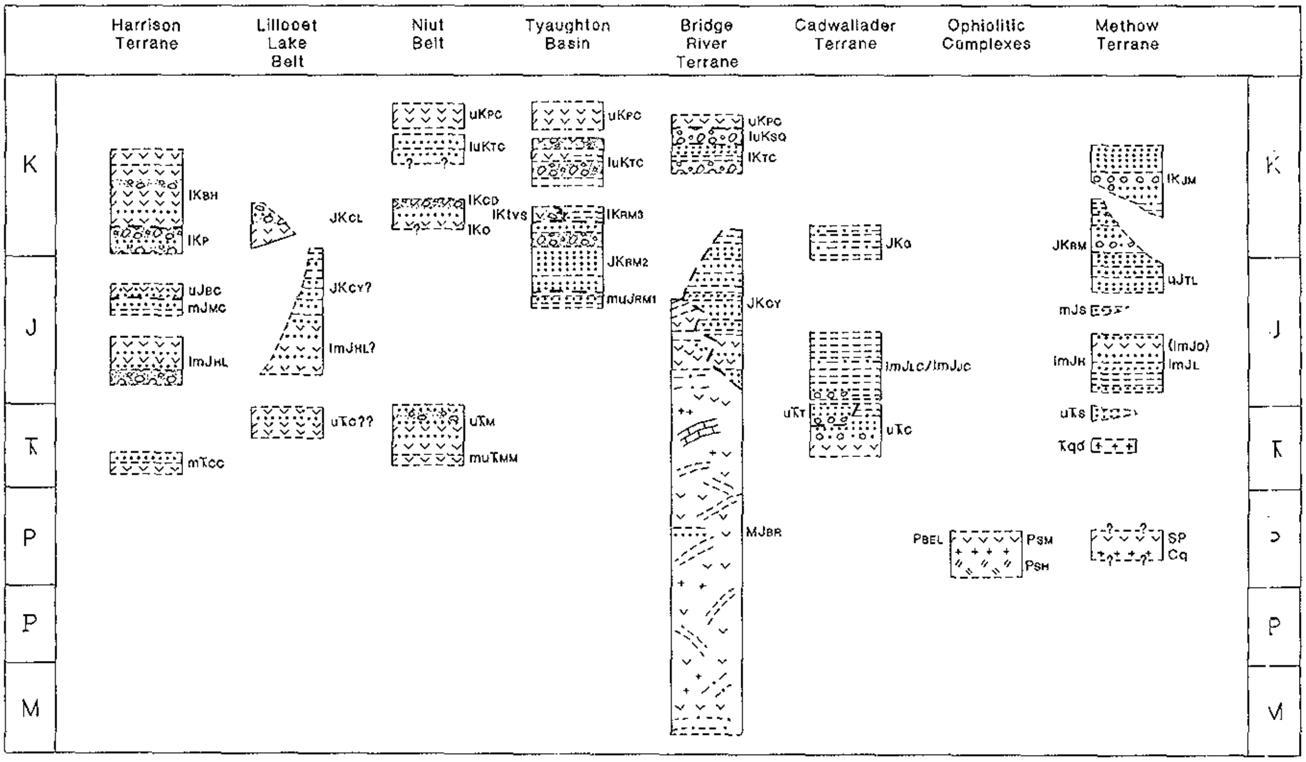

Figure 40. Correlation chart of tectonostratigraphic assemblages in the southeastern Coast Belt. Harrison Terrane (Arthur *et al.*, 1993): lKBH=Brokenback Hill Fm; lKP=Peninsula Fm; uJBC=Billhook Creek Fm; mJMC=Mysterious Creek Fm; lmJHL=Harrison Lake Fm; mꞔCC= Camp Cove Fm. Lillooet Lake Belt (Riddell, 1992; Journeay and Mahoney, 1994): JKCL=Cerulean Lake unit; JKCY=Cayoosh assemblage; lmJHL=Harrison Lake Fm; uꞔC=Cadwallader Gp. Niut Belt (Rusmore and Woodsworth, 1991a; Umhoefer *et al.*, 1994): lKCD=Cloud Drifter fm; lKO=Ottarasko fm; uꞔM=Mosley fm; muꞔMM=Mount Moore fm. Tyaughton Basin (this study): uKPC=Powell Creek fm; luKSQ=Silverquick fm; lKTC and luKTC=Taylor Creek Gp; lKtvs=Tosh Creek succession; lKRM3, JKRM2 and muJRM1=Relay Mountain Group. Bridge River Terrane (this study; Mahoney and Journeay, 1993; Journeay and Mahoney, 1994): JKCY=Cayoosh assemblage; MJBR=Bridge River Complex. Cadwallader Terrane (this study): JKG=Grouse Creek unit; lmJLC=Last Creek fm; lmJJC=Junction Creek unit; uꞔT=Tyaughton Group; uꞔC=Cadwallader Group. Ophiolitic Complexes (this study): PBEL=Bralorne-East Liza Complex; PSM=Shulaps serpentinite mélange unit; PSH=Shulaps harzburgite unit. Methow Terrane (this study; Coates, 1974; O'Brien, 1986, 1987; Ray, 1986; Schiarizza *et al.*, 1995; Schiarizza, 1996): lKJM=Jackass Mountain Group; JKRM=Relay Mountain Group; uJTL=Thunder Lake sequence; mJs=Callovian shale unit; lmJD=Dewdney Creek Fm; lmJH=Huckleberry fm; lmJL=Ladner Gp; uꞔs=upper Triassic rocks along Tatlayoko Lake; ꞔqd=Mount Skinner Igneous Complex; SP=Spider Creek formation; Cq=Coquihalla serpentine belt.

gests the possibility that the Lillooet, Niut and Cadwallader belts are components of a once-continuous arc system that bounded the Bridge River ocean basin to the west, north and northeast. Alternatively, the Lillooet Lake - Niut belt and the Cadwallader Terrane may represent completely different arc sequences that formed on opposite sides of the Bridge River ocean basin. Other interpretations are also possible, but must be consistent with the contrasting structural positions of the type Cadwallader Terrane and the Lillooet Lake belt, on opposite sides of Bridge River Terrane. One other way to achieve this distribution is by pre-Hauterivian sinistral displacement of the northern portion of the Cadwallader arc system to a more southerly and outboard position now represented by the Lillooet Lake belt (*e.g.* Monger *et al.*, 1994).

Conglomerates exposed in the Intermontane Belt north of the Chilcotin River, more than 100 kilometres north of the type area of the Cadwallader Group, were correlated with the Hurley Formation by Rusmore and Woodsworth (1991a), although they did not map the area or study the conglomerates in detail. The correlation is based on general similarity of clast types, which include limestone, volcanic and plutonic rock fragments, and the presence of rare clasts of bright greenish-turquoise-coloured siliceous tuff that appear identical to those in the type area of the formation (Rusmore, 1985, 1987). This area was subsequently mapped by Read (1992, 1993), who established that the conglomerates are in the upper part of a thrust-imbricated succession that lies structurally beneath the Cache Creek Terrane, and includes Mississippian to Pennsylvanian greenstone with minor limestone lenses, Upper Permian felsic to mafic volcanics, Late Permian quartz monzonite, granodiorite and diorite, Middle to Upper Triassic limestone and associated siltstone and calcareous sandstone, undated conglomerate and quartz-bearing feldspathic sandstone, and Lower Jurassic shale (Bald Mountain Belt of Figure 39). The conglomerates, which have yielded a limestone clast containing Middle to Late Triassic conodonts, were correlated with the Hurley Formation by Rusmore and Woodsworth (1991a), but were assigned a Jurassic age by Read (1992, 1993). More recently, however, Read *et al.* (1995) have accepted the correlation of Rusmore and Woodsworth, and refer to the entire Mississippian to Jurassic succession within the Bald Mountain belt as Cadwallader Terrane. Nevertheless, we consider the correlation suspect, in part because the older rocks of the Bald Mountain belt are dissimilar to those associated with Cadwallader Terrane in its type area. An alternative correlation, more consistent with the overall stratigraphy of the Bald Mountain belt, as well as its structural position beneath Cache Creek Terrane, is that the Late Permian mafic to felsic volcanics and associated intrusions correlate with similar Late Permian to Early Triassic bimodal volcanic rocks and associated intrusions of the Kutcho Formation (Thorstad and Gabrielse, 1986; Thompson *et al.*, 1995) in northern British Columbia and potentially correlative rocks of the Sitlika assemblage (Paterson, 1974) in central British Columbia. If this correlation is correct, then the Triassic limestone and associated conglomerates, sandstones and shales of the Bald Mountain belt might correlate with lithologically similar Triassic and Jurassic rocks of the Sinwa and Inklin formations, which overlie the Kutcho Formation.

METHOW TERRANE

Within the Taseko - Bridge River map area, Methow Terrane consists of Lower to Middle Jurassic sedimentary and local volcanic rocks that correlate, at least in part, with the Dewdney Creek Formation of the Ladner Group, together with overlying Lower Cretaceous clastic sedimentary rocks of the Jackass Mountain Group. This follows the definition of Methow Terrane by Wheeler *et al.* (1991), and is consistent with the distinctive lithologic and stratigraphic attributes of both the Jurassic and Cretaceous parts of the succession, when compared to coeval rocks of Bridge River and Cadwallader terranes and the Tyaughton basin. The provenance studies of Garver (1989, 1992) and Garver and Brandon (1994) indicate, however, that the Jackass Mountain Group correlates with parts of the Taylor Creek Group of the Tyaughton basin. Furthermore, Jura-Cretaceous rocks within parts of Methow Terrane outside the Taseko - Bridge River map area correlate with the Relay Mountain Group of the Tyaughton basin (Schiarizza *et al.*, 1995), which overlies Bridge River and Cadwallader terranes. The Upper Jurassic to Lower Cretaceous rocks included in Methow Terrane are therefore part of an overlap assemblage that links the lower part of the terrane with Bridge River and Cadwallader terranes. These rocks will be discussed in a later section on the Tyaughton - Methow basin, whereas the term Methow Terrane is retained for Middle Jurassic and older rocks, which will be discussed here.

Methow Terrane, together with overlying Jura-Cretaceous clastic sedimentary rocks comprising the Methow portion of the Tyaughton - Methow basin, comprises the northeastern element of the southeastern Coast - north Cascade orogen from the vicinity of Chilko Lake southeastward to northern Washington state (*see* Figure 31). Within the Eastern Cascades fold belt, east of the Fraser River fault, Lower to Middle Jurassic rocks of Methow Terrane consist of mainly fine-grained clastic sedimentary rocks of the Ladner Group, which in its upper part includes a distinctive assemblage of upper Toarcian to Bajocian volcanic and sedimentary rocks assigned to the Dewdney Creek Formation (O'Brien, 1986, 1987). The Dewdney Creek Formation includes a proximal eastern facies that includes arc-related pyroclastic rocks and lava flows together with clastic sedimentary rocks, and a more distal western facies that consists of volcanic-derived coarse-grained sandstones and conglomerates intercalated with thin-bedded sandstone, siltstone and argillite (Mahoney, 1993). These Middle Jurassic rocks are markedly different from age-equivalent strata found within other major tectonostratigraphic assemblages of the southeastern Coast Belt, as the Middle Jurassic portion of Cadwallader Terrane is predominantly shale with no coarser clastics and no volcanic rocks (Umhoefer, 1990; Schiarizza *et al.*, 1993b), and the Middle Jurassic of the Bridge River Terrane is mainly chert (Cordey and Schiarizza, 1993). The base of the Ladner Group is exposed locally, where it rests stratigraphically above a sequence of ocean floor basalts and associated gabbro and ultramafic rock assigned to the Spider Peak Formation and Coquihalla serpentine belt (Ray, 1986). These basement rocks are not directly dated, but may in part be Lower Triassic if interpillow chert breccias in the Spider Peak basalts were the source of an Early Triassic chert clast within the overlying Ladner Group (Ray, 1986).

Within the Taseko - Bridge River map area, Methow Terrane comprises part of a belt that has been traced continuously for about 140 km (*see* Figure 31). It is separated from adjacent tectonostratigraphic assemblages of the southeastern Coast Belt to the southwest by the Yalakom and Camelsfoot faults, and is offset from the belt of Methow Terrane rocks in the East Cascade fold belt along the Fraser River fault. The Jurassic rocks (including Units lmJvs, mJcs and mJyv of this report) are correlated with the Dewdney Creek Formation (specifically the western facies of Mahoney, 1993) on the basis of lithology, late Toarcian to Bajocian age range, and stratigraphic position beneath the Jackass Mountain Group (Schiarizza *et al.*, 1990a; Mahoney, 1992, 1993). Older rocks, equivalent to the Boston Bar Formation of O'Brien (1986, 1987) have not been positively identified within this belt, but might be represented by shales and siltstones in the lower part of the fault slice that crosses Swartz Lake (Figure 3).

Lower to Middle Jurassic rocks in the Chilko Lake area were included in Cadwallader Terrane by Wheeler *et al.* (1991) but are assigned to Methow Terrane by Riddell *et al.* (1993a) and Schiarizza *et al.* (1995) (Figure 39). This assignment is based on correlation of Aalenian to Bajocian rocks within the succession, which include thick beds of volcanic-derived sandstone and granule conglomerate, as well as local occurrences of andesitic breccias, tuffs and flows, with the Dewdney Creek Formation. It is consistent with their stratigraphic position beneath the Jackass Mountain Group, as well as with structural arguments which indicate that these rocks are an extension of the Methow Terrane belt exposed in the Taseko - Bridge River map area, offset by 115 kilometres of dextral displacement along the Yalakom fault (Riddell *et al.*, 1993a). The Jurassic rocks of Methow Terrane west of Chilko Lake are locally underlain by Upper Triassic shallow marine to nonmarine clastic rocks, including granitoid-bearing conglomerates, that overlie quartz diorite plutons of early Late Triassic age (Schiarizza *et al.*, 1995; Schiarizza, 1996). These Upper Triassic rocks resemble parts of the Tyaughton Group (Cadwallader Terrane) in lithology and faunal content (Tipper, 1969), which suggests the possibility that Cadwallader and Methow terranes are different facies of a single arc - basin system. This is consistent with their shared paleogeographic position east of Bridge River Terrane, and the fact that both terranes include arc volcanics that are coeval with subduction-accretion tectonics within the Bridge River Complex.

OPHIOLITIC ASSEMBLAGES

Late Paleozoic ophiolitic rocks in the Taseko - Bridge River map area are assigned to either the Shulaps Ultramafic Complex or the Bralorne-East Liza Complex. The Shulaps Complex includes most of the elements of a complete ophiolite succession, but the original igneous stratigraphy has been dismembered and largely inverted during structural telescoping. The internal deformation was apparently coincident with thrust emplacement of the Shulaps Complex above Cadwallader Terrane and the Bralorne-East Liza Complex, which lie beneath the Shulaps complex across a southwest-vergent thrust system that is exposed near the headwaters of East Liza Creek. Other external contacts are younger strike-slip and normal faults related to the Yalakom - Marshall Creek fault system. Greenstone, gabbro, diorite and associated rocks of the Bralorne-East Liza Complex are imbricated with Cadwallader Terrane throughout the Taseko - Bridge River area (Figure 8). These rocks are correlated with plutonic blocks found within the Shulaps serpentinite mélange unit on the basis of lithologic similarity and coincident isotopic ages.

Wright *et al.*, (1982) included the Shulaps and Bralorne-East Liza complexes in their Bridge River Ophiolite assemblage, and Potter (1983, 1986) included the Shulaps Complex within Bridge River Terrane and interpreted it to be a fragment of oceanic mantle and crust that formed the basement to the Bridge River Complex. The structural relationships documented during the present study, however, indicate that the Shulaps and Bralorne-East Liza Complexes are thrust above and imbricated with Cadwallader Terrane, and that the Bridge River Complex occurs at a lower structural level, beneath Cadwallader Terrane, within the southwest-vergent thrust stack generated in mid-Cretaceous time. These relationships suggest that the Shulaps and Bralorne-East Liza complexes are not part of Bridge River Terrane, but, rather, represent oceanic crust that originated beneath, or east of, Cadwallader Terrane.

Greenstones and gabbros of the Bralorne-East Liza Complex and Shulaps serpentinite mélange unit are lithologically and chemically similar to those of the Spider Peak Formation and associated Coquihalla serpentine belt, which comprise the basement to Methow Terrane in the East Cascade fold belt (Ray, 1986). Derivation of the Shulaps Complex from Methow Terrane is possible given that the Shulaps Complex is the structurally highest and presumably most easterly-derived element of the mid-Cretaceous thrust stack exposed west of the Yalakom fault. Furthermore, when the 115 kilometres of dextral displacement known from other correlations is restored along the Yalakom - Hozameen fault system (after it is restored to a single fault by removing 70 to 80 kilometres of dextral offset along the Fraser River fault) the Shulaps Complex and Coquihalla serpentine belt are brought together (*see* Figure 31). Assuming that this correlation is correct, the intimate relationship between Cadwallader Terrane and the Bralorne-East Liza Complex may reflect their imbrication within a wide duplex zone generated during obduction of the Shulaps ophiolite above Cadwallader Terrane. Alternatively, or in addition, this intimate relationship may reflect a stratigraphic relationship between Cadwallader Terrane and the Bralorne-East Liza Complex, which would indicate that the Cadwallader and Methow terranes were deposited above the same or similar oceanic basement.

A model consistent with the structural relationships and correlations summarized above has the Shulaps, Bralorne-East Liza and Coquihalla complexes as part of an oceanic plate that originated to the east of a separate oceanic plate from which the Bridge River Complex was derived. Triassic-Jurassic subduction of the Bridge River plate beneath the Shulaps plate formed the Bridge River accretion-subduction complex, and also generated the Late Triassic and Middle Jurassic arc magmatism that formed Cadwallader and Methow terranes on the overriding plate.

TYAUGHTON - METHOW BASIN

The Tyaughton - Methow basin is a belt of Jura-Cretaceous clastic sedimentary rocks that occurs along the northeast side of the southeastern Coast - north Cascade orogen, where it was deposited above Bridge River, Cadwallader and Methow terranes. The basin developed in two distinct time intervals. The older part records a relatively long period of predominantly shallow water marine deposition in Late Jurassic and Lower Cretaceous time, that postdated a protracted episode of Triassic-Jurassic accretionary tectonics within the Bridge River Complex. Rocks deposited in this time interval are only locally exposed, in part because of erosion represented by a widespread mid-Cretaceous unconformity to disconformity (Schiarizza *et al.*, 1995). The upper part of the basin comprises mid-Cretaceous synorogenic clastic sedimentary rocks that were deposited above this unconformity. These rocks were partitioned into two stratigraphically distinct sub-basins, Tyaughton and Methow, that were separated by an intervening landmass uplifted during Cretaceous contractional deformation (Garver, 1989, 1992).

Within the southeastern Coast - north Cascade orogen, the lower part of the Tyaughton - Methow basin is best exposed in the Taseko - Bridge River map area, where it is represented by the Relay Mountain Group. The stratigraphic base of the group is not exposed in this area but, as discussed in Chapter 2, there is strong evidence that it was deposited above the Bridge River Complex, and that the Bridge River Complex underlies the main belt of Tyaughton basin rocks that extends from the present study area northwestward to Chilko Lake. This interpretation implies correlation of the Relay Mountain Group with at least parts of the Cayoosh assemblage, which overlies the Bridge River Complex to the south (Mahoney and Journeay, 1993; Journeay and Mahoney, 1994). This correlation is supported by the lithologic similarity between the basal unit of the Relay Mountain Group and the Gun Lake unit (Cayoosh assemblage) exposed in the southern part of the Taseko - Bridge River map area, and by the presence of Lower Cretaceous *Buchia*-bearing sandstones in the upper part of the Cayoosh assemblage farther to the southeast (Journeay and Mahoney, 1994). The Jura-Cretaceous, *Buchia*-bearing Truax Creek conglomerate may also represent a Relay Mountain-correlative within the Cayoosh assemblage directly south of Carpenter Lake, but, because it occurs as a fault-bounded lens, stratigraphic relationships have not been established.

Although the main belt of Tyaughton basin rocks within and northwest of the Taseko - Bridge River map area is interpreted to have been deposited above the Bridge River Complex, Jura-Cretaceous siltstones and fine-grained sandstones that are exposed locally in the Camelsfoot thrust belt (Grouse Creek unit of this report) are in apparent stratigraphic contact with Cadwallader Terrane. Furthermore, a separate belt of Relay Mountain Group rocks that is well exposed 100 kilometres northwest of the type area, between Chilko and Tatlayoko lakes (Tipper, 1969a; Figure 39), is in stratigraphic contact with Middle Jurassic rocks that are correlated with the Dewdney Creek Formation of Methow Terrane (Schiarizza *et al.*, 1995). Correlative Late Jurassic *Buchia*-bearing sandstones also occur within the Methow Terrane belt of the Eastern Cascades fold belt, where they were assigned to the Thunder Lake sequence by O'Brien (1986, 1987) and inferred to disconformably overlie the Ladner Group. Within the same belt, however, a separate interval of Upper Jurassic argillites containing thin *Buchia*-bearing sandstone horizons is included within the Ladner Group and inferred to represent the upper part of a continuous Lower to Upper Jurassic sedimentary interval (Ray, 1986).

The above relationships indicate that the Relay Mountain Group and correlative rocks overlap Methow, Cadwallader and Bridge River terranes. Age-equivalent rocks are largely absent from the western part of the southeastern Coast Belt (Niut and Lillooet Lake belts of Figure 39) although correlatives may occur locally, as Journeay and Mahoney (1994) suggest that an undated succession of volcaniclastic sandstones and siltstones within the Lillooet Lake belt may comprise part of the Cayoosh assemblage (Figure 40). Rocks that may correlate with the Relay Mountain Group occur locally within the southwestern Coast Belt, where they comprise the Mysterious Creek, Billhook Creek, Peninsula and lower Brokenback Hill formations of Harrison Terrane (Arthur *et al.*, 1993). These upper Middle Jurassic to Lower Cretaceous rocks include shales, sandstones and conglomerates that are lithologically similar to the Relay Mountain Group, but the succession also contains volcanic tuffs and breccias that are not present within the Relay Mountain Group. They rest stratigraphically above the Harrison Lake Formation, which is intruded by the easternmost representatives of a suite of Late Jurassic plutons that extends across the entire southwestern Coast Belt, and intrudes rocks of Wrangellia Terrane along the western margin of the belt (Nelson, 1979; Monger, 1991a; Monger and Journeay, 1994). Therefore, if the rocks overlying the Harrison Lake Formation do correlate with the Relay Mountain Group, they link the terranes of the southeastern Coast Belt with those of the western Coast Belt and adjacent Insular Belt by late Middle Jurassic time.

Hauterivian volcanic and sedimentary rocks, age-equivalent to the upper part of the Relay Mountain Group, occur within the Niut belt, where they are represented by the Ottarasko and Cloud Drifter formations (Figure 40; Rusmore and Woodsworth, 1989; Mustard and van der Heyden, 1994). These rocks resemble age-equivalent volcanic and sedimentary rocks of the Gambier assemblage in the southwestern Coast Belt (Monger and Journeay, 1994), and may also correlate with part of the undated, but post-158 Ma, Cerulean Lake unit of the Lillooet Lake belt (Riddell, 1992). They are distinguished from the Relay Mountain Group by their volcanic component, although a transitional facies may be preserved in the southern part of the Niut belt, between Taseko and Chilko lakes, where Hauterivian volcanic rocks interfinger with Lower Cretaceous sedimentary rocks similar to the Relay Mountain Group (Tipper, 1978; McLaren, 1990). The Tosh Creek unit of the present study area may represent a part of this transitional facies, but it might be younger and correlate with volcanic-derived units of the Taylor Creek Group. Nevertheless, these relationships suggest that in Hauterivian time, arc-related volcanic and sedimentary rocks in the southwestern Coast Belt and western part of the southeastern Coast Belt were transitional eastward into purely sedimentary rocks deposited in the upper part of the Relay Mountain Group of the Tyaughton basin (Umhoefer *et al.*, 1994).

The upper part of the Tyaughton - Methow basin consists of thick sequences of synorogenic clastic sedimentary rocks that were deposited during mid-Cretaceous contractional deformation. These rocks occur as two distinct assemblages of contrasting lithology and stratigraphy, that are inferred to have been deposited in two sub-basins partitioned by an intervening highland that was uplifted during mid-Cretaceous tectonism (Figure 41; Garver, 1989, 1992). The eastern, Methow sub-basin was filled mainly from the east, but locally received detritus shed from the intervening highland to the west. The western, Tyaughton sub-basin was also infilled from both sides, and includes deposits that were derived from the same eastern source as the Methow part of the basin, which must have bypassed the intrabasinal highland.

Mid-Cretaceous rocks in the Tyaughton part of the basin are represented by the Taylor Creek Group and overlying Silverquick formation, which were deposited above the Bridge River Complex and Relay Mountain Group. Within the Taseko - Bridge River map area, these mid-Cretaceous rocks have been subdivided into 6 informal interfingering units that represent 3 distinct petrofacies (Garver, 1989, 1992). The volcanic petrofacies, including the Paradise and Elbow Pass formations, was derived from a western source terrane dominated by intermediate volcanic rocks, probably represented by Hauterivian to Albian volcanic rocks of the Gambier Group and correlatives, which outcrop in the western Coast Belt and the western part of the southeastern Coast Belt (McLaren, 1990; Monger, 1993; Arthur *et al.*, 1993; Umhoefer *et al.*, 1994; Lynch, 1995). The cherty petrofacies includes the Dash and Silverquick formations and the Beece

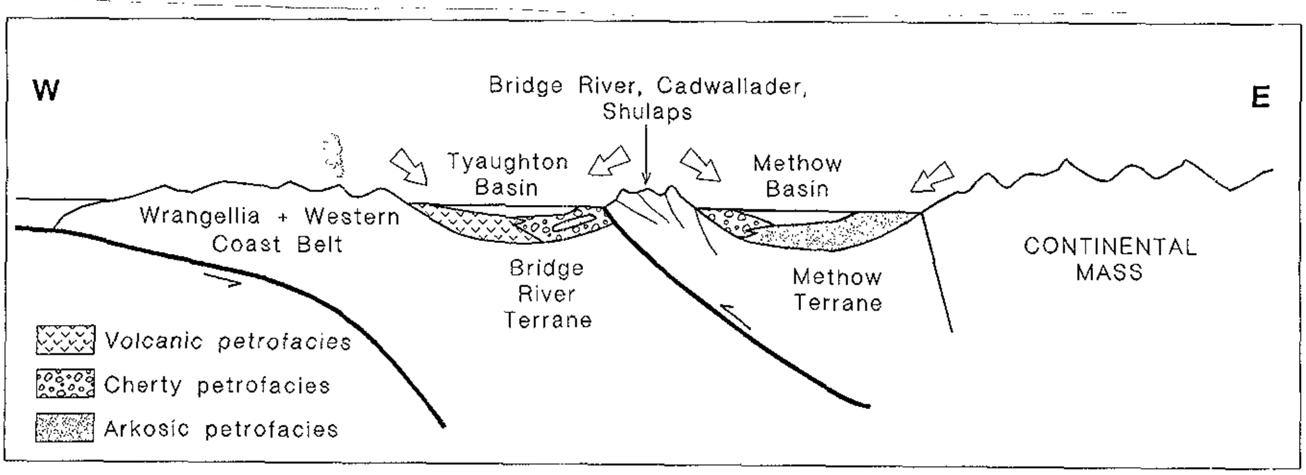

Figure 41. Schematic summary of the tectonic setting and inferred sediment sources of mid-Cretaceous rocks in the Tyaughton - Methow basin, after Garver (1989, 1992).

Creek succession. Provenance and paleocurrent data indicate that these rocks were derived from a source terrain to the east that was underlain by the Bridge River Complex (Figure 41). In addition to detritus supplied from the Bridge River Complex, however, the Silverquick formation and Beece Creek succession also contain a significant proportion of sandstone clasts. Some of these resemble the Upper Triassic Hurley Formation of Cadwallader Terrane, and some were probably derived from the underlying Lizard formation, indicating more than one pulse of uplift along the eastern margin of the basin (Garver, 1989, 1992). The arkosic petrofacies of the Tyaughton sub-basin is represented by the Lizard formation. Provenance studies, including fission-track dating of detrital zircons, indicate that these arkosic turbidites were derived from the same source terrain as the much thicker arkosic deposits of the Methow sub-basin to the east (Garver, 1989, 1992; Garver and Brandon, 1994), suggesting that the highland separating the two sub-basins was locally bypassed.

The Taylor Creek Group outcrops continuously from the Taseko - Bridge River area northwestward to Chilko Lake. The northwestern portion of the belt is composed mainly of shales and chert-bearing sandstones and conglomerates that are lithologically similar to the Beece Creek succession of the Taseko - Bridge River area (Riddell *et al.*, 1993a; Schiarizza *et al.*, 1995). The belt is truncated to the north by a fault-bounded belt of Cadwallader Terrane, and thin intervening slivers of Bridge River Complex and Relay Mountain Group. Since the latter two units are known to rest stratigraphically beneath the Taylor Creek Group in the present study area, they are inferred to underlie the group within this entire belt. A separate belt of Taylor Creek rocks outcrops on the southwest side of the Tchaikazan fault from the western part of the present study area to beyond Tatlayoko Lake (Figure 40; McLaren, 1990; Rusmore and Woodsworth, 1993; Mustard *et al.*, 1994). This belt includes abundant felsic, intermediate and local mafic volcanic rocks, as well as shales, lithic sandstones and chert-bearing pebble conglomerates. Although these rocks extend into the Niut Belt, external contacts are mainly faults, and stratigraphic ties with older rocks of the belt are not documented.

Upper Cretaceous volcanic rocks of the Powell Creek formation stratigraphically overlie the mid-Cretaceous clastic rocks of the Tyaughton sub-basin, with basal contacts that range from conformable to markedly unconformable. The most extensive exposures of the formation extend from the present study area to Chilko Lake, on the northeast side of the Tchaikazan fault. Exposures of more limited extent occur along the southwest side of the fault, west of Chilko Lake, and along the Klinaklini River in the northwest corner of Figure 40 (McLaren, 1990; Rusmore and Woodsworth, 1993; Mustard *et al.*, 1994; Schiarizza *et al.*, 1995). These rocks may represent the final pulse of Cretaceous arc-related volcanism within the southern Coast Belt. Their distribution suggests a general eastward migration of the main locus of this volcanism through time, as they are deposited above predominantly sedimentary rocks of the Tyaughton basin, which apparently pass westward into Hauterivian to Albian volcanic-dominated successions represented by western exposures of the Taylor Creek Group and the Gambier Group.

Mid-Cretaceous rocks of the Methow sub-basin are characterized by thick deposits of easterly-derived arkosic sandstone, and conglomerate containing granitoid and volcanic clasts. These rocks make up most of the Jackass Mountain Group, which occurs throughout the sub-basin, as well as the predominantly nonmarine Pasayten Group, which overlies the Jackass Mountain Group in the Canadian portion of the Eastern Cascades Fold Belt (Coates, 1974; Monger, 1989). Rocks correlative with the Jackass Mountain and Pasayten groups in northern Washington State include the Goat Creek, Panther Creek and Harts Pass formations, and the Winthrop sandstone (Barksdale, 1975; McGroder *et al.*, 1990). The arkosic rocks of the Methow sub-basin are mainly Albian in age, although they include somewhat older and younger strata in places (McGroder *et al.*, 1990). Southwest of the Yalakom fault, near Chilko and Tatlayoko lakes (Figure 40), arkosic rocks make up the entire Jackass Mountain Group and rest either directly above Middle Jurassic rocks of Methow Terrane, or above an intervening sliver of

Upper Jurassic Relay Mountain Group locally preserved beneath a sub-Jackass Mountain Group unconformity (Schiarizza *et al.*, 1995). Farther to the southeast, however, the arkoses generally overlie an interval of Lower Cretaceous volcanic-lithic sandstones, conglomerates and associated finer grained rocks that are included in the basal part of the Jackass Mountain Group (Units lKJMy1 and lKJMc1 of this report; Division A of Duffell and McTaggart, 1952 and Trettin, 1961; Unit 7 and part of Unit 8 of Coates, 1974). These basal rocks of the Jackass Mountain Group range from Hauterivian to Aptian in age. They, at least in part, may record the initial emergence of the eastern source terrane, prior to the major uplift and unroofing of the metamorphic and plutonic rocks that supplied detritus to the overlying arkoses within the Jackass Mountain Group (Garver, 1989, 1992). Relationships may be more complex, however, as their ages partially overlap those of Hauterivian and Barremian(?) rocks in the upper part of the Relay Mountain Group, which at the northwest end of the Methow sub-basin were deposited at the end of a protracted period of Jura-Cretaceous Relay Mountain sedimentation, then partially eroded prior to deposition of the Jackass Mountain arkoses (Schiarizza *et al.*, 1995).

Paleocurrent data, thickness variations and facies relationships indicate that the arkosic sediments of the Methow sub-basin were derived from the east to northeast (Cole, 1973; Coates, 1974; Kleinspehn, 1982, 1985). Provenance studies, including fission-track analyses of detrital zircons, indicate that the source area included contemporaneous volcanic rocks as well as metamorphic rocks and S-type plutonic rocks (Cole, 1973; Garver, 1992; Garver and Brandon, 1994). A common interpretation is that the arkosic sediments were derived from highlands within the presently adjacent Intermontane Belt, including the Early Cretaceous Okanogan - Spences Bridge arc, and/or from the Omineca Crystalline Belt farther east (Coates, 1974; Kleinspehn, 1985; Thorkelson and Smith, 1989; Garver, 1992; Hurlow and Nelson, 1993). However, these interpretations are not consistent with recent sets of tilt-corrected paleomagnetic data, which suggest that the southeastern Coast Belt lay about 2000 km south of the presently adjacent Intermontane Belt in mid-Cretaceous time (Ague and Brandon, 1992; Wynne *et al.*, 1995; Irving *et al.*, 1995). A mid-Cretaceous reconstruction of the southern Coast Belt based on these paleomagnetic data places it at the latitude of northern Mexico, where a possible source for the easterly-derived arkoses of the Methow basin might be the Peninsular Ranges batholith of southern California, which also restores to this mid-Cretaceous paleolatitude (Garver and Brandon, 1994; Cowan, 1994).

In the Eastern Cascades Fold Belt, westerly-derived chert-bearing sandstones and conglomerates interfinger with easterly-derived arkoses of the Methow sub-basin at two different stratigraphic levels. They are best exposed in northern Washington State, where they comprise the Middle to Late Albian Virginian Ridge Formation and the Late Albian to Cenomanian Ventura member of the Midnight Peak Formation (Cole, 1973; Tennyson and Cole, 1978; Trexler, 1984, 1985; McGroder *et al.*, 1990). Garver (1989, 1992) correlates these chert-bearing units with the Dash and Silverquick formations, respectively. This correlation is supported by the composition and available age constraints of the chert-bearing units, as well as by the overlying stratigraphy, as the Ventura member grades upwards into andesitic volcanic breccias and flows of the Midnight Peak Formation, which is correlated with the Powell Creek formation of the Tyaughton sub-basin. Correlation of the chert-bearing units implies that uplift within the tectonic highland that partitioned the Tyaughton - Methow basin in mid-Cretaceous time occurred in at least two distinct pulses. Each pulse was recorded in chert-rich clastic detritus, derived from Bridge River Terrane, that was shed, simultaneously, into both the western (Tyaughton) and eastern (Methow) sub-basins (Figure 41).

An interesting aspect of the mid-Cretaceous Tyaughton - Methow basin is that, while the Tyaughton portion of the basin was deposited above Bridge River Terrane and the Methow portion above Methow Terrane, there is no known stratigraphic contact between the mid-Cretaceous clastic rocks and Cadwallader Terrane. Furthermore, Cadwallader Terrane is only very locally overlain by Jura-Cretaceous clastic sedimentary rocks that probably correlate with the older part of the Tyaughton - Methow basin (Grouse Creek unit of this study). However, the mid-Cretaceous rocks of the Tyaughton basin contain detritus that can be linked to Cadwallader Terrane, as well as ophiolitic detritus that was presumably derived from the Shulaps and Bralorne-East Liza complexes (Garver, 1989, 1992). These observations, as well as the present position of Cadwallader Terrane, structurally above the Tyaughton basin and Bridge River Terrane, suggest that Cadwallader Terrane and associated ophiolitic rocks occurred mainly within the tectonically uplifted zone that separated the Tyaughton and Methow basins (Figure 41); mid-Cretaceous rocks may never have been deposited and older deposits may have been largely removed by erosion during mid-Cretaceous uplift.

REGIONAL SIGNIFICANCE OF MAIN DEFORMATIONAL EPISODES

THE QUESTION OF MIDDLE JURASSIC DEFORMATION AND TERRANE AMALGAMATION

Potter (1983, 1986) suggested that deformation within Bridge River Terrane began in Middle Jurassic time. Specific events that he assigned to the Middle Jurassic included obduction of the Shulaps Ultramafic Complex (which he interpreted as basement to the Bridge River Complex) over the Bridge River schists, and thrust imbrication of the Bridge River Complex along "ductile" fault zones that formed prior to complete lithification of Triassic to Middle Jurassic cherts and mudstones in the Carpenter Lake assemblage. Rusmore (1985, 1987) noted that the Cadwallader Group was imbricated with the Bridge River and Shulaps complexes along the western margin of the Shulaps Range and, accepting Potter's arguments for Jurassic deformation of Bridge River Terrane, suggested that Bridge River and Cadwallader terranes were amalgamated by thrusting in the Middle Jurassic. Rusmore (1985) further speculated that the Eldorado fault might be a structure similar to the Shulaps thrust and may have formed during the Middle Jurassic juxtaposition of the Bridge River and Cadwallader terranes. Rusmore *et al.* (1988) suggested that Bridge River and Cadwallader terranes were mutually juxtaposed and accreted to the Intermontane terrane in the Middle Jurassic. They cited the arguments of Potter (1983, 1986) and Rusmore (1985, 1987), and further suggested that the Relay Mountain Group might be an overlap assemblage deposited unconformably above both Cadwallader and Bridge River terranes after their amalgamation. They pointed out that this model allowed, but did not require, correlation of the Cadwallader Terrane with Stikinia and the Bridge River Complex with the western belt of the Cache Creek Terrane. Rusmore and Woodsworth (1991a) expanded on this point, and suggested that the Bridge River Complex and western Cache Creek Terrane were part of a single ocean basin that closed in Middle Jurassic time, resulting in the final accretion of an outboard Stikine-Cadwallader island arc to the western margin of North America.

The present study provides the first detailed systematic mapping that encompasses the type areas of Cadwallader and Bridge River terranes, the Shulaps Ultramafic Complex, and the Tyaughton basin. It revises many earlier interpretations regarding the stratigraphic relationships between the Tyaughton basin and older rocks, the ages of structures in the area, and the terrane affinities of ophiolitic rocks. Specifically, many structures that were thought to be Jurassic by the workers cited above are assigned here to the mid-Cretaceous. In the following paragraphs we evaluate the evidence for Middle Jurassic deformation and terrane amalgamation presented by previous workers, and summarize what is known of the Middle Jurassic tectonic evolution of the area in the context of more recent data and interpretations.

The Middle Jurassic age for obduction of the Shulaps Ultramafic Complex, as interpreted by Potter (1983, 1986), is the main piece of evidence advanced in favour of Middle Jurassic deformation and terrane amalgamation. Potter inferred an inverted metamorphic gradient in Bridge River schists beneath the Shulaps Complex, and suggested that the metamorphic heat source was hot upper mantle of the obducted Shulaps Complex. He reasoned that the thrusting was Jurassic in age in order for the Shulaps allochthon to be rooted in a high heat-flow setting related to subsea volcanism in the Triassic-Middle Jurassic Bridge River basin. More recent work has established, however, that most of the metamorphism and deformation of the Bridge River schists was Eocene in age, and that the schists were exhumed and juxtaposed against the overlying Shulaps Complex along a system of normal faults related to the Yalakom - Marshall Creek dextral strike-slip fault system. The apparent inverted metamorphic gradients noted by Potter (1983, 1986), beneath his inferred Middle Jurassic Shulaps thrust, are therefore interpreted to be the result of juxtaposition across Eocene normal, thrust, and dextral strike-slip faults, as discussed in Chapter 3. Furthermore ophiolitic rocks of the Shulaps Complex are now known to be Late Paleozoic, rather than Triassic - Jurassic, and are interpreted as part of the basement to Methow and(?) Cadwallader terranes rather than Bridge River Terrane.

Potter (1983, 1986) suggested that detrital euhedral chromite found in lower Middle Jurassic (Aalenian) sandstone beds in fault contact with the eastern margin of the Shulaps Ultramafic Complex might have been derived from the complex, and therefore record its uplift and erosion. These sandstones are now assigned to Methow Terrane (unit lmJys). They are separated from the adjacent Shulaps Complex by the Yalakom fault, and therefore restore to a position about 115 kilometres northwest of the Shulaps exposures. Nevertheless, as ophiolitic rocks of the Shulaps Complex and Coquihalla serpentine belt are thought to represent the basement of Methow Terrane, the chromite might reflect local uplift of this oceanic basement during arc-related tectonism. It does not reflect tectonism related to closure of the Bridge River ocean basin, because cherts imbricated within the northern part of the Bridge River Complex are now known to be at least as young as upper Callovian (Cordey and Schiarizza, 1993).

Rusmore (1985, 1987) suggested that rocks of the Cadwallader Group in the western Shulaps Range occurred along the northern extension of Potter's (1983, 1986) Shulaps thrust. Accepting a Middle Jurassic age for imbrication of the Shulaps and Bridge River complexes along this structure, she used the presence of Cadwallader rocks along it to infer that Cadwallader and Bridge River terranes were juxtaposed during Middle Jurassic thrusting. Our study has confirmed that the Shulaps Complex is thrust above Cadwallader Terrane in the western Shulaps Range, but we suggest that this west-directed thrusting was a mid-Cretaceous rather than a Middle Jurassic event. Although the deformation is not well dated in the Shulaps Range it is inferred to have been coincident with westerly-directed thrust-imbrication of Cadwallader Terrane and ophiolitic rocks of the Bralorne-East Liza Complex elsewhere within the map area. These thrusts are constrained to be post-Valanginian in the western Camelsfoot Range, where they also imbricate clastic sedimentary rocks of the Grouse Creek unit. They are inferred to be mid-Cretaceous because this is the age of well-dated west-vergent contractional structures elsewhere in the region, and because the mid-Cretaceous Silverquick formation is the oldest component of the Tyaughton basin that contains detritus that can be linked to Cadwallader Terrane and associated ophiolitic rocks. The Bridge River Complex typically occurs beneath the Cadwallader Terrane within this west-vergent thrust system, suggesting that Bridge River Terrane originated west of the Cadwallader Terrane. This paleogeographic arrangement does not support correlation of the Cadwallader - Bridge River couplet with Stikine and Cache Creek terranes, as suggested by Rusmore *et al.* (1988) and Rusmore and Woodsworth (1991a), because Stikine Terrane occurs west of Cache Creek Terrane. Therefore, the Middle Jurassic amalgamation of Cache Creek and Stikine terranes (Monger *et al.*, 1982; Cordey *et al.*, 1987, and references therein) cannot be used as indirect evidence supporting a similar timing for thrust-imbrication of Cadwallader and Bridge River terranes.

Rusmore *et al.* (1988) and Umhoefer (1989) suggested that deformation associated with the Middle Jurassic amalgamation of the Bridge River and Cadwallader terranes is reflected by an angular unconformity between Cadwallader Terrane and overlying Upper Jurassic rocks of the Tyaughton basin. This unconformity was inferred from exposures on the north side of the Fortress Ridge fault, about 3 kilometres southwest of Relay Mountain. There, exposures of the Lower to Middle Jurassic Last Creek formation of Cadwallader Terrane display numerous tight folds, whereas adjacent rocks of the lower unit of the Relay Mountain Group face away from the older formation and are generally homoclinal, with only a few mesoscopic folds. The interpretation that the Relay Mountain Group was deposited above an angular unconformity hinges on the assumption that its contact with the adjacent Last Creek formation is stratigraphic. However, the Last Creek formation in this area is most likely an offset remnant of the more extensive exposures of Cadwallader Terrane that occur south of the Fortress Ridge fault, where it is juxtaposed above the Tyaughton basin and Bridge River Complex across a major system of thrust faults (Figure 3). The small area of Last Creek formation north of the Fortress Ridge fault is therefore interpreted as a klippe that structurally overlies the Relay Mountain Group, rather than an inlier of older rocks that stratigraphically underlies the group, and the apparent structural disparity between the two units is probably a reflection of hangingwall *versus* footwall deformation patterns within this part of the thrust system. Furthermore, indirect evidence suggests that the Relay Mountain Group in this area was probably deposited above Bridge River Terrane rather than Cadwallader Terrane (*see* Chapter 2). The only Tyaughton basin deposits here inferred to have been deposited above Cadwallader Terrane are those of the Grouse Creek unit in the western Camelsfoot Range. There is no obvious angular discordance between the Grouse Creek siltstones and underlying Cadwallader Terrane, but such a relationship would be difficult to discern due to the limited strike-length exposed and the intensity of Cretaceous deformation.

Middle Jurassic deformation within Bridge River Terrane was postulated by Potter (1983, 1986) mainly on the basis of his model for Shulaps thrusting which, as indicated above, is no longer considered valid. As corroborative evidence, however, he pointed to "ductile" fault zones within Triassic and Jurassic mudstone and chert of the Bridge River Complex, which were inferred to pre-date complete lithification of the rocks. He suggested several scenarios that might account for this style of deformation, including deformation within a subduction complex. Our work confirms that the Bridge River Complex is characterized by complex outcrop-scale faulting, and consequently does not exhibit a coherent stratigraphy. Subsequent work has also documented a much wider age range for the complex than recognized by Potter, and has led to the discovery of Triassic blueschists within it. The intricate network of structures that characterize the Bridge River Complex are therefore interpreted to reflect its accumulation within an accretion - subduction complex. This style of deformation apparently operated, either continuously or intermittently, from the late Middle Triassic (the age of Bridge River blueschists) to latest Middle Jurassic (the age of the youngest known cherts to be imbricated within the complex). Jura-Cretaceous clastic sedimentary rocks of the Relay Mountain Group, which were apparently deposited above the Bridge River Complex (Chapter 2), display a coherent stratigraphy and are therefore inferred to postdate the subduction-related deformation within the northern part of the complex.

Potter (1983, 1986) used the presence of granitic and metamorphic clasts in lower Upper Jurassic (Oxfordian) conglomerate of the Relay Mountain Group (Jeletzky and Tipper, 1968) as supporting evidence for Middle Jurassic deformation within the region. Rusmore *et al.*, (1988) reiterated this point and also speculated that the Relay Mountain Group might be an overlap assemblage deposited unconformably above both Cadwallader and Bridge River terranes after their amalgamation. The present study indicates that there is no preserved stratigraphic contact at the base of the Relay Mountain Group within the Taseko - Bridge River map area. On the basis of indirect evidence we infer that the Relay Mountain Group was most likely deposited above the Bridge River Complex, although correlative rocks in the Camelsfoot Range (the Grouse Creek unit) may have been deposited above Cadwallader Terrane, and those near Tatlayoko Lake to the northwest are in stratigraphic contact with Methow Terrane. We therefore concur with Rusmore *et al.*, that the Relay Mountain Group overlaps at least parts of Bridge River, Cadwallader and Methow terranes. However, the Relay Mountain Group does not resemble an abnormally thick syn- or post-tectonic basinal assemblage, and is not known to contain detritus derived from the Bridge River Complex, the Shulaps Complex or any of the distinctive lithologies within Cadwallader Terrane (*see* Chapter 2). Furthermore, the early to mid Mesozoic phase of accretionary tectonics that pre-dated deposition of the Relay Mountain Group did not completely close the Bridge River basin, because continuous sedimentation is recorded across the contact between the Bridge River Complex and overlying Jura-Cretaceous Cayoosh assemblage south of the Taseko - Bridge River map area (Mahoney and Journeay, 1993; Journeay and Mahoney, 1994). Final closure may be related to a younger pulse of subduction-related deformation that is indicated by Early Cretaceous blueschists of the Cayoosh-correlative(?) Shuksan Terrane of the North Cascade Mountains (Monger. 1991b; Monger and Journeay, 1994). This closure culminated in the mid to early Late Cretaceous contractional deformation that characterizes the southeastern Coast - north Cascades orogen, and resulted in the deposition of voluminous detritus derived from the uplifted and eroded Bridge River Complex in the synorogenic Tyaughton - Methow basin (Garver, 1989, 1992).

In summary, Middle Jurassic deformation within the Taseko - Bridge River area is documented only within the Bridge River Complex, and is a component of a protracted episode of Middle Triassic to late Middle Jurassic accretionary tectonics within a subduction zone. The presence of Late Triassic and Middle Jurassic arc-derived rocks within Cadwallader and Methow Terranes suggests that this deformation represents offscraping at a convergent plate margin where Bridge River oceanic crust subducted eastward beneath an adjacent oceanic plate that developed the Cadwallader and Methow arc sequences. However, this subduction-related deformation did not culminate in complete closure of the Bridge River basin, and did not involve either uplift and thrust-imbrication of Bridge River rocks with adjacent terranes or obduction of ophiolitic rocks. Clastic deposition within the Tyaughton - Methow basin was initiated in Late Middle Jurassic time, and overlapped deformed Bridge River rocks along this convergent margin as well as adjacent arc sequences of Cadwallader and Methow terranes. Partially coeval, but finer grained clastic rocks of the Cayoosh assemblage were deposited conformably above relatively undeformed Bridge River rocks within that part of the basin that remained open to the south. This initiation of sustained clastic sedimentation within the Tyaughton - Methow basin and Cayoosh assemblage may reflect the narrowing of the Bridge River basin related to the emergence or arrival of the western Coast Belt, as discussed in the final section of this chapter. Final closure of the Bridge River basin, coupled with uplift and erosion of Bridge River Terrane and its thrust-imbrication with Cadwallader Terrane and associated ophiolitic rocks, occurred in Early to mid-Cretaceous time. This event is documented by the timing of contractional faults in the area as well as by the stratigraphic record preserved in the upper part of the Tyaughton - Methow basin.

MID-CRETACEOUS CONTRACTIONAL DEFORMATION

The systems of mid-Cretaceous contractional faults and folds that are exposed in different parts of the Taseko - Bridge River map area (Figure 19) are thought to comprise segments of the same Cretaceous thrust belt that has been disrupted and deformed by later strike-slip related structures. The persistent stacking order that is apparent wherever these early structures are recognized suggests that, prior to this late deformation, imbricated Cadwallader Terrane and Bralorne-East Liza Complex comprised a large thrust sheet that lay above footwall Bridge River Complex and Tyaughton basin across much of the map area. This thrust sheet was in turn overlain by the Shulaps Ultramafic Complex, which is presently exposed only in the northern Shulaps Range. Deformation was predominantly southwest-vergent, although northeast-directed structures occur locally. The southwest-vergent structures are best dated in the Gun Creek - Elbow Mountain thrust belt, where they deform Albian rocks, but predate deposition of the Cenomanian and younger Powell Creek formation, and intrusion of the 92 Ma Dickson - McClure batholith. Some of the deformation is older, however, as detritus in the Albian Taylor Creek Group records uplift and erosion of the underlying Bridge River Complex and Relay Mountain Group, as well as source terrains to the west and east (Garver, 1989). Still earlier pulses of Cretaceous deformation may be reflected in the angular unconformity between Hauterivian shales and underlying Jurassic rocks of the Relay Mountain Group near Lorna Lake, and a 130 Ma date from the first step of an Ar-Ar step-heating age spectrum for Bridge River blueschists at the head of North Cinnabar Creek. The youngest structures to form within this protracted episode of Cretaceous deformation include northeast-dipping reverse and reverse-sinistral faults of the Eldorado system, which probably formed between 91 and 86 Ma.

The fault systems in the Taseko - Bridge River area reflect an important episode of mid-Cretaceous contractional deformation that is well documented throughout the southeastern Coast - north Cascades orogen (Figure 42). However, the Eldorado fault system is the only structure that has been traced for any distance beyond the study area. It continues southeastward to the Fraser River fault, 130 kilometres southeast of Bralorne, as the Bralorne - Kwoiek Creek fault system (Woodsworth, 1977; Rusmore, 1985; Monger, 1986; Journeay, 1990). This system, which is locally up to several kilometres wide, comprises an anastomosing network of east to northeast-dipping faults that imbricate Bridge River Complex, Cayosh assemblage and, in the north, Cadwallader Terrane and Bralorne-East Liza Complex (Monger and Journeay, 1994). Individual fault strands generally dip east to northeast. They cut two sets of southwest-vergent folds, and commonly place highly strained hanging wall rocks above a less deformed footwall, suggesting that they ramped upsection to the southwest from deeper tectonic levels (Journeay, 1990; Journeay *et al.*, 1992).

Although no map-scale mid-Cretaceous structures have been traced northwestward from the Taseko - Bridge River area, mesoscopic folds that may be of this age occur within the Taylor Creek Group in a continuous belt that extends from the present study area to Chilko Lake. A mid-Cretaceous age for these structures is based on recognition of the angular unconformity that separates the Taylor Creek Group from the overlying Powell Creek formation as far to the northwest as the north end of Taseko Lake (Riddell *et al.*, 1993a). Just to the north of this belt are rocks belonging to Cadwallader Terrane and the Bridge River Complex, which outcrop east of Chilko Lake, between the Konni Lake and Taseko faults (Figure 42). Mesoscopic folds that deform these rocks are also inferred to be of mid-Cretaceous age, as this belt is interpreted to be the offset counterpart of the Camelsfoot thrust belt (Riddell *et al.*, 1993a).

Journeay and Friedman (1993) describe early Late Cretaceous southwest-directed thrust faults in the Lillooet Lake - Harrison Lake area, and refer to them as the Coast Belt thrust system (Figure 42). These structures formed in earliest Late Cretaceous time, coincident with late Albian to early Cenomanian thrusting within the Taseko - Bridge River area, 100 kilometres to the north (stage 2 of Figure 24). The foreland of the Coast Belt thrust system comprises predominantly east-dipping thrust faults that imbricate Harrison Terrane and correlative rocks of the western Coast Belt (Figure 40). The time of thrusting is bracketed by late and post-kinematic plutons which yield U-Pb zircon dates of 94±2 Ma and 91 +4/-3 Ma, respectively (Journeay and Friedman, 1993). The foreland belt is structurally overlain by an imbricate zone of folded thrust sheets that are cut by high-angle reverse faults. These thrust sheets include greenschist to amphibolite facies metavolcanic and metasedimentary rocks assigned to the Slollicum and Twin Island schists, which may correlate with Upper Jurassic and Lower Cretaceous rocks of Harrison Terrane (Journeay and Friedman, 1993). They extend along strike to the northwest into the Lillooet Lake belt of figures 39 and 40, which includes Upper Triassic rocks that have been assigned to Cadwallader

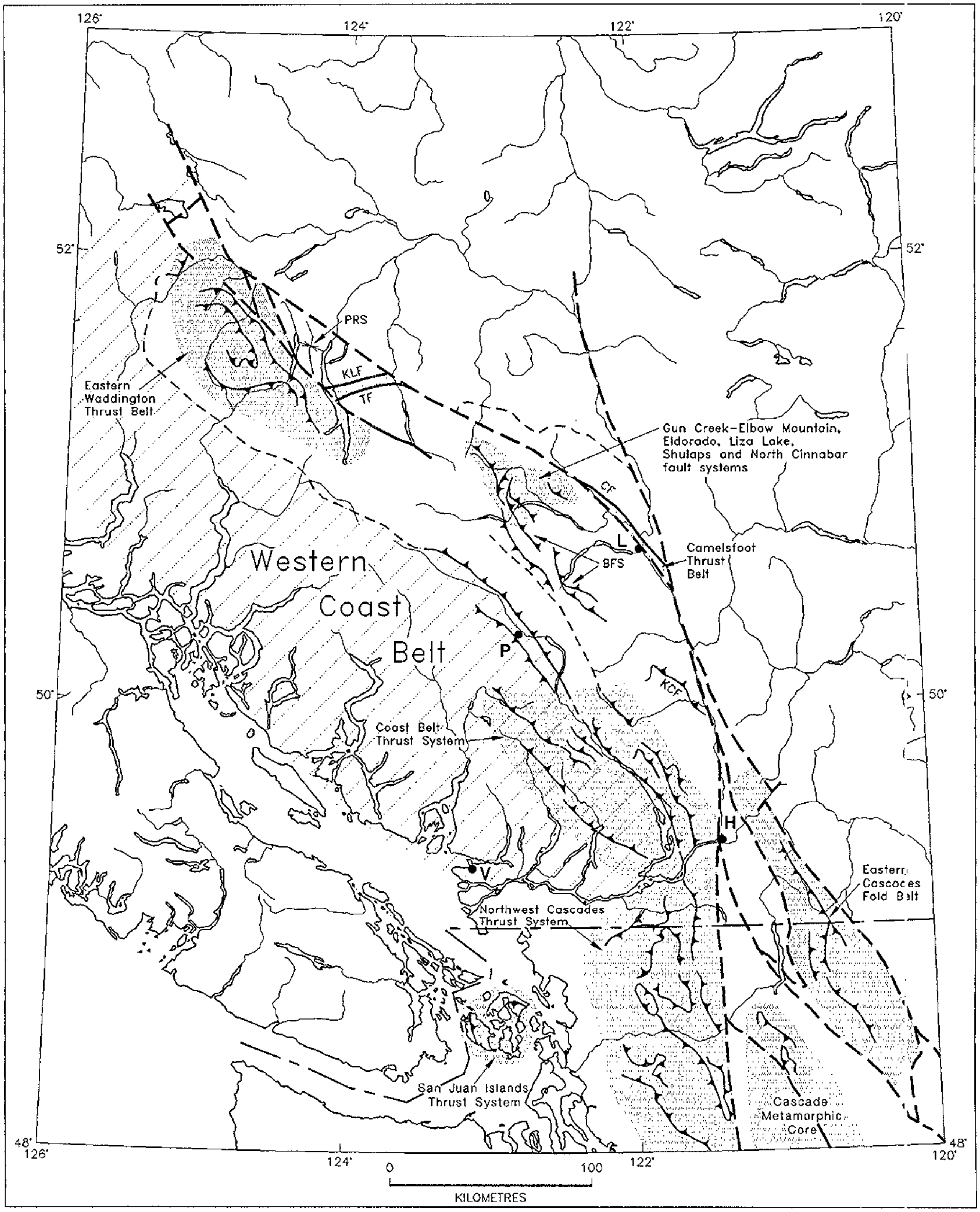

Figure 42. Map showing the distribution of mid-Cretaceous contractional fault systems within the southeastern Coast - north Cascades orogen. BFS=Bralorne fault system; CF=Camelsfoot fault; KCF=Kwoiek Creek fault; KLF=Konni Lake fault; PRS=Potato Range syncline; TF=Taseko fault. H=Hope; L=Lillooet; P=Pemberton; V=Vancouver. Sources of information are indicated in the text.

Terrane, as well as overlying Lower to Middle Jurassic rocks that have been correlated with the Harrison Lake Formation (Journeay and Mahoney, 1994; Monger and Journeay, 1994). Synkinematic plutons emplaced during the early stage of thrusting within the imbricate belt have yielded U-Pb zircon dates of 97±1 Ma and 96 +6/-3 Ma, whereas the later stage of reverse faulting is bracketed by the emplacement of synkinematic and postkinematic plutons with U-Pb zircon dates of 96 +6/-3 Ma and 94 +6/-5 Ma, respectively (Journeay and Friedman, 1993). The imbricate zone is bounded to the northeast by a major northeast-dipping ductile shear zone referred to as the Central Coast Belt detachment (Journeay and Friedman, 1993). The hinterland portion of the Coast Belt thrust system, in the hangingwall of this shear zone, consists of folded and thrust-imbricated amphibolite-grade metamorphic rocks of the Cogburn Creek Group and Settler schist, which are correlated with the Bridge River Complex and Cayoosh assemblage, respectively (Journeay and Friedman, 1993; Monger and Journeay, 1994). Synkinematic Barrovian metamorphism of these rocks and those of the underlying imbricate zone is attributed to tectonic burial associated with the stacking of thrust sheets, coincident with the emplacement of synkinematic mid-Cretaceous plutons of the Spuzzum suite at depths of 20 to 30 kilometres (Journeay, 1990; Journeay and Friedman, 1993). Subsequent uplift was followed by a younger phase of lower pressure Buchan-type metamorphism associated with the emplacement of post-kinematic plutons of the 86 to 84 Ma Scuzzy and Mount Rohr suites, at depths of 10 to 20 kilometres (Journeay, 1990; Parrish and Monger, 1992).

The metamorphic rocks in the hinterland of the Coast Belt thrust system correlate with those in the upper structural levels of the Cascade metamorphic core (including Cogburn Creek Group, Twisp Valley schist, Mad River Terrane and Chiwaukum schist), which likewise underwent synkinematic metamorphism and intrusion in mid to early Late Cretaceous time, followed by relatively rapid uplift in the early Late Cretaceous (Tabor *et al.*, 1989; McGroder, 1991). This deformation and metamorphism was, at least in part, coincident with the assembly of thrust sheets in the Northwest Cascades - San Juan thrust system to the west, which is constrained by stratigraphic evidence on the San Juan Islands to have occurred between 100 and 84 Ma (Brandon *et al.*, 1988). An earlier phase of subduction-related deformation is documented by 130 to 120 Ma blueschist-facies rocks of the Shuksan metamorphic suite (Brown and Blake, 1987), which comprises the upper structural level of the Northwest Cascades thrust system (Misch, 1966; Tabor *et al.*, 1989). The Shuksan suite is correlated with the Settler schist and Cayoosh assemblage of the eastern Coast Mountains by Monger (1991b), whereas structurally lower levels of the Northwest Cascades system include basalt and chert of the Elbow Lake Formation, which may correlate with the Bridge River Complex (Tabor *et al.*, 1989; Monger and Journeay, 1994). The lowest structural levels of the Northwest Cascades system comprise the Jurassic Wells Creek volcanics and stratigraphically overlying clastic sedimentary rocks of the Jura-Cretaceous Nooksack Group (Tabor *et al.*, 1989), which were interpreted by Misch (1966) to be autochthonous or parautochthonous beneath the structurally overlying elements of the thrust system. These rocks are correlated with Jurassic and Cretaceous volcanic and clastic sedimentary rocks of Harrison Terrane within the southern part of the western Coast Belt just to the north (McGroder, 1991; Monger and Journeay, 1994). Structural relationships within the northern Cascade Range are therefore much the same as in the southern Coast Belt, where strongly imbricated and metamorphosed assemblages of the eastern Coast Belt (including Bridge River Terrane and Cayoosh assemblage) were thrust westward over a relatively more rigid block comprising the western Coast Belt (including Harrison Terrane). McGroder (1991) suggests that this relatively rigid western block (his Greater Insular Terrane) extends eastward into the Cascade Metamorphic Core, where it is represented by the Skagit gneiss and Cascade River schist (Misch, 1966), which he interprets to occupy the deepest structural level of the core. In contrast to structurally overlying rocks (correlated with Bridge River Terrane and Cayoosh assemblage), which were uplifted shortly after metamorphism in the Late Cretaceous, these underlying rocks probably remained at relatively deep crustal levels until early Tertiary time, as demonstrated by K-Ar dates on biotite (McGroder, 1991).

Mid-Cretaceous contractional deformation is also well documented in the Eastern Cascades foldbelt, to the east of the Cascade metamorphic core (Figure 42). There, Jura-Cretaceous strata of the Methow Terrane/basin are deformed by predominantly east-northeast vergent folds and thrust faults that formed between 100 and 88 Ma (McGroder, 1989), coincident with late Albian - Cenomanian southwest-directed thrusts in the Taseko - Bridge River area (stage 2 of Figure 24). An earlier pulse of deformation is inferred from the stratigraphic record, as it also is in the Taseko - Bridge River area, since Middle Albian chert-rich deposits of the Methow basin (Virginia Ridge Formation) were derived from a newly uplifted source terrane to the west. This chert detritus was probably derived from the adjacent Bridge River-correlative Hozameen Group, which is inferred to have been uplifted along a west-vergent thrust system that marked the onset of crustal loading experienced by correlative rocks (*e.g.* Cogburn Creek Group, Twisp Valley schist, Mad River Terrane) in the adjacent Cascade metamorphic core (McGroder, 1991). The shortening stepped westward in the early Late Cretaceous, to the Northwest Cascades - San Juan thrust system, and the coeval east-vergent structures in the Methow Terrane/basin are interpreted as backthrusts in the rear of the predominantly west-vergent Cascade orogen (McGroder, 1989, 1991).

The northernmost system of Cretaceous contractional structures within the southeastern Coast - north Cascades orogen is a belt of northeast-directed thrust faults and related folds, referred to as the eastern Waddington thrust belt (Figure 42), which extends from Chilko Lake to the Klinaklini River (Tipper, 1969; McLaren, 1990; Rusmore and Woodsworth, 1991b, 1993, 1994; Mustard *et al.*, 1994; van der Heyden *et al.*, 1994). These structures deform Triassic and Lower Cretaceous strata of the Niut belt (Figures 39 and 40), together with Late Cretaceous plutonic rocks. The western limit of the thrust belt is largely defined by post-kinematic latest Cretaceous to Tertiary plutons, but Late Jurassic plutonic rocks are locally incorporated in its western part (Rusmore and Woodsworth, 1994; van der Heyden *et al.*, 1993), suggesting that the western Coast Belt was involved in the thrusting. Cretaceous contractional structures that are coeval with the thrust belt are not documented within the Methow Terrane and basin to the east, although folds occur locally (*e.g.* Potato Range syncline of Figure 42) that might be of the same age (Schiarizza *et al.*, 1995; Umhoefer and Kleinspehn, 1995).

Northeast-directed thrusts of the Eastern Waddington Thrust Belt formed in early Late Cretaceous time, as they deform the synkinematic 87 Ma Pagoda orthogneiss, but are truncated by the 68 Ma Enchanted Valley pluton (Parrish, 1992; Rusmore and Woodsworth, 1994). Metamorphism, which accompanied and outlasted deformation, generated a series of southwest-dipping isograds that demonstrate a northeast to southwest increase in metamorphic grade. Rusmore and Woodsworth (1994) suggest that the heat for this inverted metamorphic gradient was provided by Cretaceous plutonic rocks derived from the active Coast Belt magmatic arc, which may have been thrust northeastward over the presently exposed part of the thrust belt. However, the thrusting accommodated only limited crustal thickening, as the metamorphism occurred under conditions of relatively low pressure (Rusmore and Woodsworth, 1994). Coeval metamorphism within the Coast Belt thrust system to the south was also of the low-pressure type, and was associated with the emplacement of 86 to 84 Ma post-kinematic plutons (Journeay and Friedman, 1993). There, however, an earlier episode of southwest-directed contractional deformation substantially thickened the crust and was accompanied by synkinematic high pressure metamorphism associated with the emplacement of 97 to 94 Ma plutons. Although no earlier southwest-directed structures have been documented at the latitude of the Eastern Waddington Thrust Belt, Rusmore and Woodsworth suggest that the Eastern Waddington Belt comprises a set of relatively young backthrusts within the predominantly southwest-directed Coast Belt contractional orogen.

LATE CRETACEOUS - PALEOGENE DEXTRAL STRIKE-SLIP FAULTING

The Late Cretaceous to Eocene structural history of the Taseko - Bridge River area is dominated by dextral strike-slip faults and related transpressional and transtensional structures. The oldest structure known to have dextral movement is the Castle Pass fault, which truncates the youngest contractional structures in the area, including the North Cinnabar fold-fault system and the 91 to 86 Ma Eldorado fault. Most movement along the Castle Pass fault occurred in the Late Cretaceous, prior to intrusion of the 67 Ma Eldorado pluton. Other prominent dextral faults in the area were active mainly in the Paleocene and Eocene, although there is some evidence for transpressional deformation adjacent to the Yalakom fault between 80 and 70 Ma (Chapter 3).

Dextral strike-slip faults and related structures in the Taseko - Bridge River area are part of a larger system of dextral faults that has been traced for about 600 kilometres along the eastern side of the southeastern Coast - north Cascades orogen in southern British Columbia and northern Washington (Figure 43). This system was active from about mid-Late Cretaceous time to the Late Eocene. The switch from Early and early Late Cretaceous contractional deformation to Late Cretaceous and early Tertiary dextral strike-slip deformation is evident throughout the southeastern Coast - north Cascades orogen. It probably relates to an abrupt change in motion of offshore oceanic plates, from east-directed orthogonal convergence of the Farallon or Kula plate with the North American margin to north-directed oblique convergence of the Kula plate (Engebretson *et al.*, 1985, 1995; Umhoefer and Schiarizza, 1995).

The youngest dextral structure within the southeastern Coast - north Cascades orogen is the Fraser River - Straight Creek fault, which truncates structures of the Yalakom fault system between 40 and 50 kilometres southeast of the Taseko - Bridge River map area (Monger and McMillan, 1989). Restoration of 70 to 160 kilometres of dextral slip on the Fraser River fault matches structures and lithotectonic belts within the southeastern Coast Belt with correlative features in the Cascade Mountains of British Columbia and Washington State (Monger and Journeay, 1994). The most

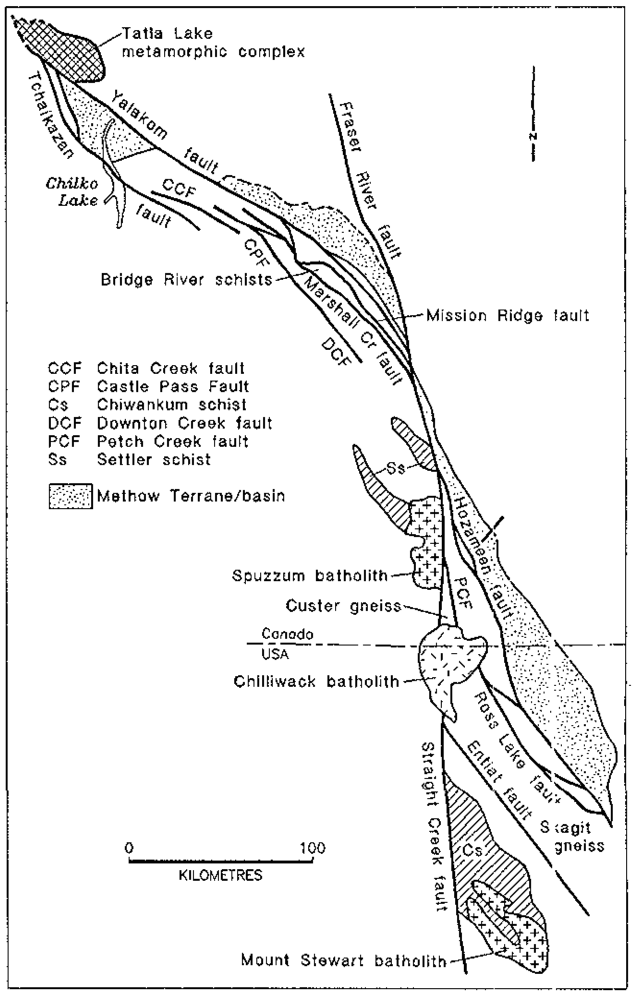

Figure 43. Simplified map showing the major Late Cretaceous and Paleogene dextral strike-slip faults along the eastern part of the southeastern Coast - north Cascades orogen. Sources of information are indicated in the text.

likely offset correlative of the Yalakom fault is the Hozameen fault (Monger, 1989; Ray, 1986), as both structures lie between the Bridge River Terrane (Bridge River Complex and Hozameen Group) to the west and the Methow Terrane to the east. The Hozameen fault extends southward into the North Creek and Foggy Dew faults along the southwest side of Methow Terrane in Washington State (McGroder, 1987). The southern portion of the Hozameen-Foggy Dew fault separates older rocks on the west from younger rocks on the east, contains kinematic indicators that indicate dextral-slip, and was active between 85 and 50 Ma (McGroder, 1987; Miller and Bowring, 1990).

The Mission Ridge fault has been correlated to the Petch Creek fault, from which it is offset by about 100 kilometres along the Fraser River fault (Coleman and Parrish, 1991). The Petch Creek fault is considered the northern extension of the Ross Lake fault (Ray, 1986). All three faults are east-dipping and separate low-grade rocks of the Bridge River terrane on the east from high-grade metamorphic rocks on the west that have dextral kinematic indicators (Ray, 1986; Coleman and Parrish, 1991; Haugerud, 1985). Late-stage, down-to-the-east normal displacement of 20 kilometres has been estimated for the northern Ross Lake fault near the U.S.-Canada border (Haugerud, 1985), and 10 to 18 kilometres of similar normal movement has been suggested for the Mission Ridge fault (Coleman and Parrish, 1991).

Correlation of the Mission Ridge-Petch Creek-northern Ross Lake faults suggests that metamorphic rocks in the Shulaps Range (Bridge River schists) correlate with at least parts of the Custer and Skagit gneisses. These rocks formed a north-south elongate metamorphic complex before dextral movement on the Fraser River - Straight Creek fault separated them. Final unroofing of the lower plate metamorphic rocks in both areas occurred during and after dextral, ductile deformation that has been dated at between 48.5 and 45 Ma (Coleman and Parrish, 1991; Haugerud, 1985; Haugerud *et al.*, 1991). Biotite K-Ar cooling ages are 44-45 Ma in the lower plates of both complexes (Wanless *et al.*, 1978; Haugerud *et al.*, 1991).

The Late Cretaceous to early Paleocene Castle Pass fault system is interpreted to continue southeastward for at least 60 kilometres as the Downton Creek fault (Journeay *et al.*, 1992), which predates 63 Ma plutons of the Bendor suite, and has evidence for both southwest-vergent thrust faulting and dextral strike-slip faulting. The projected southeast extension of the Downton Creek fault intersects the Fraser River fault about 90-100 km north of the northwest extension of the main Ross Lake fault. The southern part of the Ross Lake fault zone is a complex, mid-crustal dextral-oblique fault zone that resembles the Castle Pass - Downton Creek fault system in structural style and timing of faulting. It was first active in its present form as a left-stepping contractional zone between the Gabriel Peak tectonic belt and the Twisp River fault zone, which connects to the south with the Foggy Dew fault, the southern end of the Yalakom-Hozameen fault system (Miller and Bowring, 1990; Miller, 1994). The Ross Lake stepover was active at about 68 to 65 Ma, but it may have been active before this time, and may have remained active until about 57 Ma.

The Skagit crystalline core of the North Cascades, which forms a belt 30 to 40 kilometres wide between the Ross Lake fault zone and the Entiat fault, was also the site of deformation at the same time as the early stages of dextral strike-slip faulting in the Taseko - Bridge River area. It contains mylonitic shear zones that are dominated by southwest-vergent reverse faults, northwest-striking dextral strike-slip faults, and oblique dextral-thrust zones (Hurlow and Nelson, 1991). The 73 Ma Cardinal Peak pluton (Haugerud *et al.*, 1991) was intruded into an active shear zone within this belt (Miller, 1991). Recent mapping and U-Pb dating of deformed and undeformed dikes demonstrates that the Entiat fault was active as a dextral strike-slip fault in the period 70 to 67 Ma (Hurlow and Nelson, 1991), synchronous with Castle Pass faulting.

The Fraser River - Straight Creek fault zone cuts all of the faults of the Yalakom fault system and its southern extensions except the Marshall Creek fault, which appears to merge with the Fraser River fault (Monger and McMillan, 1989). There is ample evidence that the Fraser River - Straight Creek fault zone experienced mainly dextral strike-slip motion, but estimates of offset vary considerably. Misch (1977) correlated the Mount Stuart Batholith and associated Chiwaukum Schist in the southern North Cascades to the Spuzzum Batholith and associated Settler Schist in British Columbia, which suggests 160 to 190 kilometres of offset across the Straight Creek fault (Figure 42). This argument for at least 160 kilometres of dextral offset has been strengthened by a number of recent studies which demonstrate similarities in petrology, geochronology and structural history for the two areas (Ague and Brandon, 1990; Brown and Walker, 1993; Miller and Paterson, 1992; Journeay and Friedman, 1993). However, Vance (1985) has argued for 80 to 90 kilometres of dextral displacement across the Straight Creek fault based on the apparent offset of northwest-striking high-angle faults and parts of the Shuksan metamorphic belt, and Miller *et al.* (1993a) also argue for 90 kilometres of offset based on restoring two similar mélange belts across the fault. Similar variation exists in displacement estimates across the Fraser River fault system to the north. These include 70 to 90 kilometres offset of the Yalakom and Hozameen faults and the northern boundary of the Jackass Mountain Group (Monger, 1985; Monger and Journeay, 1994), about 100 kilometres offset between the Mission Ridge and Petch Creek faults (Coleman and Parrish, 1991), and 135 to 160 kilometres offset between the Late Permian Farwell and northern Mount Lytton plutons (Friedman and van der Heyden, 1992). This variability may in part reflect the difficulty in establishing unique piercing points due to the smearing out of truncated structures and geological units along the Fraser River fault (*see* maps of Monger, 1989 and Monger and McMillan, 1989), as well as the possibility of differential vertical motions across the fault. Furthermore, although latest motion on the Fraser River - Straight Creek fault postdates most or all other structures in the region, the earliest stages of motion were probably coincident with deformation along and within many of the faults and geological units that were subsequently displaced. As a result, the amount of dextral displacement probably varies from place to place along the

Fraser River - Straight Creek fault, as some of the movement along parts of the fault system was transferred to strike-slip, transpressional and transtensional structures that are now truncated by it.

The Fraser River - Straight Creek fault system was apparently inactive by the end of the Eocene, as it is truncated by the 35 Ma Chilliwack batholith near the International boundary (Monger and Journeay, 1994). The latest stages of movement resulted in about 100 kilometres of dextral offset of the post 46.5 Ma Mission Ridge fault (Coleman and Parrish, 1991). However, activity on the Straight Creek fault commenced by at least about 50 Ma, as it is inferred to have influenced sedimentation patterns in Lower to Middle Eocene rocks of the adjacent Swauk basin (Taylor *et al.*, 1988), and to have localized pre-47 Ma folding of these rocks (Tabor *et al*, 1984). This suggests that some of the movement along the Straight Creek and southern Fraser River faults was coincident with activity along the Yalakom fault, and that the southern continuation of the Yalakom fault has changed through time. Early movement on the Yalakom fault probably extended into the Hozameen fault, but after about 50 Ma the latter structure became inactive, and subsequent movement along the Yalakom fault was continuous with that on the Straight Creek fault. At about 45 Ma movement along the Straight Creek - Fraser River fault diverged into the Marshall Creek fault, and fundamentally switched the local strain conditions in the Shulaps-Mission Ridge metamorphic belt from dextral-transpression to transtension (*see* Figure 30). Most of the post 45 Ma movement along the Straight Creek fault must have transferred to the northern part of the Fraser River fault, however, to account for the offsets of the Yalakom and Mission Ridge faults from, respectively, the Hozameen and Petch Creek faults.

The Yalakom fault has been traced for about 150 kilometres northwest of the Taseko - Bridge River area. The Relay Creek and Castle Pass fault systems, however, have not been recognized as important structures to the northwest (Riddell *et al.*, 1993a,b; Schiarizza *et al.*, 1995), suggesting that they either die out or merge with the Yalakom fault. The Chita Creek fault may connect with the Tchaikazan fault in the Mount Waddington map area (Umhoefer and Kleinspehn, 1995), and the Tchaikazan fault may merge with the Yalakom fault near its apparent northwestern termination (van der Heyden *et al.*, 1994; Mustard *et al.*, 1994).

The Yalakom fault apparently ends along the southwestern margin of the Tatla Lake Metamorphic Complex, although Schiarizza *et al.* (1995) infer that a kinematically linked extensional fault segment extends north-northwestward from there to mark the western limit of a belt of metamorphic tectonites that are locally exposed beneath an extensive cover of Quaternary alluvium and Late Tertiary volcanics (Tipper, 1969b; *see* Figure 31). Friedman and Armstrong (1988) document 55 to 47.5 Ma extensional shear along subhorizontal west-northwest-trending mineral lineations within the mylonite zone comprising the upper part of the Tatla Lake Complex, followed by folding and brittle faulting during the final stages of uplift. This extensional deformation is inferred to be kinematically linked to the Yalakom fault (Coleman and Parrish, 1991; Umhoefer and Kleinspehn, 1995; Schiarizza *et al.*, 1995), and overlaps in age with major extensional faulting in the Omineca and Intermontane belts of southern British Columbia and northern Washington, which occurred from 58 to 45 Ma (Parrish *et al.*, 1988). Parrish and Coleman (1990) link the termination of the Yalakom fault near Tatla Lake to this broad zone of extensional faulting, which they interpret as a transfer zone linking the Yalakom fault to the Tintina-Northern Rocky Mountain Trench fault system. This interpretation is a modification of an earlier model presented by Price (1979) and Price and Carmichael (1986), who inferred that the Fraser River Fault system, rather than the Yalakom, was the main locus of Early to Middle Eocene dextral strike-slip in southwestern British Columbia.

MID-CRETACEOUS PALEOLATITUDE OF THE SOUTHERN COAST BELT

Pre-Tertiary relationships between the southeastern Coast Belt and the Intermontane belt to the east are uncertain. This boundary is largely defined by the Pasayten fault, which marks the eastern boundary of Methow Terrane. The adjacent Intermontane Belt is underlain mainly by early Mesozoic arc-derived volcanic and plutonic rocks of Quesnel Terrane, Late Paleozoic to early Mesozoic volcanic and sedimentary rocks of the oceanic Cache Creek Terrane, and overlapping Early Cretaceous plutonic and volcanic rocks of the Okanogan - Spences Bridge arc (Monger, 1989; Monger and McMillan, 1989; Hurlow and Nelson, 1993). Although these rocks have little in common with those of the adjacent Coast Belt, a common interpretation is that Methow Terrane has been directly west of these Intermontane Belt rocks throughout much of the Mesozoic, and the more westerly elements of the Coast Belt have been accreted during one or more episodes of Mesozoic subduction-related tectonics (Coates, 1974; Anderson, 1976; Tennyson and Cole, 1978; Monger *et al.*, 1982; O'Brien *et al.*, 1992). According to this interpretation, the Early to mid-Cretaceous Spences Bridge arc might have been generated by eastward subduction of the last vestiges of the Bridge River ocean basin within the southeastern Coast Belt, and age-equivalent easterly-derived clastic sedimentary rocks of the Tyaughton - Methow basin (*e.g.* Jackass Mountain Group) would have been derived from this arc and/or from associated highlands in other parts of the Intermontane Belt or the adjacent Omineca Crystalline Belt (Kleinspehn, 1985; Monger, 1986; Thorkelson and Smith, 1989; Garver, 1992; Hurlow and Nelson, 1993).

The above interpretations have recently been challenged by three sets of tilt-corrected paleomagnetic data, which suggest that the southeastern Coast Belt lay about 2900 km south of its present latitude in mid-Cretaceous time (Ague and Brandon, 1992; Wynne *et al.*, 1995), whereas the mid-Cretaceous Spences Bridge Group on the adjacent Intermontane Belt was deposited 1200 km south of its present latitude (Irving *et al.*, 1995). A mid-Cretaceous reconstruction of the southern Coast Belt based on these paleomagnetic data places it at the latitude of northern Mexico, where a possible source for the easterly-derived arkoses of the

Tyaughton - Methow basin might be the Peninsular Ranges batholith of southern California, which also restores to this mid-Cretaceous paleolatitude (Garver and Brandon, 1994; Cowan, 1994).

The discordant paleomagnetic data presented by Wynne *et al.* (1995) come from the Silverquick and Powell Creek formations near Mount Tatlow, about 30 kilometres east-northeast of the Taseko - Bridge River map area. Stratigraphic and provenance links provided by these rocks and slightly older strata of the Taylor Creek and Jackass Mountain groups demonstrate that the diverse tectonic assemblages of the southern Coast Belt, including Methow Terrane, were tied together by mid-Cretaceous time (Garver, 1992; Garver and Brandon, 1994). The mid-Cretaceous Tyaughton basin deposits interfinger to the west with coeval and somewhat older Lower Cretaceous volcanic rocks of the Gambier arc, which is inferred to have developed above and east-dipping subduction zone beneath the Insular and Coast belts (Garver, 1992; Thorkelson and Smith, 1989). Because this Coast Mountains arc is presently separated from the Okanogan - Spences Bridge arc of the Intermontane by coeval clastic sedimentary rocks of the Tyaughton - Methow basin and a major belt of contractional deformation, some tectonic models have invoked 2 east-dipping Cretaceous subduction zones, one beneath the Insular-Coast and the other beneath the Intermontane Belt. In these models, convergence across the Intermontane subduction zone generates the Spences Bridge arc and leads directly to collision between the Intermontane and Insular superterranes (Monger *et al.*, 1982; Thorkelson and Smith, 1989). The paleomagnetic data suggest an alternative model, whereby the two Early to mid-Cretaceous arc systems formed at different latitudes along the continental margin and were subsequently juxtaposed by orogen-parallel dextral displacement of the Coast Belt relative to the Intermontane Belt. Models derived from paleomagnetic data require that this major displacement occurred in Late Cretaceous to Paleocene time, as lower Middle Eocene rocks within the Insular Belt yield paleopoles that are concordant with Early to Middle Eocene paleopoles from the Intermontane Belt of southern British Columbia and cratonic North America (Irving and Brandon, 1990).

The discordant Spences Bridge and Silverquick-Powell Creek paleomagnetic sites are presently separated by prominent dextral strike-slip faults of the Yalakom and Fraser River fault systems, but these faults have a combined displacement of only 200 to 300 kilometres and were active mainly in Eocene time (Monger, 1985; Kleinspehn, 1985; Riddell *et al.*, 1993a; Umhoefer and Schiarizza, 1993; Monger and Journeay, 1994). The paleomagnetic data suggest that a somewhat older system of faults, with close to 2000 kilometres of dextral displacement, occurs along the boundary between the Coast and Intermontane belts. East of the Fraser River fault, this boundary coincides with the Pasayten fault zone (*see* Figure 2). This is a major geological boundary that has been traced continuously for more than 200 kilometres, and across which mid-Cretaceous and older stratigraphic, plutonic and structural elements have little in common (Monger, 1989; Monger and McMillan, 1989). The oldest structures documented along the Pasayten fault zone are ductile fabrics within plutonic rocks of the easternmost Intermontane belt that formed during an episode of Early to mid-Cretaceous sinistral strike-slip to transpressional deformation (Greig, 1992, Hurlow, 1993). No corresponding structures are present within rocks of the adjacent Coast Belt (Methow Terrane), indicating that the most recent movement along this boundary is younger than mid-Cretaceous. In the Coquihalla River area, studied in detail by Greig (1989, 1992), these younger structures include a Middle Eocene east-directed thrust fault, as well as post-Middle Eocene northeast-side-up and syn-Early Miocene northeast-side-down faults. Farther south, the Pasayten fault zone also contains brittle deformation fabrics that formed in Late Cretaceous to Middle Eocene time (Hurlow, 1993).

The lack of evidence for Late Cretaceous dextral movement along the Pasayten fault may reflect significant Tertiary dip-slip movement along the fault zone. Varsek *et al.* (1993), on the basis of deep seismic reflection data, suggest that the Pasayten fault dips eastward and places plutonic rocks of the Intermontane Belt above Methow Terrane strata of the Coast Belt. If there was a significant amount of Tertiary reverse movement on this fault then it may have overridden a steeply-dipping dextral fault that juxtaposed the Intermontane and Coast belts in Late Cretaceous time. Young normal-sense movement on the east-dipping Pasayten fault could also effectively hide an older dextral strike-slip fault, providing that the dextral fault dipped more gently to the east than the younger normal fault.

West of the Fraser River fault, the boundary between the Coast and Intermontane belts is defined, in part, by the Slok Creek and Hungry Valley fault systems, which separate Methow Terrane from an assemblage of Cretaceous rocks that includes volcanic rocks correlated with the Spences Bridge Group (Tipper, 1978; Read, 1988; Monger and McMillan, 1989; Green, 1990; Hickson, 1992). The Slok Creek fault and eastern portion of the Hungry Valley system are dextral strike-slip faults that cut rocks as young as Eocene. The western part of the Hungry Valley system, however, has a more westerly trend and cuts only Cretaceous rocks (Figure 39). It was mapped as a northeast-directed thrust fault by Tipper (1978), but the segment exposed in Churn and Dash creeks was probably the locus of dextral strike-slip movement (Chapter 3). This could be a remnant of a Late Cretaceous -Early Tertiary fault system. Alternatively, it could be an Eocene structure that has offset an older fault system.

The volcanic and comagmatic intrusive rocks correlated with the Spences Bridge Group northeast of the Hungry Valley fault are overlain by mid to Upper Cretaceous sedimentary and volcanic rocks that have been correlated with the Silverquick-Powell Creek succession of the Coast Belt (Green, 1990; Hickson, 1992; Mahoney *et al.*, 1992). Similar mid-Cretaceous non-marine chert-rich conglomerates and sandstones also occur within the Intermontane Belt east of the Fraser River fault, where they overlie the Cache Creek and(?) Spences Bridge groups (Monger and McMillan, 1989; Read, 1990). Correlation of these sedimentary and volcanic rocks within the Intermontane Belt with the Silverquick-Powell Creek succession in its type area in the Coast Belt clearly contradicts the discordant paleomagnetic results presented by Irving *et al.* (1995) and Wynne *et al.* (1995). This correlation is based on similarities in age, lithology and depositional environment, but the correlated rocks are not in physical continuity and are separated by Jura-Cretaceous rocks of Methow Terrane as well as several major structures. Furthermore, chert clasts in the Tyaughton basin deposits (including Silverquick in its type area) were derived from the Bridge River Complex of the Coast Belt (Garver, 1992), while those stratigraphically above the Spences Bridge Group were probably derived from the Cache Creek Complex of the Intermontane Belt (Hickson *et al.*, 1991; Mahoney *et al.*, 1992). This suggests that, despite their similarities, the two successions formed in different depositional systems. It is therefore possible that the two successions represent similar depositional environments, but were developed at widely separated places along the mid-Cretaceous Cordilleran margin, as the paleomagnetic data indicate.

As outlined in the preceding paragraphs, the paleomagnetic model for major Late Cretaceous-Paleocene latitudinal displacement of the Coast Belt relative to the Intermontane Belt contradicts a number of geological models that were based on inferred links between the two belts. These links include provenance relationships in which Lower Jurassic to mid-Cretaceous clastic sedimentary rocks of Methow Terrane are inferred to have a source in the adjacent Intermontane Belt (*e.g.* Coates, 1974; Anderson, 1976; Tennyson and Cole, 1978; O'Brien *et al.*, 1992), as well as stratigraphic correlations of mid-Cretaceous rocks within the two belts (*e.g.* Mahoney *et al.*, 1992). This dilemma remains to be resolved (*see* discussion by Cowan, 1994), but the problem is sufficiently well defined in this area to be a focus for paleomagnetic and geologic studies designed to test the hypothesis of major latitudinal displacements.

TECTONIC EVOLUTION

A Late Cretaceous restoration of the southeastern Coast - north Cascades orogen is presented in Figure 44. It is based on first removing 80 kilometres of dextral offset on the Fraser River - Straight Creek fault system (matching the Yalakom and Hozameen faults), and then restoring 115 kilometres of dextral offset on the Yalakom - Hozameen fault system (matching the Konni Lake and Camelsfoot faults, as well as the Shulaps Ultramafic Complex and Coquihalla serpentine belt). Although the displacement histories of these faults were probably more complicated, as discussed in a previous section, this first-order restoration provides a reasonable base for viewing the distribution of major tectonostratigraphic assemblages and mid-Cretaceous contractional fault systems within the orogen prior to Late Cretaceous and early Tertiary strike-slip faulting. In this section we will first summarize the relationships of these tectonostratigraphic assemblages and then present a simple model for the Mesozoic to early Tertiary tectonic evolution of the area.

Oceanic rocks of Bridge River Terrane underlie a long linear belt that extends for most of the length of the southeastern Coast Belt. In the northern part of this belt the Bridge River Complex accumulated as a Middle Triassic to late Middle Jurassic accretion-subduction complex that was unconformably overlain by latest Middle Jurassic to mid-Cretaceous clastic sedimentary rocks of the Tyaughton basin. Farther south, however, western parts of the complex display no evidence of this subduction-related deformation and are gradationally and conformably overlain by mainly fine-grained clastic sedimentary rocks of the Jura-Cretaceous Cayoosh assemblage (Journeay and Northcote, 1992; Journeay and Mahoney, 1994). Near the international boundary, Bridge River Terrane is represented by the Hozameen Group in the east, and by high-grade metamorphic rocks that probably correlate with the Bridge River Complex and Cayoosh assemblage within the structural and metamorphic culmination of the southeastern Coast - north Cascades orogen to the west. The latter assemblages include the Twisp Valley schist, Napeequa unit and Chiwaukum schist of the Cascade Metamorphic Core (McGroder, 1991; Miller *et al.*, 1993b), and the Cogburn Creek Group and Settler schist in the southeastern Coast Belt (Monger and Journeay, 1994). Correlatives of the Bridge River Complex also occur farther west, south of the western Coast Belt, where they include the Elbow Lake Formation of the northwest Cascade thrust system and the Deadman Bay Terrane of the San Juan Islands thrust system (Miller *et al.*, 1993b). The Shuksan metamorphic suite of the Northwest Cascades thrust system may correlate with the Cayoosh assemblage, representing the upper part of Bridge River Terrane (Monger, 1991b). Early Cretaceous blueschist-facies metamorphism of the Shuksan suite (Brown and Blake, 1987) indicates that a pulse of subduction-related deformation affected the southern part of the Bridge River - Cayoosh basin at the onset of the major episode of Early to Late Cretaceous contractional deformation that affected the orogen.

Methow Terrane and overlying clastic rocks of the Methow basin occupy a belt that occurs directly east of Bridge River Terrane. Methow Terrane includes Lower to Middle Jurassic clastic and arc volcanic rocks that are recognized over the entire length of this belt. In the central part of the belt these rocks rest unconformably above oceanic basement of the Coquihalla serpentine belt (Ray, 1986), which restores to, and is inferred to correlate with, obducted ophiolitic rocks of the Shulaps Ultramafic Complex in the Taseko - Bridge River area (Figure 44). At the north end of the belt, the Jurassic rocks of Methow Terrane were deposited above Upper Triassic clastic rocks that resemble those of Cadwallader Terrane, which in turn were deposited nonconformably above Middle to Late Triassic tonalitic to dioritic plutons (Schiarizza *et al.*, 1995; Schiarizza, 1996).

Cadwallader Terrane includes Upper Triassic arc volcanics and arc-derived clastics, together with Lower to Middle Jurassic mainly fine-grained clastic rocks. Rocks that are confidently correlated with Cadwallader Terrane within and near its type area comprise numerous small fault-bounded lenses distributed across a limited area west of the Late Paleozoic Shulaps Ultramafic Complex (Figure 44). The Cadwallader rocks in this area are invariably imbricated with Shulaps-correlative ophiolitic rocks of the Bralorne-East Liza Complex, and are inferred to comprise remnants of a large, composite, Cretaceous thrust sheet that was thrust westward over the Bridge River Complex and Tyaughton

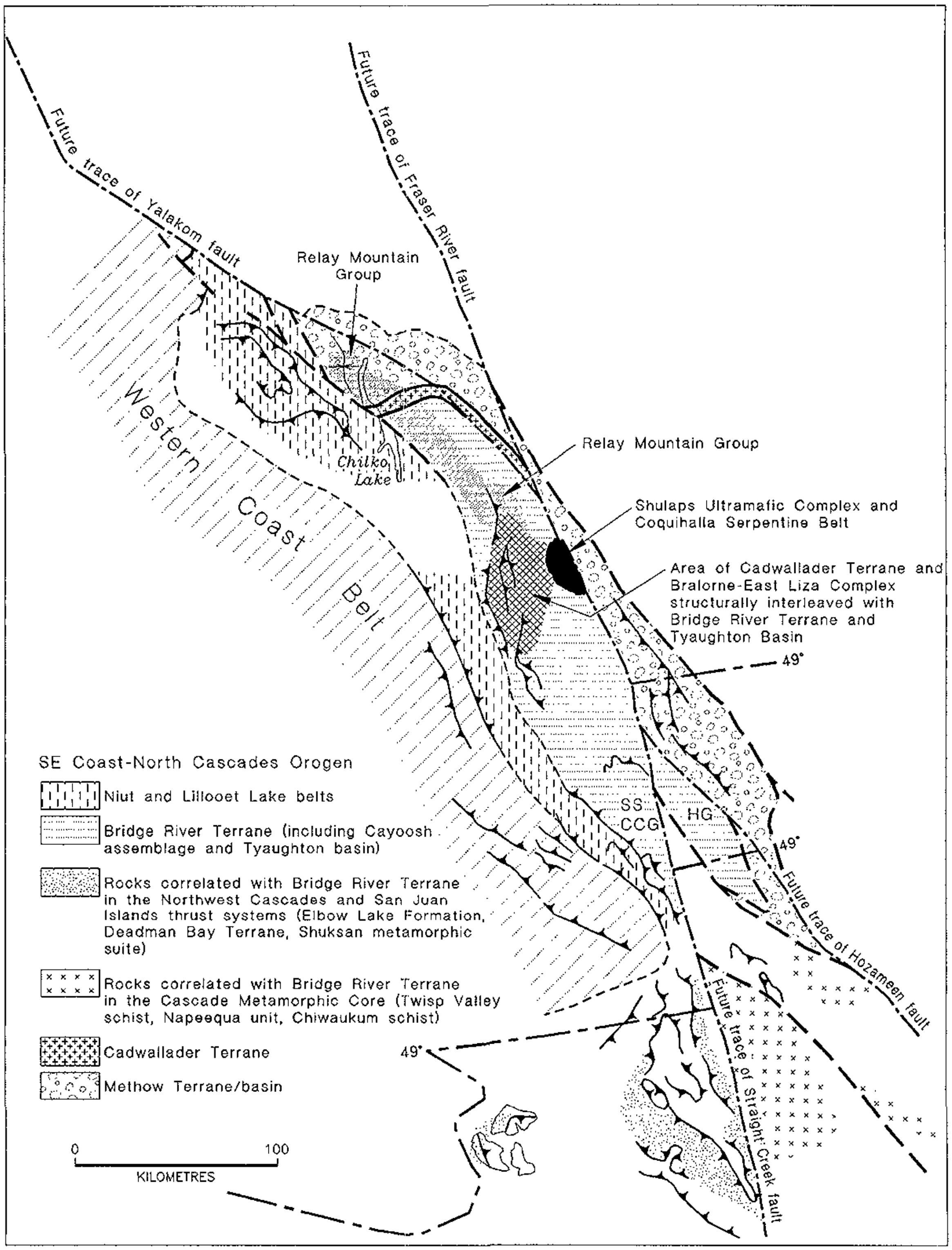

Figure 44. Map showing the distribution of Bridge River Terrane and associated tectonostratigraphic assemblages in the southeastern Coast - north Cascades orogen after restoring latest Cretaceous to Tertiary dextral strike-slip displacement on the Fraser River - Straight Creek and Yalakom - Hozameen fault systems. CCG=Cogburn Creek Group; HG=Hozameen Group; SS=Settler schist.

basin. This thrust sheet is in turn structurally overlain by the Shulaps Ultramafic Complex, which is inferred to have been derived from beneath Methow Terrane. These relationships suggest that Cadwallader Terrane occupied a paleogeographic position between Bridge River and Methow terranes. This is consistent with relationships farther to the north, where the most continuous belt of Cadwallader rocks, corresponding to the restored Camelsfoot and Konni Lake belts (Riddell *et al.*, 1993a), occurs between Bridge River and Methow terranes (Figure 44). The lithologic similarity between the Upper Triassic Tyaughton Group of Cadwallader Terrane and correlative rocks in the lower part of Methow Terrane near Tatlayoko Lake suggest that Cadwallader and Methow terranes may actually comprise different parts of a single arc - basin system. This link is consistent with the fact that both terranes are associated with Late Paleozoic ophiolitic rocks, and both terranes include arc volcanics that are coeval with subduction-accretion tectonics within the adjacent Bridge River Complex. These relationships suggest that Cadwallader and Methow terranes are parts of an arc system that formed above Late Paleozoic ocean crust in response to subduction of the Bridge River oceanic plate to the west.

The western part of the southeastern Coast Belt comprises Triassic through Cretaceous arc-derived volcanic and sedimentary successions assigned to the Niut and Lillooet Lake belts (*see* Figures 39 and 40). Upper Triassic arc volcanic rocks of the Lillooet Lake belt had previously been assigned to the Cadwallader Group (Roddick and Hutchison, 1993; Riddell, 1992; Monger and Journeay, 1994), but are here differentiated from the type-Cadwallader Group in the Taseko - Bridge River area because the two successions apparently restore to opposite sides of Bridge River Terrane (Figure 44). The Triassic rocks of the Lillooet Lake belt are stratigraphically overlain by Lower to Middle Jurassic arc volcanic and sedimentary rocks correlated with the Harrison Lake Formation of the adjacent western Coast Belt (Journeay and Mahoney, 1994). The southern end of the Lillooet Lake belt includes metavolcanic and metasedimentary rocks of the Slollicum schist, which correlate, at least in part, with the Lower Cretaceous Peninsula and Brokenback Hill formations (Monger and Journeay, 1994). These formations occur in the upper part of Harrison Terrane (Arthur *et al.*, 1993) and comprise part of the Lower Cretaceous Gambier volcanic arc assemblage, which is widespread within the southwestern Coast Belt (Monger and Journeay, 1994).

The Niut belt is underlain mainly by Middle to Upper Triassic arc volcanic and sedimentary rocks of the Mount Moore and Mosley formations, associated Late Triassic plutons, and Lower Cretaceous volcanic and sedimentary rocks assigned to the Ottarasko and Cloud Drifter formations (Rusmore and Woodsworth, 1991a; Mustard and van der Heyden, 1994; Schiarizza, 1996). The Lower Cretaceous rocks (Umhoefer *et al.*, 1994) are lithologically similar to age-equivalent rocks of the Gambier assemblage, whereas the Triassic rocks have been correlated with those of Stikine Terrane (Rusmore and Woodsworth, 1991a). While not disputing the latter correlation, we suggest that this belt of Triassic rocks continues southeastward to also include the Lillooet Lake Belt. This correlation is suggested by their along strike position, general lithologic similarity, the presence of Triassic quartz dioritic intrusive rocks within both belts (Riddell, 1992; Mustard and van der Heyden, 1994; Schiarizza, 1996), and their mutual association with younger sequences of arc volcanic and sedimentary rocks that probably correlate with the Lower Cretaceous Gambier Group (Riddell, 1992, Umhoefer *et al.*, 1994). This correlation is consistent with the recent discovery of Middle Triassic (Ladinian) chert and siliceous siltstone intercalated with mafic volcanic rocks in the Mount Moore formation of the Niut belt (F. Cordey and P.S. Mustard, personal communication, 1994; Schiarizza, 1996). These rocks may correlate with Middle Triassic (Ladinian) siliceous siltstone and mafic volcanic rocks at the base of Harrison Terrane (Camp Cove Formation, Arthur *et al.*, 1993), which may in turn be linked to the Triassic rocks of the Lillooet Lake belt by their mutual association with the overlying Harrison Lake Formation (Journeay and Mahoney, 1994).

As summarized above, rocks within the Lillooet Lake - Niut belt have stratigraphic ties to the adjacent western Coast Belt. The Lillooet Lake - Niut belt occurs west of Bridge River Terrane over most of its length, and was involved in the early Late Cretaceous structural telescoping of Bridge River Terrane over the western Coast Belt in the vicinity of Lillooet and Harrison lakes (Journeay and Friedman, 1993). In the north, however, the Lillooet Lake - Niut belt is juxtaposed against Methow Terrane, having cut across the contacts between Bridge River, Cadwallader and Methow terranes near Chilko Lake (Figure 44). The present boundary may correspond, at least in part, to Tertiary dextral strike-slip faults, but as these are inferred to have only a few kilometres of displacement (Umhoefer *et al.*, 1994; Umhoefer and Kleinspehn, 1995), this truncation boundary may relate to the emplacement of the Lillooet Lake - Niut Belt (together with the western Coast Belt) against the adjacent terranes of the eastern Coast Belt at some earlier date. The time of this original emplacement is not well defined, but may have been as early as the latest Middle Jurassic. This inference is based on the distribution of the oldest rocks within the Tyaughton - Methow basin, the latest Middle Jurassic to Lower Cretaceous Relay Mountain Group, which defines a belt that cuts across the Methow/Cadwallader/Bridge River terrane contacts, but follows, and is directly east of, the boundary of the Lillooet Lake - Niut belt (Figure 44). Although not shown on Figure 44, this belt of Jura-Cretaceous clastic sedimentary rocks probably continues southward to beyond the international boundary, where it is represented by the Cayoosh assemblage and metamorphic equivalents (Journeay and Mahoney, 1994; Monger and Journeay, 1994). Initiation of clastic sedimentation within the Tyaughton - Methow - Cayoosh clastic basin may have been diachronous in detail (Journeay and Mahoney, 1994), but we infer that this long period of sustained clastic sedimentation was a response to the emergence or arrival of this western crustal block by late Middle Jurassic time. This is consistent with the stratigraphic record within most of the Lillooet Lake, Niut and western Coast belts, where Upper Jurassic and lowermost Cretaceous rocks are largely absent, suggesting that this western crustal block was emergent during this interval and may have supplied sediment to the adjacent basin (Figure 40). It is also permitted by the provenance of clastic detritus within the Relay Mountain Group, which was derived from a mixed volcanic and plutonic source within a magmatic arc (Umhoefer, 1989). Facies patterns are generally not well defined within the lower part of the Relay Mountain Group, but thick intervals of Late Jurassic conglomerate are found only within western exposures of the group (Tipper, 1969; Schiarizza, 1996; Leckie Creek area of this study), suggesting that it was derived, at least in part, from a western source. Lower Cretaceous rocks of the Relay Mountain Group also become coarser in the west (Umhoefer, 1989), and in the Tosh Creek area the upper (Hauterivian) part of the group may be transitional into coarse volcanic conglomerates and breccias (Tosh Creek succession of this report). These relationships are consistent with the interpretations of Tipper (1969) and Umhoefer *et al.* (1994), who suggested that Hauterivian volcanic and sedimentary rocks of the Niut Belt, comprising the eastern part of an early Cretaceous arc within the western Coast Belt, were transitional eastward into clastic rocks of the Relay Mountain Group.

The stratigraphic record in the upper part of the Tyaughton - Methow basin indicates that volcanic-lithic sedimentary rocks derived from the west continued to be deposited within the western part of the basin in Albian time, but were mixed with chert-rich detritus derived from intrabasinal highlands formed by uplifted Bridge River Complex (Garver, 1992). Contractional deformation may have resulted in emergence of most of the Bridge River belt south of the Taseko - Bridge River area, as this part of the belt supplied chert-rich clastic detritus to the Tyaughton sub-basin to the northwest (*see* Figure 11), as well as to the southern part of the Methow sub-basin to the east (Trexler, 1985; Monger, 1989). However, most of the vast quantities of mid-Cretaceous arkosic sediment deposited in the Methow sub-basin, and locally in the Tyaughton sub-basin, were derived from an eastern source terrane that included contemporaneous volcanic rocks as well as plutonic and metamorphic rocks (Kleinspehn, 1985; Garver, 1992). These strata record the first major influx of clastic detritus that was clearly derived from a continental source terrane external to the Coast Belt. Available provenance data suggest that this source terrane might be rocks of the Intermontane and Omineca belts that are presently adjacent to the basin (*e.g.* Kleinspehn, 1982, 1985; O'Brien *et al.*, 1992; Garver, 1992), but do not rule out a source 3000 kilometres farther south along the continental margin (Cowan, 1994; Garver and Brandon, 1994), as indicated by several sets of tilt-corrected paleomagnetic data (Ague and Brandon, 1992; Irving *et al.*, 1995; Wynne *et al.*, 1995).

The relationships summarized in the previous paragraphs suggest that the Mesozoic to early Cenozoic evolution of the southeastern Coast Belt can be summarized in terms of 4 time periods, as indicated on Figure 45 and discussed in the following paragraphs.

TRIASSIC TO MIDDLE JURASSIC

Middle Triassic to latest Middle Jurassic time was marked by subduction of the Bridge River ocean basin be-

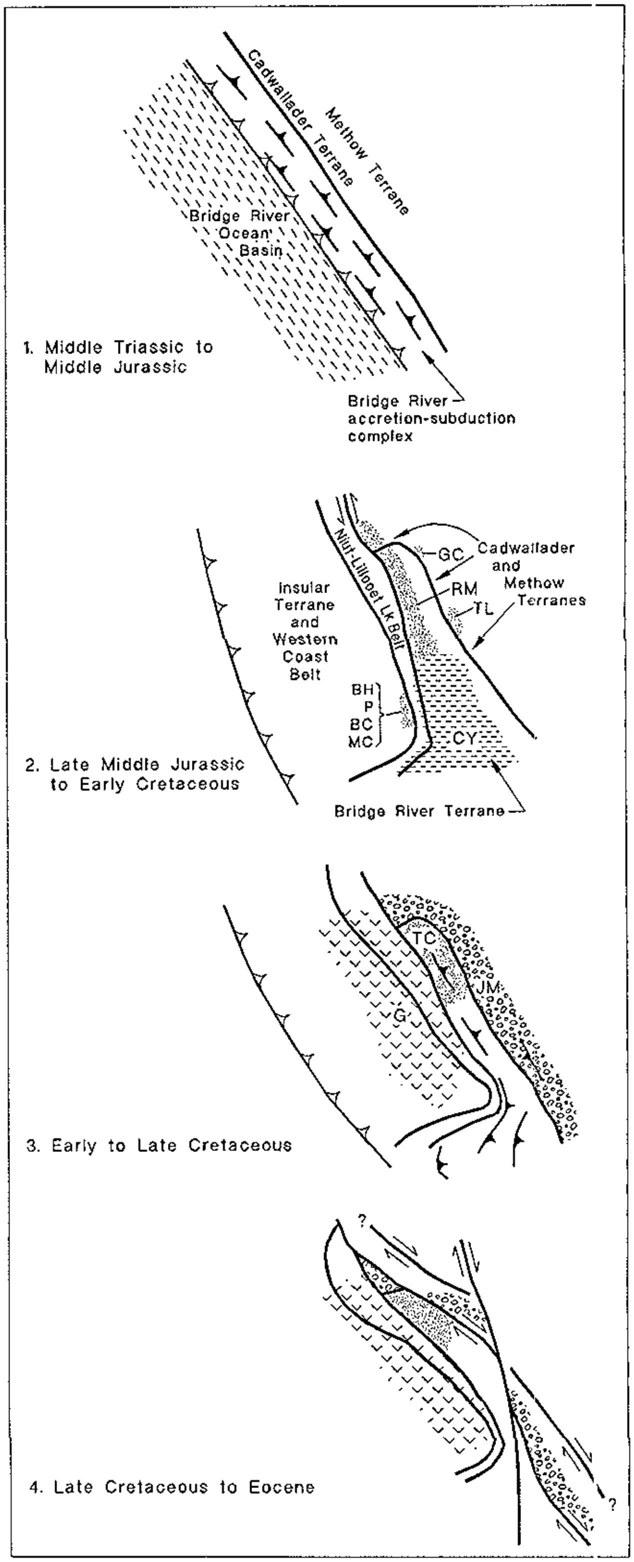

Figure 45. Schematic summary of the Mesozoic and early Tertiary tectonic evolution of the southeastern Coast - north Cascades orogen. BC=Billhook Creek Fm; BH= Brokenback Hill Fm; CY=Cayoosh assemblage; G=Gambier Group; GC=Grouse Creek unit; JM=Jackass Mountain Gp; MC=Mysterious Creek Fm; P=Peninsula Fm; RM=Relay Mountain Group; TC=Taylor Creek Group; TL=Thunder Lake sequence.

neath an overriding oceanic plate represented, in part, by late Paleozoic ophiolitic rocks of the Shulaps and Bralorne-East Liza complexes. Upper Triassic to Middle Jurassic arc volcanics and arc-derived clastic sedimentary rocks of Cadwallader and Methow terranes formed on the overriding plate in response to this subduction. The imbricated assemblage of sedimentary, volcanic and metamorphic rocks that comprises the northeastern part of the Bridge River Complex accumulated as an accretionary complex at the leading edge of the overriding plate. More coherent sections of chert and greenstone that constitute major parts of the complex farther to the south (western assemblage of the Bridge River Complex described by Journey and Northcote, 1992) represent more distal parts of this ocean basin that remained open during this early to mid-Mesozoic phase of subduction-accretion tectonics.

LATE MIDDLE JURASSIC TO EARLY CRETACEOUS

Late Middle Jurassic time saw the arrival of the Lillooet Lake - Niut belt and adjacent western Coast Belt, defining a western margin to the Bridge River basin prior to its complete collapse by subduction. The subsequent Late Jurassic to Early Cretaceous history of Bridge River, Cadwallader and Methow terranes is dominated by the deposition of clastic sediments derived mainly or entirely from this newly-arrived western crustal block. In the north, these clastic deposits are represented by the Relay Mountain Group, which overlaps Methow and Cadwallader terranes, as well as the adjacent Bridge River accretion-subduction complex. Clastic sediments farther south are represented by the Cayoosh assemblage, which was deposited, in part, above coherent oceanic crust of the western Bridge River complex, which had not been affected by subduction-related deformation. The Grouse Creek unit and Thunder Lake sequence, deposited above Cadwallader and Methow terranes, respectively, in the northeastern part of the orogen (Figure 45), might represent distal parts of the Relay Mountain depositional system. Alternatively, these sediments may have been derived from local uplifts within these terranes themselves, or from a separate source to the east.

The crustal block represented by the Lillooet Lake - Niut belt, the western Coast Belt and Wrangellia may have been emplaced to the west of Bridge River Terrane along a system of sinistral faults (Figure 45), as suggested by Monger *et al.* (1994). (Note, however, that Monger *et al.* preferred an Early to mid-Cretaceous age for this displacement.) This process may have been part of a general southward migration of arc terranes bordering the North American craton due to left-oblique convergence of adjacent oceanic lithosphere during Triassic to mid-Cretaceous time (Avé Lallemant and Oldow, 1988). Deformation associated with emplacement of the western Coast Belt may be reflected in pre-Callovian folds documented in the Harrison Terrane by Mahoney *et al.* (1995). Middle Jurassic deformation is also documented near the boundary between the western Coast and Insular belts (Monger, 1991a, 1993), where it included folding as well as sinistral displacement along northwest striking faults (Webster and Ray, 1990; Ray and Kilby, 1996). Subduction of oceanic lithosphere beneath its western margin, which may have begun in the Triassic, continued after emplacement of the crustal fragment to the west of Bridge River Terrane and was responsible for the generation of late Middle Jurassic through Lower Cretaceous plutons that occur within the western Coast Belt (Friedman *et al.*, 1995). Uplift and erosion accompanied this plutonism throughout much of the belt, such that the block supplied detritus to the adjacent clastic basin represented by the Relay Mountain Group and Cayoosh assemblage. Supracrustal rocks deposited in the western Coast Belt arc during this interval are well preserved only in Harrison Terrane, where they comprise Callovian to Valanginian strata of the Mysterious Creek, Billhook Creek and Peninsula formations and the lower part of the Brokenback Hill Formation (Arthur *et al.*, 1993). These rocks include a mixture of volcanic and sedimentary rocks, in contrast to the entirely sedimentary character of the coeval Relay Mountain Group, which was deposited in a back-arc setting.

An alternative mechanism for the narrowing of the Bridge River basin in early to mid-Mesozoic time, suggested by Arthur *et al.* (1993), is subduction to both the east and the west, thus generating coeval arc sequences on both its eastern (Cadwallader - Methow) and western (Niut - Lillooet Lake - Harrison) margins. However, this is not consistent with the geochemical and isotopic data presented by Mahoney and DeBari (1995) who suggest that the Harrison Lake Formation comprises the eastern side of an arc system that also includes the Bonanza and Bowen Island groups of Wrangellia, and that these Lower to Middle Jurassic arc volcanics were generated by eastward subduction of oceanic crust along the western margin of Wrangellia. Furthermore, the sinistral emplacement model provides an explanation for the apparent absence of Bridge River Terrane or traces of an oceanic suture within the Coast Belt north of 52° latitude. It also presents the possibility that, prior to their southward displacement in Late Middle Jurassic time, Triassic and Lower to Middle Jurassic arc sequences in the Lillooet Lake and Niut belts were the northern continuation of the similar, coeval arc sequences represented by Cadwallader and Methow terranes.

EARLY TO LATE CRETACEOUS

Final collapse of the Bridge River basin, including overlying clastics of the Cayoosh assemblage, occurred in Early to Late Cretaceous time, and gave rise to the southeastern Coast - north Cascades contractional orogen. This collapse was initiated in Hauterivian to Barremian time with subduction of some of the remaining Bridge River oceanic crust, as indicated by the clustering of K-Ar radiometric dates from blueschists in the Cayoosh-correlative (Monger, 1991b) Shuksan metamorphic suite (Brown and Blake, 1987). Shortening of the basin, by way of predominantly southwest-directed thrust faults, continued until the early Late Cretaceous and was accompanied by synorogenic clastic sedimentation in the Tyaughton - Methow basin. These sediments were derived partly from the western Coast Belt, partly from uplifted highlands within the orogen itself, and partly from a continental source east of the orogen (Garver, 1989, 1992; Garver and Brandon, 1994). The influence of the latter source area suggests that the deformation within the southeastern Coast - north Cascades orogen may have included its collapse against the North American continental margin, and/or have been coincident with major uplift of adjacent North American rocks. Although many geologically-based interpretations suggest that the eastern source terrane comprised adjacent rocks of the Intermontane and Omineca belts, paleomagnetic data suggest that this interaction occurred 3000 kilometres farther south along the continental margin (Ague and Brandon, 1992; Wynne *et al.*, 1995).

The Early to Late Cretaceous development of the southeastern Coast - north Cascades orogen probably occurred within a framework of continuing east-dipping subduction of adjacent oceanic lithosphere along the outboard margin of the Insular Belt (Armstrong, 1988; van der Heyden, 1992; Friedman *et al.*, 1995). Arc volcanics related to this subduction include the Early Cretaceous (Hauterivian to Albian) Gambier assemblage of the western Coast Belt and correlative Ottarasko formation of the Niut belt. Hauterivian strata within the back-arc Relay Mountain Group are entirely sedimentary, but the overlying (Albian) Taylor Creek Group locally includes a significant volcanic component (this study; McLaren, 1990). Still younger volcanics, represented by the Upper Cretaceous Powell Creek formation are restricted to the eastern Coast Belt. This eastward shift in arc magmatism with time is also reflected in the ages of plutonic rocks within the southern Coast Belt: Jura-Cretaceous plutonism within the western Coast Belt spread eastward into the western part of the eastern Coast Belt at about 100 Ma (Albian), and the locus of plutonism then shifted abruptly eastward at about 90 Ma, such that Upper Cretaceous plutons are restricted to the eastern Coast Belt (Friedman *et al.*, 1995).

The polarity of the short-lived subduction event recorded by Early Cretaceous blueschists of the Shuksan metamorphic suite is unknown. However, Lynch (1995) presents geochemical data suggesting that volcanic rocks of the Gambier assemblage at the south end of the western Coast Belt comprise part of an east-facing arc situated above a west to southwest-dipping subduction zone. In contrast, the large-scale patterns of magmatism within the Coast Belt (Armstrong, 1988; van der Heyden, 1992), and the record from the adjacent seafloor of Jurassic to Tertiary subduction of oceanic crust beneath the continental margin (Engebretson *et al.*, 1985, 1995), suggest that the bulk of the Coast Plutonic Complex and associated volcanic rocks are the products of a long-lived east-dipping subduction zone along the outboard boundary of the Insular Belt. The anomalous arc polarity suggested for the southern part of the Gambier assemblage may indicate that the Early Cretaceous subduction of the remnants of the Bridge River ocean basin was to the west, beneath the southern part of the western Coast Belt.

The tectonostratigraphic assemblages and mid-Cretaceous contractional structures which characterize the southeastern Coast - north Cascades orogen have not been recognized north of 52° latitude, where they pinch out between the Yalakom fault and the Late Jurassic Wilderness Mountain pluton. Van der Heyden *et al.* (1994) suggest that the Wilderness Mountain pluton comprises the hanging wall of a west-dipping fault at the northern end of the Eastern Waddington thrust belt. They link the northern termination of the thrust belt to the original northern termination of the Tyaughton basin, suggesting that the contractional deformation involved rotational collapse of the basin about a hinge coinciding with this northern paleogeographic boundary. This model may apply to the entire southeastern Coast - north Cascades orogen, which is centred about the remnants of the Bridge River ocean basin together with overlying clastic deposits of the Tyaughton basin and Cayoosh assemblage. A northward-tapering paleogeography to this system of basins may be inferred from the northward plunge of the orogen, away from the structural and metamorphic culmination near the international boundary, where McGroder (1991) postulates a minimum of 400 to 500 kilometres of east-west shortening. The inferred northward-tapering geometry, prior to mid-Cretaceous contraction, is consistent with Monger *et al.*'s (1994) model of sinistral displacement of the western Coast Belt as a mechanism for bounding the Bridge River basin to the west (Figure 45, Stage 2).

LATE CRETACEOUS TO EOCENE

Mid to early Late Cretaceous contractional deformation within the southeastern Coast - north Cascades orogen was followed by dextral strike-slip during Late Cretaceous to late Eocene time. This change in tectonic style probably relates to an abrupt change in motion of offshore ocean plates, from east to northeast-directed orthogonal convergence with the North American margin to north-directed oblique convergence (Engebretson *et al.*, 1985, 1995). Dextral faults are most prominent along the eastern edge of the orogen, where the Yalakom - Hozameen and Fraser River - Straight Creek fault systems account for 200 to 300 kilometres of mainly Tertiary displacement (Umhoefer and Schiarizza, 1993). This tectonic regime may have also resulted in about 3000 kilometres of Late Cretaceous to Paleocene northward translation of the entire southeastern Coast - north Cascades orogen, together with the western Coast and Insular belts, from the latitude of northern Mexico to its present position relative to the North American craton (Ague and Brandon, 1992; Wynne *et al.*, 1995). More than half of this displacement apparently occurred on structures along or near the present day boundary between the southern Coast and Intermontane belts (Cowan, 1994; Irving *et al.*, 1995), although fault systems with the appropriate sense and timing of displacement have not been documented along this boundary.

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APPENDICES

APPENDIX 1

Conodont Identifications

By M.J. Orchard
Geological Survey of Canada
Vancouver, British Columbia.

BRIDGE RIVER COMPLEX

Field No. **70-MV-26** GSC Loc. No. **O-86300**
NTS 92J/15 Northing 5636705 Easting 528139
East side of Tyaughton Creek immediately above the Carpenter Lake road.
Carbonate.
Unit: uTBRglc
Microfossils: conodonts, sphaeromorphs
Conodonts:
ramiform elements (12)
Epigondolella quadrata Orchard 1991 (13)
Metapolygnathus sp. (3)
Neogondolella navicula (Huckriede 1958) (23)
CAI: 3.5-4.5
Age: Late Triassic; Early Norian *quadrata* Zone
Comment: Processed and originally identified by B. Cameron as late Ladinian (Cameron and Monger, 1971).

Field No. **87BNC-BBC-024b** GSC Loc. No. **C-117578**
NTS 92J/15 Northing 5628950 Easting 506250
South of Downton Lake, east end, on new road.
Carbonate.
Unit: MJBR
Conodonts:
Neogondolella navicula (Huckriede 1958) (6)
Epigondolella triangularis (Budurov 1972) (3)
ramiform elements (1)
CAI: 3.5-4
Age: Late Triassic; Early Norian

Field No. **87BNC-BBC-0121** GSC Loc. No. **C-117582**
NTS 92J/16 Northing 5631550 Easting 537400
South shore of Carpenter Lake, south of Marshall Creek.
Limestone blocks in greenstone.
Unit: MJBR
Microfossils: conodonts, spicules
Conodonts:
Metapolygnathus sp. (3)
CAI: 6.5-7
Age: Late Triassic; Carnian

Field No. **87BNC-BBC-0135** GSC Loc. No. **C-117586**
NTS 92J/15 Northing 5637400 Easting 524450
~2800 m west-southwest of mouth of Tyaughton Creek, on south shore of Carpenter Lake.
Carbonate.
Unit: MJBR
Microfossils: conodonts, echinoderms
Conodonts:
Neocavitella sp. (2)
Metapolygnathus nodosus (Hayashi 1968) (4)
ramiform elements (2)
CAI: 4.5-5.5
Age: Late Triassic; Late Carnian

Field No. **87BNC-GBB-050** GSC Loc. No. **C-117567**
NTS 92J/15 Northing 5640200 Easting 527350
~1600 m southwest of Marshall Lake at foot of ridge.
Carbonate.
Unit: uTBRglc
Microfossils: conodonts, ichthyoliths
Conodonts:
ramiform elements (17)
Epigondolella sp. (6)
Epigondolella quadrata Orchard 1991 (3)
Epigondolella triangularis (Budurov 1972) (1)
Neogondolella navicula (Huckriede 1958) (20)
ramiform elements (13)
CAI: 3.5-4.5
Age: Late Triassic; Early Norian

Field No. **87BNC-MJB-0376** GSC Loc. No. **C-117596**
NTS 92J/16 Northing 5632600 Easting 537410
~800 m west of Marshall Creek Falls, on Carpenter Lake road.
Carbonate.
Unit: MJBR
Conodonts:
Epigondolella sp. (4)
ramiform elements (2)
CAI: 2.5-3.5
Age: Late Triassic; probably Early Norian

Field No. **88APS-6-9-1** GSC Loc. No. **C-168332**
NTS 92J/15 Northing 5644550 Easting 512650
West of Crane Creek.
Limestone.
Unit: uTBRglc
Conodonts:
Epigondolella sp. (2)
CAI: 4.5
Age: Late Triassic; Norian

Field No. **88APS-6-10-1** GSC Loc. No. **C-168323**
NTS 92J/15 Northing 5644280 Easting 513070
West of Crane Creek.
Limestone.
Unit: uTBRglc
Conodonts:
Epigondolella quadrata Orchard 1991 (35)
ramiform elements (1)
CAI: 6-7
Age: Late Triassic; Early Norian, *quadrata* Zone

Field No. **88APS-18-1** GSC Loc. No. **C-168320**
NTS 92J/15 Northing 5645800 Easting 512150
Head of Pearson Creek.
Carbonate.
Unit: uTBRglc
Conodonts:
Epigondolella sp. (2)
Neogondolella navicula (Huckriede 1958) (5)
ramiform elements (7)
CAI: 4-6
Age: Late Triassic; Early Norian

Field No. **88BER-168** GSC Loc. No. **C-154009**
NTS 92J/15 Northing 5629045 Easting 532936
Tommy Creek, 3.7 km south of Carpenter Lake.
Limestone breccia.
Unit: MJBR
Conodonts:

Metapolygnathus sp. (1)
CAI: 6-6.5
Age: Late Triassic; Carnian

Field No. **88BER-604** GSC Loc. No. **C-154015**
NTS 92J/15 Northing 5642752 Easting 525940
South of Liza Lake.
Limestone alternating with bands of chert.
Unit: uŦBRglc
Conodonts:
Epigondolella sp. (3)
Epigondolella triangularis (Budurov 1972) (1)
CAI: 3-4
Age: Late Triassic; Early? Norian

Field No. **88BER-637** GSC Loc. No. **C-154018**
NTS 92J/16 Northing 5633545 Easting 544112
Ridge between Bighorn and Fell creeks.
Carbonate lens in phyllite.
Unit: MJBRm
Conodonts:
Idioprioniodus? sp. (1)
CAI: ~6
Age: Carboniferous?

Field No. **88BER-654** GSC Loc. No. **C-154019**
NTS 92J/16 Northing 5632121 Easting 543714
Ridge between Bighorn and Fell creeks.
Carbonate lens in greenstone.
Unit: MJBR
Conodonts:
Metapolygnathus sp. (5)
CAI: 6-7
Age: Late Triassic; Carnian

Field No. **88JIG-20-15B** GSC Loc. No. **C-168334**
NTS 92J/15 Northing 5647730 Easting 511250
Headwaters of Taylor Creek.
Chert.
Unit: uŦBRglc
Microfossils: conodonts, spumellarian radiolarians, sponge spicules
Conodonts:
Epigondolella sp. (1)
ramiform elements (2)
CAI: 7
Age: Late Triassic; Early? Norian

Field No. **88JIG-40-15** GSC Loc. No. **C-168339**
NTS 92J/15 Northing 5646100 Easting 508420
Headwaters of Eldorado Creek.
Chert.
Unit: MJBR
Conodonts:
blade fragment (1)
Idioprioniodus? sp. (1)
CAI: 4-4.5
Age: Carboniferous

Field No. **88TP-20-12** GSC Loc. No. **C-168347**
NTS 92J/15 Northing 5644720 Easting 508840
Ridge separating the headwaters of Lick and Eldorado creeks.
Carbonate.
Unit: MJBR
Conodonts:
Neogondolella sp. (1)
ramiform elements (2)
CAI: 3.5-4
Age: Permian - ?Triassic

Field No. **89APS-5-43** GSC Loc. No. **C-168101**
NTS 92J/15 Northing 5636340 Easting 512560
Carpenter Lake Road, 3 km north of Gold Bridge.
Chert.
Unit: uŦBRglc
Microfossils: conodonts, sphaeromorphs
Conodonts:
Neogondolella? sp. indet. (1)
CAI: 4-6
Age: Triassic

Field No. **89APS-5-4-3** GSC Loc. No. **C-168102**
NTS 92J/15 Northing 5636500 Easting 512670
Carpenter Lake Road, 3 km north of Gold Bridge.
Chert.
Unit: uŦBRglc
Conodonts:
ramiform elements (3)
CAI: 5.5
Age: Ordovician - Triassic

Field No. **89APS-5-6-2** GSC Loc. No. **C-168287**
NTS 92J/15 Northing 5636570 Easting 512720
Carpenter Lake Road, 3 km north of Gold Bridge.
Carbonate.
Unit: uŦBRglc
Conodonts:
Epigondolella sp. indet. (30)
Epigondolella triangularis (Budurov 1972) (1)
Epigondolella spatulata (Hayashi 1968) (3)
ramiform elements (6)
CAI: 5.5-7
Age: Late Triassic; late Early Norian *triangularis* Zone

Field No. **89APS-5-6-3** GSC Loc. No. **C-168288**
NTS 92J/15 Northing 5636660 Easting 512820
Carpenter Lake Road, 3 km north of Gold Bridge.
Carbonate.
Unit: uŦBRglc
Conodonts:
Epigondolella sp. (12)
ramiform elements (2)
CAI: 4-6
Age: Late Triassic; probably Early Norian

Field No. **89APS-7-1-2** GSC Loc. No. **C-168291**
NTS 92J/15 Northing 5636750 Easting 512800
Carpenter Lake Road, 3 km northeast of Gold Bridge.
Carbonate.
Unit: uŦBRglc
Conodonts:
Epigondolella sp. (11)
ramiform elements (13)
CAI: 4-6
Age: Late Triassic; probably Early Norian

Field No. **89APS-22-5** GSC Loc. No. **C-168103**
NTS 92J/15 Northing 5638620 Easting 507500
Northwest of Gun Lake.
Chert.
Unit: MJBR
Micrfossils: conodonts, sponge spicules, sphaeromorphs
Conodonts:
Neogondolella sp. indet. (3)
ramiform elements (10)
CAI: 4-6
Age: Permian - Triassic.

Field No. **89BGA-11-1** GSC Loc. No. **C-168260**
NTS 92J/15 Northing 5635840 Easting 513030
Road south of Carpenter Lake, 2.5 km northeast of Gold Bridge.
Carbonate.
Unit: uŦBRglc
Conodonts:
Epigondolella sp. cf. *E. triangularis* (Budurov 1972) (3)

CAI: 5.5
Age: Late Triassic; probably Early Norian

Field No. **89BGA-11-3-2b** GSC Loc. No. **C-168263**
NTS 92J/15 *Northing 5635900* *Easting 513060*
Road south of Carpenter Lake, 2.5 km northeast of Gold Bridge.
Carbonate.
Unit: uTRBRglc
Conodonts:
ramiform elements (15)
CAI: 5.5-6.5
Age: Carboniferous - Triassic

Field No. **89BNC-BRC-449** GSC Loc. No. **C-158871**
NTS 92J/15 Northing 5632500 Easting 513320
2 km east-southeast of Gold Bridge.
Limestone interbedded with chert.
Unit: uTRBRglc
Conodonts:
ramiform elements (2)
Epigondolella quadrata Orchard 1991 (13)
Epigondolella sp. cf. *E. spatulata* (Hayashi 1968) (2)
Neogondolella hallstattensis (Mosher 1968) (4)
CAI: 4-6
Age: Late Triassic; Early Norian

Field No. **89JG-7-11** GSC Loc. No. **C-168126**
NTS 92J/15 Northing 5645900 Easting 513425
Headwaters of North Cinnabar Creek.
Carbonate.
Unit: uTRBRglc
Conodonts:
Epigondolella sp. cf. *E. spatulata* (Hayashi 1968) (1)
Epigondolella sp. indet. (3)
CAI: 4-4.5
Age: Late Triassic; Early Norian

CADWALLADER TERRANE

Cadwallader Group: Hurley Formation

Field No. **83-WV-R-61B** GSC Loc. No. **C-103604**
NTS 92O/02 Northing 5649800 Easting 503900
Approximately 3 km east-southeast of Spruce Lake; peak south of Peak 7150.
Thin black micrite bed.
Unit: uTRCHv
Fossils: conodonts, foraminifers, radiolarians, ichthyoliths
Conodonts:
Metapolygnathus nodosus (Hayashi 1968) (2)
Metapolygnathus primitius (Mosher 1970) (85)
Neogondolella navicula (Huckriede 1958) (60)
ramiform elements (37)
CAI: 3-4
Age: Late Triassic; Early Norian, Upper *primitius* Zone

Field No. **84-WV-R-23** GSC Loc. No. **C-103619**
NTS 92J/15 Northing 5644900 Easting 504800
0.75 km south-southwest of Peak 7450.
Micritic turbidite.
Unit: uTRCHv
Fossils: conodonts, ostracodes, radiolarians
Conodonts:
ramiform elements (1)
Epigondolella quadrata Orchard 1991 (12)
CAI: 4-4.5
Age: Late Triassic; Early Norian, *quadrata* Zone

Field No. **84-WV-R-24** GSC Loc. No. **C-103620**
NTS 92J/15 Northing 5645100 Easting 504800
0.75 km southwest of Peak 7450.
Micritic turbidite
Unit: uTRCH
Fossils: conodonts, ichthyoliths, radiolarians, silicified ostracodes, foraminifers, sponge spicules
Conodonts:
Epigondolella sp. (26)
Epigondolella sp. aff. *E. spatulata* (Hayashi 1968) (4)
Epigondolella quadrata Orchard 1991 (34)
Neogondolella sp. (3)
ramiform elements (20)
CAI: 4-4.5
Age: Late Triassic; Early Norian

Field No. **84-WV-R-111** GSC Loc. No. **C-103627**
NTS 92J/15 Northing 5647500 Easting 505200
1 km south of Peak 7810, west of Eldorado Creek.
Carbonate. Float in snow.
Unit: uTRCHv
Fossils: conodonts, ichthyoliths, shell fragments, chaetognath spine?, holothurians
Conodonts:
Epigondolella postera (Kozur and Mostler 1971) (16)
Neogondolella steinbergensis (Mosher 1968) (1)
ramiform elements (4)
CAI: 4
Age: Late Triassic; Middle Norian, *postera* Zone

Field No. **86BNC-BCCA-BCR-40** GSC Loc. No. **C-117618**
NTS 92J/15 Northing 5626610 Easting 509200
200 m east of the north end of Gwyneth Lake.
Carbonate.
Unit: uTRCH
Microfossils: conodonts, ichthyoliths
Conodonts:
Epigondolella triangularis (Budurov 1972) (2)
Neogondolella sp. (1)
CAI: 5
Age: Late Triassic; late Early Norian, *triangularis* Zone

Field No. **87BNC-GBB-0205** GSC Loc. No. **C-117572**
NTS 92J/15 Northing 5648150 Easting 520630
~5 km northwest of Liza Lake, on ridge crest.
Carbonate.
Unit: uTRCH
Microfossils: conodonts, ichthyoliths
Conodonts:
Epigondolella sp. indet (2)
CAI: 4-4.5
Age: Probably Late Triassic, Norian

Field No. **88BER-03** GSC Loc. No. **C-154006**
NTS 92J/15 Northing 5647100 Easting 505900
West of upper Eldorado Creek.
Carbonate.
Unit: uTRCH
Microfossils: conodonts, ichthyoliths
Conodonts:
Epigondolella ex gr. *bidentata* Mosher 1968(2)
ramiform elements (1)
CAI: 3.5-4
Age: Late Triassic; Middle-Late Norian

Field No. **88BGA-8-2** GSC Loc. No. **C-168311**
NTS 92J/15 *Northing 5645620* *Easting 503480*
2.5 km north of lower Eldorado Creek.
Carbonate.

Unit: uTCH
Conodonts:
Epigondolella? sp. indet. (1)
CAI: 3.5
Age: Late Triassic; ?Norian

Field No. **89APS-23-12-3** **GSC Loc. No. C-168296**
NTS 92J/16 Northing 5631900 Easting 564750
West of Applespring Creek.
Carbonate.
Unit: uTCH
Microfossils: conodonts, ichthyoliths
Conodonts:
Epigondolella sp. cf. *E. quadrata* Orchard 1991 (2)
CAI: 4
Age: Late Triassic; probably Early Norian

Field No. **89BGA-22-3b** **GSC Loc. No. C-168269**
NTS 92J/15 Northing 5631340 Easting 512940
East of Brexton townsite.
Carbonate.
Unit: uTCH
Conodonts:
Epigondolella sp. cf. *E. quadrata* Orchard 1991 (3)
ramiform elements (1)
CAI: 7-8
Age: Late Triassic; Early Norian

Field No. **89BGA-27-2b** GSC Loc. No. **C-168273**
NTS 92J/15 Northing 5631000 Easting 505600
North side of Downton Lake.
Carbonate.
Unit: uTCH
Microfossils: conodonts, ichthyoliths
Conodonts:
Epigondolella sp. cf. *E. quadrata* Orchard 1991 (4)
Epigondolella sp. cf. *E. triangularis* (Budurov 1972) (1)
Neogondolella? sp. (1)
CAI: 5
Age: Late Triassic; Early Norian

Field No. **89BNC-BRC-472** **GSC Loc. No. C-158872**
NTS 92J/15 Northing 5642800 Easting 506500
Ridge parallel to B&F Creek.
Loose block of limestone on ridge.
Unit: uTCH
Microfossils: conodonts, ichthyoliths
Conodonts:
Metapolygnathus primitius (Mosher 1970) (1)
CAI: 2-3
Age: Late Triassic; Late Carnian - Early Norian *primitius* Zone

Field No. **89BNC-BRC-501** GSC Loc. No. **C-158374**
NTS 92J/15 Northing 5648200 Easting 505320
Head of Eldorado Creek.
Limestone.
Unit: uTCH
Microfossils: conodonts, radiolarians
Conodonts:
Epigondolella sp. indet. (3)
Neogondolella sp. (1)
CAI: 3.5-4
Age: Late Triassic; probably Early Norian

Field No. **89RMA-16-1-7** GSC Loc. No. **C-168120**
NTS 92J/15 Northing 5645240 Easting 529300
3.5 km northwest of Shulaps Peak.
Carbonate.
Unit: uTCH
Conodonts:
gondolelloid (1)
ramiform elements (2)
CAI: 4.5-5
Age: Permian - Triassic

Field No. **89RMA-21-3-2** GSC Loc. No. **C-168122**
NTS 92J/15 Northing 5644630 Easting 528820
4 km west of Shulaps Peak.
Carbonate.
Unit:uTCH
Microfossils: conodonts, ichthyoliths
Conodonts:
Metapolygnathus? sp. indet. (1)
CAI: 5
Age: Late Triassic

Hurley Formation - conodont-bearing clasts in conglomerates:

Field No. **82-MVV-LST3** GSC Loc. No. **C-087475**
NTS 92J/16 Northing 5644748 Easting 549365
East side of the Yalakom River, 0.5 km southeast of Junction Creek.
Limestone pebbles from conglomerate.
Unit: uTCH
Fossils: conodonts, ichthyoliths
Conodonts:
Epigondolella sp. (2)
CAI: 3-3.5
Age: Late Triassic; Early? Norian

Field No. **83-WV-R-5** GSC Loc. No. **C-103614**
NTS 92J/15 Northing 5647700 Easting 508000
1.75 km northwest of Peak 7550, east of Eldorado Creek.
Clast in pebbly mudstone.
Unit: uTCH
Fossils: conodonts, ichthyoliths, foraminifers
Conodonts:
Epigondolella englandi Orchard 1991 (8)
Neogondolella sp. indet. (1)
Epigondolella mosheri (Kozur and Mostler 1971) (2)
CAI: 5
Age: Late Triassic; Late Norian

Field No. **84-WV-R-17** GSC Loc. No. **C-103621**
NTS 92J/15 Northing 5646100 Easting 503650
East of Gun Creek, 0.5 km east-northeast of Peak 7220.
Carbonate cobbles from conglomerate.
Unit: uTCH
Fossils: conodonts, ichthyoliths, shell fragments
Conodonts:
Epigondolella sp. indet. (2)
CAI: 3.5
Age: Late Triassic

Field No. **84-WV-R-114A** GSC Loc. No. **C-103641**
NTS 92O/02 Northing 5650250 Easting 503300
2 km east of Spruce Lake.
Carbonate clast from conglomerate.
Unit: uTCH or uTT (Tyaughton Group)
Fossils: conodonts, foraminfers, ichthyoliths
Conodonts:
Metapolygnathus sp. aff. *M. communisti* Hayashi 1968 (1)
Metapolygnathus sp. indet. (1)
CAI: 3-3.5
Age: Late Triassic; probably Late Carnian, ?*communisti* Zone

Field No. **84-WV-R-114C** *GSC Loc. No.* **C-103642**
NTS 92O/02 Northing 5650250 Easting 503300
2 km east of Spruce Lake.
Carbonate clast from conglomerate.
Unit: uTCH or uTT (Tyaughton Group)
Fossils: conodonts, foraminifers, ichthyoliths
Conodonts:
Metapolygnathus primitius (Mosher 1970) (1)
CAI: 3-3.5
Age: Late Triassic; Late Carnian - Early Norian, *primitius* Zone

Field No. **84-WV-R-119C** GSC Loc. No. **C-103630**
NTS 92J/15 Northing 5646375 Easting 528550
Ridgecrest 0.75 km south-southwest of Peak 8680, Shulaps Range.
Several small carbonate clasts from conglomerate, mixed sample.
Unit: uTCH
Fossils: conodonts, ichthyoliths, microgastropods
Conodonts:
Epigondolella sp. indet. (1)
CAI: 5
Age: Late Triassic; Early-Middle Norian.

Field No. **88BER-576** GSC Loc. No. **C-154014**
NTS 92J/15 Northing 5631085 Easting 511287
2 km south of Gold Bridge.
Limestone pebbles from limestone-pebble conglomerate.
Unit: uTCH (?)
Microfossils: conodonts, ichthyoliths
Conodonts:
Metapolygnathus? sp. (1)
ramiform elements (2)
CAI: 5
Age: Probably Late Triassic

SHULAPS ULTRAMAFIC COMPLEX

Conodont-bearing knockers in serpentinite mélange

Field No. **89RMA-15-3A** GSC Loc. No. **C-168119**
NTS 92J/15 Northing 5645220 Easting 529660
2.5 km west of Shulaps Peak.
Chert knocker within serpentinite mélange.
Unit: PSM
Conodonts:
Neogondolella sp. (1)
CAI: 6
Age: Permian - Triassic

Field No. **89RMA-28-4-1** GSC Loc. No. **C-154100**
NTS 92J/16 Northing 5633050 Easting 552860
5 km southeast of the confluence of the Yalakom and Bridge rivers.
Limestone block within serpentinite.
Unit: PSM
Conodonts:
Neocavitella sp. (3)
Metapolygnathus sp. cf. *M. zoae* Orchard 1991 (2)
Metapolygnathus nodosa (Hayashi 1968) (160)
ramiform elements (5)
CAI: 5.5-6.5
Age: Late Triassic; Late Carnian, Middle? *nodosa* Zone

APPENDIX 2

Radiolarian Identifications

By F. Cordey
311-1080 Pacific St.
Vancouver, BC V6E 4C2

BRIDGE RIVER COMPLEX

Field No. 88JIG-20-15B GSC Loc. No. C-168334
NTS 92J/15 Northing 5647730 Easting 511250
Headwaters of Taylor Creek.
Chert.
Unit: uTBRglc
Microfossils: Conodonts, spumellarian radiolarians, sponge spicules.
Radiolarians:
Capnodoce sp.
Age: Late Triassic; Late Carnian-Middle Norian.

Field No. 89FC-BR-2 GSC Loc. No. C-301365
NTS 92O/O2 Northing 5655033 Easting 520795
East side of Noaxe Creek, 3.7 km northwest of Big Sheep Mountain.
Red chert.
Unit: MJBR
Radiolarians:
Parahsuum sp.
Praeconocaryomma sp.
Age: Early or Middle Jurassic; Pliensbachian-Bajocian.

Field No. 89FC-BR-3 GSC Loc. No. C-301366
NTS 92O/O2 Northing 5655033 Easting 520795
East side of Noaxe Creek, 3.7 km northwest of Big Sheep Mountain.
Green/volcaniclastic chert.
Unit: MJBR
Radiolarians:
?*Bagotum modestum* Pessagno and Whalen
Paracanoptum anulatum (Pessagno and Poisson)
?*Hsuum optimus* Carter
Parahsuum sp.
Praeconocaryomma cf. *media* Pessagno and Poisson
Stichocapsa sp.
Age: Early Jurassic; Pliensbachian-Toarcian.

Field No. 89FC-BR-4 GSC Loc. No. C-301367
NTS 92O/O2 Northing 5655033 Easting 520795
East side of Noaxe Creek, 3.7 km northwest of Big Sheep Mountain.
Green chert.
Unit: MJBR
Radiolarians:
Canoptum sp.
?*Hsuum lucidium* Yeh
Hsuum aff. *maclaughlini* Pessagno et al.
Laxtorum (?) *jurassicum* Isozaki and Matsuda
Praeconocaryomma cf. *media* Pessagno and Poisson
Age: Early Jurassic; Pliensbachian-Toarcian.

Field No. 89FC-BR-6 GSC Loc. No.C-301368
NTS 92O/02 Northing 5655033 Easting 520795
East side of Noaxe Creek, 3.7 km northwest of Big Sheep Mountain.
Brown/grey chert.
Unit: MJBR
Radiolarians:
Parahsuum sp.
Praeconocaryomma sp.
Trillus elkhornensis Pessagno and Blome
Age: Early or Middle Jurassic; Pliensbachian-Bajocian.

Field No. 89FC-BR-7 GSC Loc. No. C-301369
NTS 92O/02 Northing 5655033 Easting 520795
East side of Noaxe Creek, 3.7 km northwest of Big Sheep Mountain.
Dark green chert.
Unit:MJBR
Radiolarians:
?*Paracanoptum anulatum* (Pessagno and Poisson)
?*Canoptum spinosum* Yeh
Hsuum aff. *maclaughlini* Pessagno et al.
Age: Early or Middle Jurassic; Pliensbachian-Bajocian.

Field No. 89FC-BR-8 GSC Loc. No. C-301370
NTS 92O/02 Northing 5653337 Easting 520083
East side of Noaxe Creek, 3.8 km west of Big Sheep Mountain.
Red chert (not in place).
Unit: MJBR
Radiolarians:
?*Canutus izeensis* Pessagno and Whalen
Hsuum sp. K Kishida and Sugano
Orbiculiforma sp.
Parahsuum aff. *snowshoense* Pessagno and Whalen
Parasaturnalis aff. *vigrassi* Yeh
Praeconocaryomma cf. *media* Pessagno and Poisson
Age: Early or Middle Jurassic; Pliensbachian-Bajocian.

Field No. 89FC-BR-9 GSC Loc. No. C-301371
NTS 92O/02 Northing 5652906 Easting 520010
East side of Noaxe Creek, 3.8 km west of Big Sheep Mountain.
Red chert.
Unit: MJBR
Radiolarians:
Emiluvia sp.
Parvicingula sp. E Kishida and Sugano
Tetratrabs sp.
Xiphostylus helense (Blome)
Age: Early or Middle Jurassic; Toarcian-middle Callovian

Field No. 89FC-BR-11 GSC Loc. No. C-301372
NTS 92O/02 Northing 5652946 Easting 519593
East side of Noaxe Creek, 4.3 km west of Big Sheep Mountain.
Grey chert.
Unit: MJBR
Radiolarians:
Archaeodictyomitra sp. F Kishida and Sugano
Hsuum cf. *belliatulum* Pessagno and Whalen
Hsuum cf. *lupheri* Pessagno and Whalen
Hsuum cf. *validum* Yeh
Hsuum (?) cf. sp. F Pessagno and Whalen
Tricolocapsa sp.
Wrangellium sp.
Age: Early or Middle Jurassic; possibly Toarcian-Bajocian.

Field No. 89FC-BR-15 GSC Loc. No. C-301373
NTS 92O/02 Northing 5652336 Easting 519340
Southeast side of lower Noaxe Creek.
Black chert.
Unit: MJBR
Radiolarians:
Hsuum cf. *mulleri* Pessagno and Whalen

Praeconocaryomma cf. *immodica* Pessagno and Poisson
Trillus sp.
Napora sp.
Age: Early or Middle Jurassic; Pliensbachian-Bajocian.

Field No. 89FC-BR-16 GSC Loc. No. C-301374
NTS 92O/02 Northing 5652336 Easting 519340
Southeast side of lower Noaxe Creek.
Black chert.
Unit: MJBR
Radiolarians:
Acanthocircus suboblongus (Yao)
Amphibracchium sp.
Orbiculiforma sp.
Praeconocaryomma cf. *immodica* Pessagno and Poisson
Trillus sp.
Xiphostylus cf. *helense* (Blome)
Age: Middle Jurassic; Aalenian-Bajocian.
Reference: Cordey and Schiarizza (1993, loc. 10).

Field No. 89FC-BR-17 GSC Loc. No. C-301375
NTS 92O/02 Northing 5652336 Easting 519340
Southeast side of lower Noaxe Creek.
Black chert.
Unit: MJBR
Radiolarians:
Napora sp.
Parahsuum sp.
Praeconocaryomma immodica Pessagno and Poisson
Xiphostylus cf. *helense* (Blome)
Age: Early Jurassic; Pliensbachian-Toarcian.

Field No. 89FC-BR-18 GSC Loc. No. C-301376
NTS 92O/02 Northing 5652336 Easting 519340
Southeast side of lower Noaxe Creek.
Black chert.
Unit: MJBR
Radiolarians:
Napora sp.
Parahsuum sp.
Praeconocaryomma immodica Pessagno and Poisson
Xiphostylus sp.
Age: Early Jurassic; Pliensbachian-Toarcian.

Field No. 89FC-BR-19 GSC Loc. No. C-301377
NTS 92O/02 Northing 5652336 Easting 519340
Southeast side of lower Noaxe Creek.
Black chert.
Unit: MJBR
Radiolarians:
Pantanellium sp.
Parahsuum sp.
Xiphostylus sp.
Age: Early or Middle Jurassic.

Field No. 89FC-BR-21 GSC Loc. No. C-301378
NTS 92O/02 Northing 5652190 Easting 519109
Southeast side of lower Noaxe Creek.
Green chert.
Unit: MJBR
Radiolarians:
Xiphostylus sp.
Praeconocaryomma sp.
Age: Early or Middle Jurassic; Pliensbachian-Callovian.

Field No. 89FC-BR-22 GSC Loc. No. C-301379
NTS 92O/02 Northing 5652190 Easting 519109
Southeast side of lower Noaxe Creek.
Red chert.
Unit: MJBR
Radiolarians:
Parahsuum sp.
Praeconocaryomma sp.
Age: Early or Middle Jurassic; Pliensbachian-Bajocian.

Field No. 89FC-BR-23 GSC Loc. No. C-301380
NTS 92O/02 Northing 5652190 Easting 519109
Southeast side of lower Noaxe Creek.
Red chert.
Unit: MJBR
Radiolarians:
Andromeda praecrassa Baumgartner
Mirifusus sp.
Parahsuum sp.
Praeconocaryomma sp.
Pseudocrucella sp.
Triactoma aff. *blakei* (Pessagno)
Age: Middle Jurassic; Bajocian-Bathonian.

Field No. 89FC-BR-24 GSC Loc. No. C-301381
NTS 92O/02 Northing 5652190 Easting 519109
Southeast side of lower Noaxe Creek.
Red chert.
Unit: MJBR
Radiolarians:
Andromeda praecrassa Baumgartner
Mirifusus sp.
Parasuum aff. *indomitus* (Pessagno and Whalen)
Praeconocaryomma sp.
Pseudocrucella aff. *sanfilippoae* (Pessagno)
Triactoma aff. *blakei* (Pessagno)
Age: Middle Jurassic; Bajocian-Bathonian.

Field No. 89FC-BR-25 GSC Loc. No. C-301382
NTS 92O/02 Northing 5652045 Easting 518938
Southeast side of lower Noaxe Creek.
Red chert.
Unit: MJBR
Radiolarians:
Canoptum sp.
? *Protopsium ispartaense* Pessagno and Poisson
nassellarians and undescribed spumellarians
Age: Mesozoic, possibly Early Jurassic.

Field No. 89FC-BR-26 GSC Loc. No. C-301383
NTS 92O/02 Northing 5652045 Easting 518938
Southeast side of lower Noaxe Creek.
Red chert.
Unit: MJBR
Radiolarians:
Orbiculiforma sp.
nassellarians and undescribed spumellarians
Age: Mesozoic.

Field No. 89FC-BR-31 GSC Loc. No. C-301384
NTS 92O/02 Northing 5655307 Easting 521502
3.3 km northwest of Big Sheep Mountain.
Grey bedded chert.
Unit: MJBR
Radiolarians:
Triassocampe sp.
Sarla sp.
Age: Late Triassic; Carnian-Norian.

Field No. 89FC-BR-32 GSC Loc. No. C-301385
NTS 92O/02 Northing 5655307 Easting 521502
3.3 km northwest of Big Sheep Mountain.
Light grey bedded chert.
Unit: MJBR
Radiolarians:
Acanthocircus suboblongus (Yao)
Hsuum aff. *validum* Yeh
Mesosaturnalis tetraspinus Yao

?*Mirifusus* sp.
Napora sp.
Parahsuum sp.
Parvicingula sp.
?*Perispyridium* sp.
Praeconocaryomma sp.
Triactoma aff. *blakei* (Pessagno)
Zartus cf. *jurassicus* Pessagno and Whalen
Age: Middle Jurassic; Bajocian-Bathonian.

Field No. 89FC-BR-28 GSC Loc. No. C-176289
NTS 92J/15 Northing 5647812 Easting 517353
North side of North Cinnabar Creek, 0.7 km west of Tyaughton Creek.
Red chert.
Unit: MJBR
Radiolarians:
Scharfenbergia concentrica (Rüst)
Scharfenbergia rustae (Ormiston and Lane)
? *Tetragregnon sycamorensis* Ormiston and Lane
Age: Mississippian; Visean.
Reference: Cordey and Schiarizza (1993, loc. 1).

Field No. 89FC-BR-37 GSC Loc. No. C-176298
NTS 92J/15 Northing 5636295 Easting 511139
East side of northern Gun Lake.
Grey chert.
Unit: MJBR
Radiolarians:
Pseudostylosphaera longispinosa Kozur and Mostler
Triassocampe sp.
Yeharaia annulata Nakaseko and Nishimura
Age: Middle Triassic; Ladinian.
Reference: Cordey and Schiarizza (1993, loc. 4)

Field No. 89FC-BR-38 GSC Loc. No. C-176299
NTS 92J/15 Northing 5635998 Easting 510888
East side of northern Gun Lake.
Grey chert.
Unit: MJBR
Radiolarians:
Pseudoalbaillella cf. *longicornis* Ishiga and Imoto
Age: Permian; possibly Sakmarian-Kazanian.

Field No. 89FC-BR-39 GSC Loc. No. C-301386
NTS 92J/15 Northing 5635912 Easting 510807
East side of northern Gun Lake.
Grey chert.
Unit: MJBR
Radiolarians:
?*Latentibifistula kamigoriensis* (De Wever and Caridroit)
Pseudoalbaillella cf. *scalprata* Holdsworth and Jones
Pseudoalbaillella longicornis Ishiga and Imoto
Age: Permian; Sakmarian-Kazanian.
Reference: Cordey and Schiarizza (1993, loc. 2).

Field No. 89FC-BR-44 GSC Loc. No. C-301363
NTS 92J/15 Northing 5636739 Easting 515534
South side of Carpenter Lake, 5 km northeast of Gold Bridge.
Grey chert (not in place).
Unit: MJBR
Radiolarians:
Praeconocaryomma sp.
Trillus sp.
Age: Early or Middle Jurassic; Pliensbachian-Bajocian.

Field No. 89FC-BR-45 GSC Loc. No. C-301364
NTS 92J/15 Northing 5636739 Easting 515534
South side of Carpenter Lake, 5 km northeast of Gold Bridge.
Grey chert (not in place).
Unit: MJBR
Radiolarians:
Parahsuum sp.
Age: Early or Middle Jurassic.

Field No. 89-FC-GL-1 GSC Loc. No. C-300418
NTS 92J/15 Northing 5638620 Easting 507500
Northwest of Gun Lake.
Red chert.
Unit: MJBR
Radiolarians:
Albaillella triangularis Ishiga, Kito and Imoto
Hegleria mammifera Nazarov and Ormiston
Quadricaulis sp.
Age: Permian; Kazanian-Tatarian.
Reference: Cordey and Schiarizza (1993, loc. 3).

Field No. 90FC-AFF-2-1 GSC Loc. No. C-301387
NTS 92O/02 Northing 5656610 Easting 515150
Northeast bank of Relay Creek, 1 km northwest of confluence with Tyaughton Creek.
Black chert.
Unit: MJBR
Radiolarians:
Livarella sp.
Age: Late Triassic; Late Norian.
Reference: Cordey and Schiarizza (1993, loc. 6).

Field No. 91FC-AFF-106 GSC Loc. No. C-301388
NTS 92O/02 Northing 5656050 Easting 517200
1.2 km east of lower Mud Creek.
Green chert.
Unit: MJBR
Radiolarians:
Archaeodictyomitra exigua Blome
Eucyrtidiellum semifactum Nagai and Mizutani
Parvicingula preacutum Blome
Tricolocapsa plicarum Yao
Tricolocapsa rusti Tan
Age: Middle Jurassic; early-middle Callovian.
Reference: Cordey and Schiarizza (1993, loc. 12).

Field No. 91FC-AFF-128 GSC Loc. No. C-301402
NTS 92J/15 Northing 5647500 Easting 517500
West side of Tyaughton Creek, 0.5 km south of Cinnabar Creek.
Black siliceous siltstone.
Unit: MJBR
Radiolarians:
Capnuchosphaera cf. *triassica* De Wever
Veghicyclia cf. *haeckeli* Kozur and Mostler
Vinassaspongus cf. *subsphaericus* Kozur and Mostler
Age: Late Triassic; Carnian.

Field No. 92FC-AFF-312 GSC Loc. No. C-300433
NTS 92J/15 Northing 5630250 Easting 508300
North side of eastern Downton Lake, 2.2 km from Lajoie Dam.
Grey/black chert interbedded with black siliceous siltstone.
Unit: MJBR
Radiolarians:
Livarella sp.
Age: Late Triassic; Late Norian.

Field No. 92FC-AFF-323-1 GSC Loc. No. C-301389
NTS 92O/2 Northing 5657150 Easting 515650
East side of Relay Creek, 3 km from Tyaughton Creek.
Grey/red chert, isolated outcrop.
Unit: MJBR
Radiolarians:
Follicucullus scholasticus Ormiston and Babcock
Age: Late Permian; Kazanian-early Tatarian.

Field No. 92FC-AFF-326-2 GSC Loc. No. C-301390
NTS 92O/02 Northing 5652800 Easting 519400
East side of Noaxe Creek, 4.3 km west of Big Sheep Mountain.
Red chert.

Unit: MJBR
Radiolarians:
Acanthocircus suboblongus (Yao)
Eucyrtid gen. et sp. indet. Baumgartner
Hsuum maxwelli Pessagno
Unuma cf. *echinatus* Ichikawa and Yao
Podobursa sp.
Tricolocapsa plicarum Yao
Age: Middle Jurassic; Bathonian.

Field No. 92FC-AFF-328-1 GSC Loc. No. C-301391
NTS 92O/02 Northing 5651250 Easting 517600
0.05 km north of bridge at mouth of Noaxe Creek.
Grey/green chert.
Unit: MJBR
Radiolarians:
Archaeodictyomitra mirabilis Aita
Eucyrtidiellum ptyctum (Riedel and Sanfilippo)
Eucyrtidiellum unumaensis (Yao)
Hsuum brevicostatum (Ozvoldova)
Hsuum maxwelli Pessagno
Stylocapsa oblongula Kocher
Age: Middle or Late Jurassic; middle Callovian-middle Oxfordian.

Field No. 92FC-AFF-334-2 GSC Loc. No. C-301392
NTS 92O/02 Northing 5651200 Easting 517500
0.05 km south of bridge at mouth of Noaxe Creek.
Grey chert interbedded with siliceous siltstone/sandstone.
Unit: MJBR
Radiolarians:
Amphipyndax tsunoensis Aita
Eucyrtidiellum ptyctum (Riedel and Sanfilippo)
Age: Middle or Late Jurassic; middle Callovian-middle Oxfordian.

Field No. 93FC-CH-6 GSC Loc. No. C-301393
NTS 92J/15 Northing 5635700 Easting 510200
East side of northern Gun Lake.
Grey/brown ribbon chert, isolated outcrop, west of greenstone.
Unit: MJBR
Radiolarians:
Pseudoalbaillella lomentaria Ishiga and Imoto
Pseudoalbaillella longicornis Ishiga and Imoto
Scharfenbergia sp.
Age: Early Permian; late Asselian-early Artinskian.

Field No. 93FC-CH-8 GSC Loc. No. C-301403
NTS 92J/15 Northing 5635800 Easting 510500
East side of northern Gun Lake.
Red and grey ribbon chert, 50 m east of pillow-lavas.
Unit: MJBR
Radiolarians:
Pseudostylosphaera helicata (Nakaseko and Nishmura)
Pseudostylosphaera japonica (Nakaseko and Nishimura)
Pseudostylosphaera longispinosa Kozur and Mostler
Pseudostylosphaera tenuis (Nakaseko and Nishimura)
Plafkerium cochleatum (Nakaseko and Nishimura)
Sarla cf. *kretaensis* Kozur and Krahl
Age: Middle Triassic; Anisian-Ladinian.

Field No. 93FC-CH-9 GSC Loc. No. C-301394
NTS 92J/15 Northing 5636100 Easting 510950
East side of northern Gun Lake.
Grey and black ribbon chert, associated with thin greenstone tectonic slice.
Unit: MJBR
Radiolarians:
Archaeosemantis sp.
unidentified entactiniids
Age: possibly Early Triassic.

Field No. 93FC-CH-21 GSC Loc. No. C-301395
NTS 92J/15 Northing 5635900 Easting 510300
East side of northern Gun Lake.
Grey ribbon chert, disrupted chert section in contact with thin greenstone tectonic slice; contact is tectonic, possibly former stratigraphic contact previous to decollement.
Unit: MJBR
Radiolarians:
Follicucullus monacanthus Ishiga and Imoto
Age: Late Permian; Kazanian.

Field No. 93FC-CH-22 GSC Loc. No. C-301396
NTS 92J/15 Northing 5635850 Easting 510700
East side of northern Gun Lake.
Grey/brown ribbon chert, isolated outcrop.
Unit: MJBR
Radiolarians:
Hegleria cf. *mammifera* Nazarov and Ormiston
Pseudoalbaillella fusiformis (Holdsworth and Jones)
Pseudoalbaillella globosa Ishiga and Imoto
Quinqueremis cf. *robusta* Nazarov and Ormiston
Age: Late Permian; Kungurian.

Field No. 93FC-CH-23 GSC Loc. No. C-301397
NTS 92J/15 Northing 5635700 Easting 510700
East side of northern Gun Lake.
Grey/brown ribbon chert, isolated outcrop.
Unit: MJBR
Radiolarians:
Albaillella sinuata Ishiga and Imoto
Latentibifistula cf. *kamigoriensis* (De Wever and Caridroit)
Pseudoalbaillella fusiformis (Holdsworth and Jones)
Quadriremis sp.
Quinqueremis cf. *robusta* Nazarov and Ormiston
Age: Permian; late Artinskian-Kungurian.

Field No. 93FC-CH-12 GSC Loc. No. C-301398
NTS 92J/15 Northing 5635300 Easting 511800
Northwest side of Carpenter Lake, 4.5 km north of Gold Bridge.
Grey ribbon chert, isolated outcrop.
Unit: MJBR
Radiolarians:
poorly preserved spumellarians and nassellarians
? *Pseudostylosphaera* sp.
Age: probably Middle or Late Triassic.

Field No. 93FC-CH-14-3 GSC Loc. No. C-301399
NTS 92J/15 Northing 5635500 Easting 512700
South side of Carpenter Lake, 3 km northeast of Gold Bridge.
Red ribbon chert, isolated outcrop.
Unit: uTBRglc
Radiolarians:
poorly preserved spumellarians and nassellarians
? *Pseudostylosphaera* sp.
? *Sarla* sp.
Age: Middle or Late Triassic.

Field No. 93FC-CH-17 GSC Loc. No. C-301400
NTS 92J/15 Northing 5635000 Easting 511500
Northwest side of Carpenter Lake, 4.0 km north of Gold Bridge.
Green/brown ribbon chert, isolated outcrop with unclear relationship with local greenstone.
Unit: MJBR
Radiolarians:
? *Eptingium manfredi* Dumitrica
Oertlispongus inaequispinosus Dumitrica, Kozur and Mostler
Pseudostylosphaera aff. *compacta* (Nakaseko and Nishimura)
Age: Middle Triassic; Anisian-Ladinian.

Field No. 93FC-CH-19 GSC Loc. No. C-301401
NTS 92J/15 Northing 5635600 Easting 511600
Northwest side of Carpenter Lake, 4.75 km north of Gold Bridge.
Grey ribbon chert, isolated outcrop.
Unit: MJBR
Radiolarians:
Canoptum sp.
Paratriassoastrum sp.
Pseudostylosphaera sp.
Triassocampe sp.
Age: Middle or Late Triassic; Ladinian-Carnian.

Field No. B01-10 GSC Loc. No. C-300401
NTS 92J/16 Northing 5623923 Easting 552500
South side of Carpenter Lake, 3.5 km southwest of Terzaghi Dam.
Chert.
Unit: MJBR
Radiolarians:
Capnuchosphaera sp.
Kalherosphaera sp.
Poulpus phasmatodes De Wever
Sarla cf. *natividadensis* Pessagno
Pseudostylosphaera spinulosa (Nakaseko and Nishimura)
Pseudostylosphaera compacta (Nakaseko and Nishimura)
Tetraporobrachia sp.
Age: Late Triassic; Carnian.
References: Cordey (1986; 1988).

Field No. B02-01 GSC Loc. No. C-300402
NTS 92J/16 Northing 5622732 Easting 553825
1.4 km north of Mission Pass.
Chert.
Unit: MJBR
Radiolarians:
Capnodoce sarisa De Wever
Gorgansium sp.
Sarla sp.
Age: Late Triassic; Late Carnian-Middle Norian.
References: Cordey (1986; 1988).

Field No. B03-01 GSC Loc. No. C-300403
NTS 92J/16 Northing 5622271 Easting 554085
0.5 km north of Mission Pass.
Chert.
Unit: MJBR
Radiolarians:
Plafkerium cochleatum (Nakaseko and Nishimura)
Staurocontium cf. *minoense* Nakaseko and Nishimura
Pseudostylosphaera helicata (Nakaseko and Nishimura)
Pseudostylosphaera spinulosa (Nakaseko and Nishimura)
Age: Late Triassic; Carnian.
References: Cordey (1986; 1988).

Field No. B04-03 GSC Loc. No. C-300404
NTS 92J/16 Northing 5622949 Easting 553882
1.8 km north of Mission Pass.
Grey chert.
Unit: MJBR
Radiolarians:
Gorgansium sp.
Kozurastrum sp.
Pseudostylosphaera sp.
Age: Late Triassic; Carnian.
References: Cordey (1986; 1988).

Field No. B05-01 GSC Loc. No. C-300405
NTS 92J/15 Northing 5637770 Easting 515810
Carpenter Lake road, 200 m west of Gun Creek.
Unit: MJBR
Radiolarians:
Paracanoptum anulatum (Pessagno and Poisson)
Orbiculiforma sp.
Palaeosaturnalis sp.
Pantanellium sp.
Pseudocrucella sp.
Age: Early Jurassic; late Sinemurian-Toarcian.
Reference: Cordey and Schiarizza (1993; loc. 7).

Field No. B06-02 GSC Loc. No. C-300406
NTS 92J/15 Northing 5638361 Easting 517581
North side of Carpenter Lake, south of Mowson Pond.
Grey chert.
Unit: MJBR
Radiolarians:
Sarla vetusta Pessagno
Age: Late Triassic; Early-Middle Norian.
References: Cordey (1986; 1988); Cordey and Schiarizza (1993, loc. 5).

Field No. B07-01 GSC Loc. No. C-300407
NTS 92J/15 Northing 5634574 Easting 532843
North side of Carpenter Lake, 6.2 km southeast of mouth of Tyaughton Creek.
Grey chert.
Unit: MJBR
Radiolarians:
Paracanoptum anulatum (Pessagno and Poisson)
Canutus izeensis Pessagno and Whalen
Crucella aff. *squama* (Kozlova)
Eucyrtidiellum aff. *gujoensis* (Takemura and Nakaseko)
Hagiastrum sp. A
Homoeoparonaella sp.
Hsuum sp.
Katroma sp.
Napora mitrata Pessagno
Orbiculiforma callosa Yeh
Orbiculiforma radiata De Wever
Parahsuum sp.
Praeconocaryomma immodica Pessagno and Poisson
Praeconocaryomma parvimamma Pessagno and Poisson
Praeconocaryomma aff. *magnimamma* (Rüst)
Praeconocaryomma aff. *media* Pessagno and Poisson
Pseudocrucella sp.
Spongostaurus sp.
Saitoum sp.
Tympaneides charlottensis Carter
Zartus thayeri Pessagno and Blome
Age: Early Jurassic; Toarcian.
References: Cordey (1986; 1988); Cordey and Schiarizza (1993, loc. 9).

Field No. B09-01 GSC Loc. No. C-300409
NTS 92J/16 Northing 5630278 Easting 541283
North side of Carpenter Lake, 0.6 km south of mouth of Bighorn Creek.
Grey chert.
Unit: MJBR
Radiolarians:
Canoptum triassicum Yao
Capnodoce sp.
Pentaspongodiscus (?) sp.
Sarla sp.
Age: Late Triassic; Early-Middle Norian.
References: Cordey (1986; 1988).

Field No. B10-02 GSC Loc. No. C-300410
NTS 92J/16 Northing 5628130 Easting 542944
North side of Carpenter Lake, west of Fell Creek.
Grey chert.
Unit: MJBR
Radiolarians:

Canoptum triassicum Yao
Pantanellium sp.
Sarla sp.
Age: Late Triassic; Early-Middle Norian.
References: Cordey (1986; 1988).

Field No. B11-04 GSC Loc. No. C-300411
NTS 92J/16 Northing 5628039 Easting 543200
North side of Carpenter Lake, east of Fell Creek.
Grey chert.
Unit: MJBR
Radiolarians:
Capnuchosphaera triassica De Wever
Kalherosphaera sp.
Praeorbiculiformella sp.
Pseudoheliodiscus sp.
Pseudostylosphaera spinulosa (Nakaseko and Nishimura)
Tetraspongodiscus sp.
Age: Late Triassic; Carnian.
References: Cordey (1986; 1988).

Field No. B12-02 GSC Loc. No. C-300412
NTS 92J/16 Northing 5623963 Easting 550227
North side of Carpenter Lake, 0.7 km southeast of Viera Creek.
Grey chert.
Unit: MJBR
Radiolarians:
Capnodoce baldiensis Blome
Capnuchosphaera deweveri Kozur and Mostler
Japonocampe nova (Yao)
Renzium sp.
Age: Late Triassic; Late Carnian-Middle Norian.
References: Cordey (1986; 1988).

Field No. B13-01 GSC Loc. No. C-300413
NTS 92J/16 Northing 5623902 Easting 550385
North side of Carpenter Lake, 0.9 km southeast of Viera Creek
Grey chert.
Unit: MJBR
Radiolarians:
Canoptum rhaeticum Kozur and Mostler
Capnodoce sp.
Kozurastrum sp.
Pantanellium sp.
Sarla prietoensis Pessagno
Age: Late Triassic; Late Carnian-Middle Norian
References: Cordey (1986; 1988).

Field No. B15-02 GSC Loc. No. C-300415
NTS 92J/16 Northing 5629231 Easting 565358
Northeast side of Bridge River, 2 km west of Applespring Creek.
Grey chert.
Unit: MJBR
Radiolarians:
Falcispongus calcaneum Dumitrica
Oertlispongus sp.
Paroertlispongus sp.
Triassocampe deweveri (Nakaseko and Nishimura)
Age: Middle Triassic; late Anisian-Ladinian.
References: Cordey (1986; 1988).

CADWALLADER TERRANE

Hurley Formation

Field No. 87BNC-BBC-201 GSC Loc. No. C-117588
NTS 92O/02 Northing 5653500 Easting 508520
3.5 km northwest of Eldorado Mountain.
Carbonate.
Unit: uTCH
Microfossils: icthyoliths, nassellarian radiolarians
Radiolarians:
Canoptum? sp.
Age: Late Triassic to Early Jurassic.
Identification by E.S. Carter

Field No. 89BNC-BRC-501 GSC Loc. No. C-158874
NTS 92J/15 Northing 5648200 Easting 505820
Head of Eldorado Creek.
Grey fossiliferous limestone.
Unit: uTCH
Microfossils: conodonts, spumellarian radiolarian
Radiolarians:
Plafkerium cf. *cochleatum* (Nakaseko and Nishimura)
Age: Middle or Late Triassic; Ladinian-Carnian.

Junction Creek Unit

Field No. 89APS-15-9-2 GSC Loc. No. C-168293
NTS 92J/16 Northing 5630000 Easting 565760
West of Applespring Creek.
Carbonate.
Unit: lmJJC
Radiolarians:
Andromeda sp.
Crucella sp.
Elodium cf. *cameroni* Carter
Hsuum cf. *belliatulum* Pessagno and Whalen
Parashuum cf. *snowshoense* (Pessagno and Whalen)
Paronaella cf. *grahamensis* Carter
Parvicingula sp.
Perispyridium sp.
Praeconocaryomma sp.
Protoperispyridium sp.
Turanta barbara Pessagno and Blome
Age: Middle Jurassic; Aalenian-Bajocian.

Field No. 89BGA-8-1c GSC Loc. No. C-168259
NTS 92J/16 Northing 5647540 Easting 547070
3 km northwest of mouth of Junction Creek
Carbonate.
Unit: lmJJC
Radiolarians:
Acaeniotyle sp.
Canoptum sp.
Eucyrtis sp.
?*Emiluvia* sp.
Parashuum sp.
Age: Early or Middle Jurassic; Hettangian-Bajocian; possibly Toarcian-Bajocian.

APPENDIX 3

Macrofossil Identifications

By:
T.P. Poulton, Geological Survey of Canada, Calgary, Alberta.
J.A. Jeletzky, Deceased, formerly of the Geological Survey of Canada, Ottawa, Ontario.
J.W. Haggart, Geological Survey of Canada, Vancouver, British Columbia.

CADWALLADER TERRANE

Last Creek Formation

Field No. 87KG-PS30-1A GSC Loc. No. C-154053
NTS 92O/02 Northing 5658380 Easting 508460
North of Lower Tyaughton Creek.
Unit: lmJLC
Fauna:
Tmetoceras kirki Westermann
Pseudolioceras sp.
Erycitoides(?) sp.
Planammatoceras(?) sp.
ostreiid(?) bivalves sp.
Age: Aalenian, probably Upper Aalenian
Reference: Poulton, Report No. J14-1987-TPP

Field No. 87KG-PS30-1A GSC Loc. No. C-154074
NTS 92O/02 Northing 5658380 Easting 508460
North of Lower Tyaughton Creek.
Unit: lmJLC
Fauna:
Tmetoceras kirki Westermann
Pseudolioceras sp.
ostreiid bivalves sp.
Age: Aalenian, probably Upper Aalenian
Reference: Poulton, Report No. J14-1987-TPP

Field No. 88BGA-7-16 GSC Loc. No. C-154091
NTS 92J/15 Northing 5648850 Easting 501000
Small tributary on east side of Gun Creek.
Unit: lmJLC
Fauna:
Phylloceras(?) sp.
Haugia(?) sp.
Age: Late Toarcian
Reference: Poulton, Report No. J1-1988-TPP

TYAUGHTON BASIN

Grouse Creek Unit

Field No. 89-KGL-7-10 GSC Loc. No. C-168107
NTS 92J/16 Northing 5643630 Easting 552150
2 km north of the mouth of Shulaps Creek.
Unit: JKG
Fauna:
Buchia sp. aff. *piochii* (Gabb)
Age: probably Late Jurassic: Tithonian; perhaps earliest Cretaceous
Reference: Poulton, J8-1990-TPP

Relay Mountain Group: Unit muJRM1

Field No. 86PS-44-5-02 GSC Loc. No. C-150235
NTS 92O/03 Northing 5662560 Easting 491000
On spur 1.8 km east of Trail Ridge.
Unit: muJRM1
Fauna:
Cardioceratid (?) ammonites
Age: Callovian (?)
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-44-5-03 GSC Loc. No. C-150236
NTS 92O/03 Northing 5662560 Easting 491000
On spur 1.8 km east of Trail Ridge.
Unit: muJRM1
Fauna:
Cardioceratid (?) ammonite
Age: Callovian (?) or Oxfordian (?)
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-44-5-04 GSC Loc. No. C-150237
NTS 92O/03 Northing 5662560 Easting 491000
On spur 1.8 km east of Trail Ridge.
Unit: muJRM1
Fauna:
Cadoceras (?) (*Stenocadoceras*?) sp.
Age: Callovian (?)
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-44-5-05 GSC Loc. No. C-150244
NTS 92O/03 Northing 5662560 Easting 491000
On spur 1.8 km east of Trail Ridge.
Unit: muJRM1
Fauna:
Myophorella sp.
Astarte sp.
Age: Middle Jurassic through Lower Cretaceous, undifferentiable
Reference: Poulton, Report No. J8-1987-TPP

Field No. 87-KG-28-6-1 GSC Loc. No. C-154065
NTS 92O/02 Northing 5658600 Easting 513780
Relay Creek road.
Unit: muJRM1
Fauna:
Perisphinctid ammonite, indeterminate as to the subfamily and genus.
Age: Middle Jurassic (Bathonian Stage) to Mid-Lower Early Cretaceous (Barremian Stage).
Reference: Jeletzky, Km-4-1988-JAJ

Relay Mountain Group: Unit JKRM2

Field No. 85UMR U85-1 GSC Loc. No. C-117035
NTS 92O/02 Northing 5660326 Easting 501680
1.8 km NNW of Castle Mountain, slopes east of South Paradise Creek.
Unit: JKRM2
Fauna:
Buchia crassicollis (Keyserling)
Olcostephanus (?) sp.
Phylloceras sp.
Age: Upper Valanginian
Reference: Poulton, J6-1987-TPP

Field No. 85UMR U85-7A GSC Loc. No. C-117296
NTS 92O/02 Northing 5660086 Easting 501854
1.5 km NNW of Castle Peak, just east of South Paradise Creek, elev. 2040 m.
Unit: JKRM2
Fauna:
Buchia sp. aff. *uncitoides* (Pavlow) (?)
Buchia sp. aff. *keyserlingi* (Lahusen) (?)
Age: Upper Berriasian or Lower Valanginian, possible mixed
Reference: Poulton, J6-1987-TPP

Field No. 85UMR U85-11 GSC Loc. No. C-117297
NTS 92O/02 Northing 5660246 Easting 501777
1.7 km NNW of Castle Peak, east of Paradise Creek, elev. 2040 m.
Unit: JKRM2
Fauna:
Buchia sp. cf. *crassicollis* (Keyserling)
Age: probably Upper Valanginian
Reference: Poulton, J6-1987-TPP

Field No. 85UMR U85-16 GSC Loc. No. C-117298
NTS 92O/02 Northing 5659773 Easting 502266
1.1 km north of Castle Peak, east of South Paradise Creek, elev. 2195 m.
Unit: JKRM2
Fauna:
Buchia fischeriana (d'Orbigny) (?)
Age: Upper Oxfordian to Volgian, more likely Volgian
Reference: Poulton, J6-1987-TPP

Field No. 85UMR U85-17 GSC Loc. No. C-117299
NTS 92O/02 Northing 5659773 Easting 502266
1.1 km north of Castle Peak, east of Paradise Creek, elev. 2195 m.
Unit: JKRM2
Fauna:
Buchia crassicollis (Keyserling)
Homolsomites quatsinoensis (Whiteaves), formely referred to *Oichotomites*
belemnite, indet.
Age: Upper Valanginian
Comment: Samples U85-17 and 16 are from the same locality.
Reference: Poulton, J6-1987-TPP

Field No. 85UMR U85-30 GSC Loc. No. C-117300
NTS 92O/03 Northing 5661912 Easting 494507
1.1 km N of confluence of Lizard and Tyaughton Creeks, elev. 1920 m.
Unit: JKRM2
Fauna:
Buchia sp. aff. *uncitoides* (Pavlow)
Age: Upper Berriasian (?)
Reference: Poulton, J6-1987-TPP

Field No. 85UMR 32.9 GSC Loc. No. C-143251
NTS 92O/03 Northing 5666488 Easting 491161
1.1 km norhtwest of Elbow Mountain, N-trending spur, elev. 2300 m.
Unit: JKRM2
Fauna:
Buchia concentrica (Sowerby)
Age: Upper Oxfordian or Lower Kimmeridgian
Reference: Poulton, J6-1987-TPP

Field No. 85UMR 32.3 GSC Loc. No. C-143252
NTS 92O/03 Northing 566512 Easting 491069
0.8 km northwest of Elbow Mountain on N-trending spur, elev. 2300 m.
Unit: JKRM2
Fauna:
Buchia uncitoides (Pavlow) (?)
Age: Upper Berriasian (?)
Reference: Poulton, J6-1987-TPP

Field No. 85UMR U85-39 GSC Loc. No. C-143253
NTS 92O/03 Northing 5663519 Easting 494429
0.8 km SSW of Tyoax Pass on knob 0.7 km south of Toong's Ridge, elev. 2255 m.
Unit: JKRM2
Fauna:
Buchia okensis (Pavlow)
Age: Lower Berriasian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR U86-11 GSC Loc. No. C-143254
NTS 92O/02 Northing 5661624 Easting 503028
1.1 km northwest of Cardtable Mountain, on north slope above Paradise Creek, elev. 2150 m.
Unit: JKRM2
Fauna:
Buchia sp. cf. *piochii* (Gabb)
Age: Volgian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR U86-2 GSC Loc. No. C-143255
NTS 92O/02 Northing 5661930 Easting 503047
1.3 km northwest of Cardtable Mountain, on north slope southeast of Paradise Creek, elev. 2070 m.
Unit: JKRM2
Fauna:
Buchia mosquensis (?)
Cylindroteuthis (?) sp.
Age: probably Upper Kimmeridgian or Volgian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR U86-25 GSC Loc. No. C-143256
NTS 92O/02 Northing 5662003 Easting 502963
1.4 km northwest of Cardtable Mountain, south of Paradise Creek, elev. 1980 m.
Unit: JKRM2
Fauna:
Buchia piochii (Gabb) or *B. fischeriana* (d'Orbigny)
Age: Volgian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR U86-26 GSC Loc. No. C-143257
NTS 92O/02 Northing 5662029 Easting 503089
1.4 km northwest of Cardtable Mountain, south of Paradise Creek, elev. 1980 m.
Unit: JKRM2
Fauna:
Buchia okensis (Pavlow) (?) or *B. piochii* (Gabb)
Age: probably Lower Berriasian (?)
Reference: Poulton, J6-1987-TPP

Field No. 86UMR U86-34 GSC Loc. No. C-143258
NTS 92O/02 Northing 5663636 Easting 502162
1.3 km southeast of Relay Mountain, northwest of paradise Creek, elev. 2135 m.
Unit: JKRM2
Fauna:
Buchia sp.
Age: Volgian to Valanginian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR U86-36 GSC Loc. No. C-143260
NTS 92O/02 Northing 5663990 Easting 502170
1.2 km southeast of Relay Mountain, northwest of Paradise Creek, elev. 2225 m.
Unit: JKRM2
Fauna:
Buchia crassicollis (Keyserling) or *B. pacifica* Jeletky
Buchia sublaevis or *B. inflata* (Toula)
Buchia okensis (Pavlow) (?)
Age: mostly Mid- to Late Valanginian, possibly with Berriasian mixed in.
Comment: Probably a mixed collection.
Reference: Poulton, J6-1987-TPP

Field No. 86UMR U86-39 GSC Loc. No. C-143261
NTS 92O/02 Northing 5663479 Easting 502404
1.6 km southeast of Relay Mountain, northwest of Paradise Creek.
Unit: JKRM2
Fauna:
Buchia okensis (Pavlow)
Age: Lower Berriasian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR U86-48 GSC Loc. No. C-143262
NTS 92O/02 Northing 5662390 Easting 503532
1.6 km north of Cardtable Mountain, south of Paradise Creek, elev. 1705 m.
Unit: JKRM2
Fauna:
Buchia sp.
Age: Volgian or Berriasian most likely
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 52-7 GSC Loc. No. C-143264
NTS 92O/02 Northing 5667073 Easting 503216
1.25 km north of peak 8222, 500 m southwest of peak 7413.
Unit: JKRM2
Fauna:
Buchia concentrica (Sowerby), transitional to *B. mosquensis* (Buch)
Age: Kimmeridgian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 52-21 GSC Loc. No. C-143265
NTS 92O/02 Northing 5666923 Easting 503021
On knob 1.1 km north of peak 8222, 3.6 km northeast of Relay Mountain, elev. 2345 m.
Unit: JKRM2
Fauna:
Buchia uncitoides (Pavlow)
Age: probably Upper Berriasian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 53-3 GSC Loc. No. C-143266
NTS 92O/02 Northing 5666491 Easting 503964
1.6 km northeast of peak 8222, near saddle 3.8 km northeast of Relay Mountain, elev. 2165 m.
Unit: JKRM2
Fauna:
Buchia fischeriana (d'Orbigny) (?)
Age: probably Volgian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 53-14 GSC Loc. No. C-143267
NTS 92O/02 Northing 5666405 Easting 503875
0.9 km northeast of peak 8222 on NE-trending spur, elev. 2240 m.
Unit: JKRM2
Fauna:
Buchia sp. cf. *fischeriana* (d'Orbigny) (?)
Pronoella (?) sp.
Age: probably Upper Volgian or Lower Berriasian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 53-20 GSC Loc. No. C-143268
NTS 92O/02 Northing 5662017 Easting 503736
600 m northeast of peak 8222, elev. 2315 m.
Unit: JKRM2
Fauna:
Buchia uncitoides (Pavlow) or *B. tolmatschowi* (Sokolov)
Age: Upper Berriasian or Lower Valanginian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR U86-86 GSC Loc. No. C-143269
NTS 92O/02 Northing 5665229 Easting 502349
1.7 km northeast of Relay Mountain, elev. 2285 m.
Unit: JKRM2
Fauna:
Buchia pacifica Jeletzky
Buchia sp. aff. *inflata* (Toula) or aff. *B. keyserlingi* (Lahusen)
Age: Middle Valanginian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 86-189 GSC Loc. No. C-143272
NTS 92O/03 Northing 5666935 Easting 493559
Southwest spur of "Graveyard Mountain", 1.8 km NE of Elbow Mountain, elev. 2250 m.
Unit: JKRM2
Fauna:
Buchia sp. cf. *fischeriana* (d'Orbigny)
Meleagrinella sp.
bivalve
Age: probably Upper Volgian or Lower Berriasian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 86-190 GSC Loc. No. C-143273
NTS 92O/03 Northing 5666914 Easting 493407
Southwest spur of "Graveyard Mountain", elev. 2180 m.
Unit: JKRM2
Fauna:
Buchia uncitoides (Pavlow) or *B. tolmatschowi* (Sokolov)
Age: probably Lower Valanginian, possibly Upper Berriasian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 86-193 GSC Loc. No. C-143274
NTS 92O/03 Northing 5666341 Easting 494351
Low on southeast spur of "Graveyard Mountain", 2.6 km east of Elbow Mountain, elev. 2105 m.
Unit: JKRM2
Fauna:
Buchia piochii (Gabb) (?)
Astarte (?) sp.
Age: probably Upper Kimmeridgian or Volgian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 86-201 GSC Loc. No. C-143275
NTS 92O/03 Northing 5662750 Easting 499427
0.5 km west of the pass between south Relay Creek and north Paradise Creek, 2.1 km southwest of Relay Mountain.
Unit: JKRM2
Fauna:
Buchia piochii (Gabb)
Age: Upper Kimmeridgian or Volgian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 287-4 GSC Loc. No. C-143276
NTS 92O/03 Northing 5663953 Easting 494313
0.4 km southwest of Tyoax Pass, 3.2 km SE of Elbow Mountain.
Unit: JKRM2
Fauna:
Buchia sp. aff. *uncitoides* (Pavlow)
Buchia sp. aff. *okensis* (Pavlow)
Age: Lower or lower Middle Berriasian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 86-365 GSC Loc. No. C-143280
NTS 92O/03 Northing 5664148 Easting 495173
600m E of Tyoax Pass, near top of peak, elev. 2285 m.
Unit: JKRM2
Fauna:
Buchia fischeriana (?) (d'Orbigny)
Astarte sp.
Age: Upper Oxfordian to Volgian, probably Volgian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 86-371 GSC Loc. No. C-143281
NTS 92O/03 Northing 5663624 Easting 494653
700 m south of Tyoax Pass on east slope of S-trending spur at end of Toong's Ridge, elev. 2120 m.
Unit: JKRM2
Fauna:
Buchia concentrica (Sowerby)
Age: Upper Oxfordian or Lower Kimmeridgian
Reference: Poulton, J6-1987-TPP

Field No. 86UMR 86-395 GSC Loc. No. C-143282
NTS 92O/02 Northing 5659008 Easting 503635
1.2 km ENE of Castle Peak, elev. 2195 m.
Unit: JKRM2
Fauna:
Buchia piochii (Gabb)
Age: Upper Volgian
Reference: Poulton, J6-1987-TPP

Field No. 86KG-52-20-1 GSC Loc. No. C-150220
NTS 92O/03 Northing 5656020 Easting 498920
North-south ridge NE of Tyaughton Creek.
Unit: JKRM2
Fauna:
Buchia pacifica Jeletzky
Age: Middle Valanginian
Reference: Poulton, J7-1987-TPP

Field No. 86KG-52-20-1 GSC Loc. No. C-150249
NTS 92O/03 Northing 5656020 Easting 498920
North-south ridge NE of Tyaughton Creek.
Unit: JKRM2
Fauna:
Buchia pacifica Jeletzky
Age: Middle Valanginian
Reference: Poulton, J7-1987-TPP

Field No. 86PS-1-7-01 GSC Loc. No. C-150246
NTS 92O/03 Northing 5670780 Easting 489850
Southeast side of Dil-Dil Plateau.
Unit: JKRM2
Fauna:
Buchia sp.
other bivalves, indet.
gastropods, indet.
Age: Upper Oxfordian through Valanginian, probably Volgian
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-1-7-02 GSC Loc. No. C-150245
NTS 92O/03 Northing 5670800 Easting 489920
Southeast side of Dil-Dil Plateau.
Unit: JKRM2
Fauna:
belemnites, indet.
bivalves, indet.
Age: Middle Toarcian through Cretaceous, undifferentiable
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-1-7-03 GSC Loc. No. C-150247
NTS 92O/03 Northing 5670820 Easting 489940
Southeast side of Dil-Dil Plateau.
Unit: JKRM2
Fauna:
belemnitids, cf. *Acroteuthis* sp.
indeterminate juvenile bivalves
Age: Late Jurassic to Early Cretaceous, possibly Berriasian to Barremian.
Reference: Haggart, JWH-1989-02

Field No. 86PS-3-4-02 GSC Loc. No. C-150234
NTS 92O/03 Northing 5672040 Easting 488320
South side of Dil-Dil Plateau.
Unit: JKRM2
Fauna:
Phylloceras (?) sp.
Age: Middle Jurassic through Cretaceous, undifferentiable
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-3-4-03 GSC Loc. No. C-150231
NTS 92O/03 Northing 5671040 Easting 488320
South side of Dil-Dil Plateau.
Unit: JKRM2
Fauna:
Buchia sp. cf. *blanfordiana* (Stoliczka)
Age: Upper Kimmeridgian/Volgian
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-3-5-01 GSC Loc. No. C-150238
NTS 92O/03 Northing 5671030 Easting 488560
South side of Dil-Dil Plateau.
Unit: JKRM2
Fauna:
Buchia sp. cf. *fischeriana* (d'Orbigny)
perisphinctid ammonite, indet., constricted microconchs
Age: Volgian (?)
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-3-5-01 GSC Loc. No. C-150248
NTS 92O/03 Northing 5671030 Easting 488560
south side of Dil-Dil Plateau.
Unit: JKRM2
Fauna:
perisphinctid ammonite, indet.
microconchs and macroconch
Phylloceras sp. indet.
Buchia sp.
other bivalves, indet.
Age: Volgian (?)
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-21-13-01 GSC Loc. No. C-150227
NTS 92O/03 Northing 5666100 Easting 491740
Elbow Mountain.
Unit: JKRM2
Fauna:
Buchia sp. aff. *piochii* (Gabb)
Age: Volgian (?)
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-40-3-01 GSC Loc. No. C-150228
NTS 92O/03 Northing 5666740 Easting 491120
1 km northwest of Elbow Mountain.
Unit: JKRM2

Fauna:

Belemnoteuthis (?) sp.
Astarte (?) sp.
Mactra (?) sp.
Meleagrinella (?) sp.

Age: Upper Jurassic (?)
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-40-16-01 GSC Loc. No. C-150229
NTS 92O/03 Northing 5668380 Easting 492420
120 m east of summit 2.3 km north of Elbow Mountain.
Unit: JKRM2
Fauna:

Buchia sp.

Age: Volgian or Berriasian
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86KG-45-8-01 GSC Loc. No. C-150224
NTS 92O/03 Northing 5664400 Easting 4935660
Ridge 1 km west of Tyoax Pass.
Unit: JKRM2
Fauna:

Buchia pacifica Jeletzky

Age: Middle Valanginian
Reference: Poulton, Report No. J7-1987-TPP

Field No. 86KG-45-15-01 GSC Loc. No. C-150225
NTS 92O/03 Northing 5665320 Easting 493120
1.9 km northwest of Tyoax Pass.
Unit: JKRM2
Fauna:

Buchia sp.

Age: probably Berriasian or Valanginian
Reference: Poulton, Report No. J7-1987-TPP

Field No. 86KG-48-7-03 GSC Loc. No. C-150232
NTS 92O/03 Northing 5664000 Easting 494380
Summit 3 km southwest of Tyoax Pass.
Unit: JKRM2
Fauna:

Perisphinctid ammonite similar to *Decipia*

Age: Upper Oxfordian (?)
Reference: Poulton, Report No. J7-1987-TPP

Field No. 87-KG-PS-25-6-1A GSC Loc. No. C-154051
NTS 92O/02 Northing 5658796 Easting 512725
Paradise Creek road.
Unit: JKRM2
Fauna:

Buchia cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 (prevalent but mostly represented by small early forms)
Buchia forms transitional between *B.* cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 and *B. russiensis* (Pavlow 1907) *var. taimyrensis* Zakharov 1981 (fairly common)
Buchia russiensis (Pavlow 1907) s. lato (=*Buchia* n. sp. aff. *piochii* of Jeletzky 1968) (relatively rare)
cf. *Buchia mosquensis* (von Buch) s. lato (rare and poorly preserved)

Age: Lower part of *Buchia* cf. *blanfordiana* (Stoliczka 1866) Zone as defined by Jeletzky (*in* Jeletzky and Tipper, 1968). Uppermost part of the Lower Tithonian (=lower Volgian) or Portlandian s. str.
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-PS-25-6-1B GSC Loc. No. C-154072
NTS 92O/02 Northing 5658800 Easting 512720
Paradise Creek road.
Unit: JKRM2
Fauna:

Buchia cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 (prevalent but mostly represented by small, early forms)
Buchia forms transitional between *B.* cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 and *B. russiensis* (Pavlow 1907) var. *taimyrensis* (Pavlow 1907) s. lato (=*Buchia* n. sp. aff. *piochii* of Jeletzky 1968) (relatively rare)
cf. *Buchia mosquensis* (von Buch 1837) s. lato (rare and poorly preserved)

Age: The same as for the lot C-154051. Uppermost part of the Lower Tithonian (=lower Volgian) or Portlandian s. str.
Comment: Same locality as C-154051.
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-PS-25-6-2A GSC Loc. No. C-154052
NTS 92O/02 Northing 5658800 Easting 512720
Paradise Creek road.
Unit: JKRM2
Fauna:

Buchia forms transitional between *Buchia russiensis* (Pavlow 1907) var. *taimyrensis* (Zakharov 1981) and *Buchia* cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 (prevalent)
Buchia cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965, fairly common but represented mostly by small, early forms described as *Aucella* cf. *A. mosquensis* (Anderson 1945) (fairly rare)
Buchia russiensis (Pavlow 1907) var. *taimyrensis* Zakharov 1981 (relatively rare)
Onychites sp. indet. (a belemnite arm hook)

Age: The lot C-154052 is derived either from the basal beds of *Buchia* cf. *blanfordiana* Zone or from the transitional beds between *Buchia* cf. *blanfordiana* and *Buchia russiensis* s. lato Zones. At any rate the lot C-154052 is either only slightly older than the lot C-154051 or (less likely) about contemporary with it.
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-PS-25-6-2B GSC Loc. No. C-154073
NTS 92O/02 Northing 565880 Easting 512720
Paradise Creek road.
Unit: JKRM2
Fauna:

Buchia forms transitional between *Buchia russiensis* (Pavlow 1907) var. *taimyrensis* Zakharov 1981 and *Buchia* cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 (prevalent)
Buchia cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 (fairly common, but represented mostly by small, early forms described as *Aucella* cf. *A. mosquensis* by Anderson 1945

Age: The same as for the lots C-154052, C-154069 and C-154070 (upper part of the Lower Tithonian (=Early Volgian) or Portlandian s. str).
Comment: Same locality as C-154052.
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-PS-30-7-1 GSC Loc. No. C-154054
NTS 92O/02 Northing 5657880 Easting 509400
North of Lower Tyaughton Creek.
Unit: JKRM2
Fauna:

Poorly preserved Late Jurassic *Buchia* forms which may belong either to the late (*i.e.* early Portlandian or earliest Tithonian) forms of *Buchia mosquensis* (von Buch 1837) s. lato or to *Buchia russiensis* (Pavlow 1907) s. lato

Age: Late Jurassic. The lot C-154054 is derived either from the upper (*i.e.* Lower Portlandian s. str. or earliest Tithonian) part of *Buchia mosquensis* s. lato Zone or to some part of the later, but not the latest, Portlandian s. str. (=later but not the latest Tithonian) *Buchia russiensis* s. lato Zone.
Comment: Lot C-154054 is definitely older than either of the lots C-154051 and C-154052.
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-PS-30-12 GSC Loc. No. C-154055
NTS 92O/02 Northing 5657810 Easting 510600
North of Lower Tyaughton Creek.

Unit: JKRM2
Fauna:
Buchia russiensis (Pavlow 1907) s. lato
Age: Greater middle part of *Buchia russiensis* s. lato Zone of the Relay Mountain Group; mid-Early Tithonian (=mid-Portlandian s. str. or mid-Early Volgian).
Comment: Lot C-154055 is distinctly older than the lots C-154051 and C-154052.
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-PS-36-11 GSC Loc. No. C-154058
NTS 92O/02 Northing 5661330 Easting 510220
Lower Paradise Creek.
Unit: JKRM2
Fauna:
Buchia cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965
Buchia forms transitional between *B.* cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 and *B. russiensis* (Pavlow 1907) var. *taimyrensis* Zakharov 1981
Buchia russiensis (Pavlow 1907) s. lato
Age: The main part of *Buchia* cf. *blanfordiana* Zone. Uppermost part of the Lower Tithonian (=lower Volgian or Portlandian s. str.).
Comment: The lot C-154058 is slightly younger than the lot C-154051.
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-PS-36-14 GSC Loc. No. C-154059
NTS 92O/02 Northing 5661210 Easting 516450
Lower Paradise Creek, east end of outcrop.
Unit: JKRM2
Fauna:
Buchia forms transitional between *Buchia russiensis* (Pavlow 1907) var. *taimyrensis* Zakharov 1981 and *Buchia* cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 (prevalent)
Buchia cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 (common, but represented almost exclusively by small, early forms described as *Aucella* cf. *A. mosquensis* (Anderson 1945)
Buchia russiensis (Pavlow 1907) s. lato including *B. r.* var. *taimyrensis* Zakharaov 1981
Indeterminate pelecypods
Age: The same as for the lots C-154052 and C-154069; upper part of the Lower Tithonian (=Early Volgian) or Portlandian s. str.
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87KG-9-3 GSC Loc. No. C-154061
NTS 92O/02 Northing 5657580 Easting 516530
Lower Mud Creek.
Unit: JKRM2
Fauna:
Meleagrinella sp.
Oxytoma(?) sp.
bivalves, indet.
terebratulid brachiopods(?) sp.
fish scales(?) sp.
Age: Early Portlandian
Reference: Poulton, Report No. J14-1987-TPP

Field No. 87-KG-9-5 GSC Loc. No. C-154062
NTS 92O/02 Northing 5657480 Easting 516440
Lower Mud Creek.
Unit: JKRM2
Fauna:
Buchia russiensis (Pavlow 1907) s. lato (including less common *B. r.* var. *taimyrensis* Zakharov 1981) (prevalent)
Buchia cf. and aff. late forms of *B. mosquensis* (von Buch 1837) (rare)
Age: Approximately the same as for the lot C-154055; mid-Early Tithonian (=mid-Portlandian s. str. or mid-early Volgian).
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-9-6 GSC Loc. No. C-154075
NTS 92O/02 Northing 5657390 Easting 516350
Lower Mud Creek.
Unit: JKRM2
Fauna:
Buchia forms transitional between *B.*cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 and *B. russiensis* (Pavlow 1907) s. lato (prevalent)
Buchia russiensis (Pavlow 1907) s. lato (including *B. r.* var. *taimyrensis* Zakharov 1981; fairly common)
Age: Tithonian. Upper part of the *Buchia russiensis* s. lato Zone.
Comment: Float at base of cliff.
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-28-1 GSC Loc. No. C-154063
NTS 92O/02 Northing 5655050 Easting 516320
Relay Creek road.
Unit: JKRM2
Fauna:
Buchia ex gr. *B. mosquensis* (von Buch 1837) s. lato
B. russiensis (Pavlow 1907) s. lato (rare and poorly preserved right valves)
Age: General mid-Kimmeridgian to early Portlandian (=earliest Lower Tithonian).
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-28-2 GSC Loc. No. C-154064
NTS 92O/02 Northing 5658570 Easting 514530
East of Relay Creek road.
Unit: JKRM2
Fauna:
Late forms of *Buchia mosquensis* (von Buch 1837) s. lato (strongly prevalent)
Buchia forms transitional between *B. mosquensis* (von Buch) and B. *russiensis* (Pavlow) (fairly rare)
Buchia russiensis (Pavlow 1907) s. lato (early forms only; rare)
Age: Upper part of *Buchia mosquensis* s. lato Zone. Early Portlandian s. str. (=earliest Tithonian or earliest Early Volgian).
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-KG-39-6-2 GSC Loc. No. C-154069
NTS 92O/02 Northing 5657200 Easting 511560
North of lower Tyaughton Creek.
Unit: JKRM2
Fauna:
Buchia forms transitional between *B. russiensis* (Pavlow 1907) var. *taimyrensis* Zakharov 1981 and *B.* cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 (prevalent)
Buchia cf. *blanfordiana* (Stoliczka 1866) of Jeletzky 1965 (exclusively small, early forms described by Anderson (1945) as *Aucella* cf. *A. mosquensis*; considerably less common)
Buchia russiensis (Pavlow 1907) var. *taimyrensis* Zakharov 1981 (fairly rare)
Age: Transitional beds between *Buchia russiensis* s. lato and *Buchia* cf. *blanfordiana* zones and approximately contemporary with the lot C-154052 (upper part of the Lower Tithonian (=Early Volgian) or Portlandian s. str).
Reference: Jeletzky, Km-4-1988-JAJ

Field No. 87-PU-RM-05 GSC Loc. No. C-163760
NTS 92O/02 Northing 566553 Easting 502947
About 3.1 km NE of Relay Mountain
Unit: JKRM2
Fauna:
Buchia? sp.
Argentiniceras cf. *noduliferum* (Steuer 1897)
Protothurmannia n. sp. B of Jeletzky (1984, plate 2)
Age: Probably early Berriasian, zone of *Buchia okensis* s.s. (see Jeletzky, 1984)
Reference: Haggart, JWH-1989-02

Field No. 87-PU-RM-06 GSC Loc. No. C-163761
NTS 92O/02 Northing 566406 Easting 502897
About 3 km NE of Relay Mountain.
Unit: JKRM2
Fauna:
berriaselid ammonite, genus and species indeterminate
Phylloceras cf. *knoxvillense* (Stanton 1896)
Buchia okensis (Pavlow, 1907)
Buchia ex aff. *okensis* (Pavlow, 1907)
Age: Early Berriasian, zone of *Buchia okensis* s.s. (*see* Jeletzky, 1984)
Comment: Stratigraphically above GSC Loc. C-163760.
Reference: Haggart, JWH-1989-02

Field No. 87-PU-54 GSC Loc. No. C-143130
NTS 92O/02 Northing 5658370 Easting 507600
North of Tyaughton Creek.
Unit: JKRM2
Fauna:
Buchia (*Anaucella*) cf. *concentrica* (Sowerby) s. lato (apparently late forms only, including *B.* (*A.*) *concentrica* var. *erringtoni* (Gabb) (numerous; no other *Buchia* forms noted)
Age: Presumably the upper part of *Buchia* (*Anaucella*) *concentrica* s. lato Zone of lower to middle Kimmeridgian age. This assignment *must remain tentative because of a poor preservation of all Buchia* specimens available.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-55 GSC Loc. No. C-143131
NTS 92O/02 Northing 5658170 Easting 507910
North of Tyaughton Creek.
Unit: JKRM2
Fauna:
Buchia (*Anaucella*) *concentrica* (Sowerby) s. lato (exclusively late forms, including *B.* (*A.*) *concentrica* var. *erringtoni* (Gabb) (numerous; no other *Buchia* forms noted)
Age: The same as for the lot C-143130 (lower to middle Kimmeridgian) but the dating of the lot C143131 is offered without reservation because of a much better preservation of its buchiids.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-64 GSC Loc. No. C-143132
NTS 92O/02 Northing 5661590 Easting 504420
NE of Cardtable Mountain.
Unit: JKRM2
Fauna:
Buchia (*Anaucella*) *concentrica* (Sowerby) s. lato (a mixture of early and late forms) (numerous)
Buchia cf. *tenuistriata* (Lahusen 1888) (rare)
Age: Some part of *Buchia* (*Anaucella*) *concentrica* s. lato Zone. It is impossible to say whether the lot C-143132 represents the Upper Oxfordian or the Lower to Middle Kimmeridgian part of the zone.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-66 GSC Loc. No. C-143133
NTS 92O/02 Northing 5661730 Easting 504700
NE of Cardtable Mountain.
Unit: JKRM2
Fauna:
Buchia pacifica Jeletzky 1965 (prevalent)
Buchia tolmatschowi (Sokolov 1908) (rare)
Age: Lower part of *Buchia pacifica* Zone; Lower Valanginian
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-69 GSC Loc. No. C-143135
NTS 92O/02 Northing 5662730 Easting 505510
NE of Cardtable Mountain.
Unit: JKRM2
Fauna:
Poorly preserved *Buchia* ex gr. *pacifica* Jeletzky 1965
Age: Presumably represents some part of *Buchia pacifica* Zone (Lower Valanginian). However, because of the poor preservation of all specimens available, the lot C-143135 could also represent some part of the next older *Buchia tolmatschowi* Zone (*see* Jeletzky, 1984, for further details).
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-70 GSC Loc. No. C-143136
NTS 92O/02 Northing 5661680 Easting 505190
NE of Cardtable Mountain.
Unit: JKRM2
Fauna:
Buchia teniustriata (Lahusen 1888)
Age: Late Kimmeridgian; *Buchia tenuistriata* Zone
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-73 GSC Loc. No. C-143137
NTS 92O/02 Northing 5661100 Easting 505020
NE of Cardtable Mountain.
Unit: JKRM2
Fauna:
Poorly preserved *Buchia* ex gr. *uncitoides-pacifica* (cannot be identified any closer)
Age: late Berriasian (=*Buchia uncitoides* s. lato Zone) to early Valanginian (=*Buchia pacifica* Zone)
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-74 GSC Loc. No. C-143138
NTS 92O/02 Northing 5661040 Easting 504860
NE of Cardtable Mountain.
Unit: JKRM2
Fauna:
Buchia (*Anaucella*) *concentrica* (Sowerby) s. lato (prevalent; apparently late forms only)
B. (*A.*) *c.* var. *erringtoni* (Gabb) (fairly common)
Age: early to mid-Kimmeridgian; upper part of *Buchia* (*Anaucella*) *concentrica* s. lato Zone
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-83 GSC Loc. No. C-143140
NTS 92O/03 Northing 5665850 Easting 492000
SE of Elbow Mountain.
Unit: JKRM2
Fauna:
Buchia uncitoides (Pavlow 1907) var. *spasskensoides* (Crickmay 1930) (prevalent)
Buchia okensis (Pavlow 1907) (late form; a solitary specimen)
Age: early late Berriasian; lower part of *Buchia uncitoides* s. lato Zone
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-87 GSC Loc. No. C-143141
NTS 92O/03 Northing 5666200 Easting 492100
250 m east of Elbow Mountain.
Unit: JKRM2
Fauna:
Buchia uncitoides (Pavlow 1907) f. typ. (common)
Buchia uncitoides (Pavlow 1907) var. *acutistriata* (Crickmay 1930) (common)
Buchia uncitoides (Pavlow 1907) var. *spasskensoides* (Crickmay 1930) (rare)
Age: late Berriasian; some part (more likely middle) of *Buchia uncitoides* s. lato Zone
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-91 GSC Loc. No. C-143143
NTS 92O/03 Northing 5666400 Easting 491850
300 m north of Elbow Mountain.
Unit: JKRM2
Fauna:
Buchia tenuistriata (Lahusen 1888) (numerous; no other buchiids seen)

Age: late Kimmeridgian; *Buchia tenuistriata* Zone
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-93 GSC Loc. No. C-143144
NTS 92O/03 Northing 5666200 Easting 491840
150 m north of Elbow Mountain.
Unit: JKRM2
Fauna:

Buchia uncitoides (Pavlow 1907) f. typ. (common)
B. u. var. *acutistriata* (Crickmay 1930) (common)
B. u. var. *spasskensoides* (Crickmay 1930) (very rare)

Age: the same as for the lot C-143141 (late Berriasian)
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-95 GSC Loc. No. C-143145
NTS 92O/03 Northing 5667060 Easting 492100
1 km NNE of Elbow Mountain.
Unit: JKRM2
Fauna:

Buchia cf. *russiensis* (Pavlow 1907) s. lato (common)
Buchia sp. indet. (small to very small juvenile specimens not identifiable specifically; prevalent)

Age: Presumably some part of *Buchia russiensis* s. lato Zone (late Portlandian s. str. =late early Tithonian or late early Volgian). This age is offered as a tentative suggestion only because of a poor preservation of all specimens available.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-99 GSC Loc. No. C-143146
NTS 92O/03 Northing 5667500 Easting 491600
1.5 km north of Elbow Mountain.
Unit: JKRM2
Fauna:

Buchia cf. *russiensis* (Pavlow 1907) s. lato (three fragmentary specimens)

Age: the same as for the lot C-143145. The zonal assignment is just as tentative as for the latter lot. However, the two lots are definitely of a late Late Jurassic (Tithonian or Volgian) age.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-102 GSC Loc. No. C-143147
NTS 92O/03 Northing 5668300 Easting 491800
2 km N of Elbow Mountain
Unit: JKRM2
Fauna:

Buchia pacifica Jeletzky 1965 (numerous and typical; no other *Buchia* species noted)

Age: Approximately the same as for the lot C-143133 (early to mid Valanginian) but appears to represent a higher part (middle to upper) of *Buchia pacifica* Zone because of the absence of *B. tolmatschowi* and an invariably typical appearance of *B. pacifica*.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-103 GSC Loc. No. C-143148
NTS 92O/03 Northing 5668360 Easting 491850
2.3 km north of Elbow Mountain.
Unit: JKRM2
Fauna:

Buchia ex gr. *russiensis* (Pavlow 1907) s. lato (rare and poorly preserved; no other *Buchia* forms noted)

Age: The same as for the lots C-143145 and C-143146 (late Late Jurassic)
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-104 GSC Loc. No. C-143149
NTS 92O/03 Northing 5668400 Easting 492000
2.4 km north of Elbow Mountain.
Unit: JKRM2
Fauna:

Buchia russiensis (Pavlow 1907) s. lato (mostly advanced forms close to or identical with *B. r.* var. *taimyrensis* Zakharov 1981) (prevalent)
Buchia sp. transitional to *B.* cf. *blanfordiana* of Jeletzky 1965 (small forms only; rare)

Age: Middle to upper part of the *Buchia russiensis* s. lato Zone (late Portlandian s. str. =late early Tithonian or late early Volgian). The lot C-143149 is probably approximately contemporary with lots C-143145, C-143146, and C-143148 but, unlike these lots, it is assigned unreservedly to the *Buchia russiensis* s. lato Zone.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-106 GSC Loc. No. C-143150
NTS 92O/03 Northing 5668450 Easting 492150
2.3 km north of Elbow Mountain.
Unit: JKRM2
Fauna:

Buchia russiensis (Pavlow 1907) s. lato (mostly advanced forms close to or identical with *B. r.* var. *taimyrensis* Zakharov 1981) (prevalent)
Buchia sp. transitional from *B. r.* var. *taimyrensis* to small forms of *B.* cf. *blanfordiana* of Jeletzky 1965 (very rare)

Age: The same as for the lot C-143149 (late Portlandian s. str. =late early Tithonian or late early Volgian).
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-112 GSC Loc. No. C-154077
NTS 92O/03 Northing 5668400 Easting 492500
2.4 km north of Elbow Mountain.
Unit: JKRM2
Fauna:

Buchia (*Anaucella*) *concentrica* (Sowerby) s. lato (apparently late *B. (A.) c.* var. *erringtoni* (Gabb)-like forms only; prevalent)
Buchia (*Anaucella*) cf. *lindstroemi* (Sokolov) (a solitary valve)

Age: The same as for lot C-143138 (early to mid-Kimmeridgian)
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-PU-114 GSC Loc. No. C-154078
NTS 92O/03 Northing 5668240 Easting 492460
2.2 km north of Elbow Mountain.
Unit: JKRM2
Fauna:

Buchia (*Anaucella*) *concentrica* (Sowerby) s. lato (apparently late *B.* (*A.*) *c.* var. *erringtoni* (Gabb)-like variants only; prevalent)
Buchia transitional between *B.* (*A.*) *c.* var. *erringtoni* (Gabb) and the early forms of *B. mosquensis* (v. Buch) s. lato (rare)
Buchia cf. *B. tenuistriata* (Lahusen) (very rare)
Cylindroteuthis (*Cylindroteuthis*)? sp. indet. (poor fragmentary casts only)
Pleuromya sp. indet. (a solitary cast)

Age: Approximately the same as for the lots C-143138 and C-154077 (early to mid-Kimmeridgian). However, the lot C-154078 may be slightly younger and represent the beds transitional between the upper part of *Buchia* (*Anaucella*) *concentrica* s. lato Zone and *Buchia tenuistriata* Zone (*e.g.* the lot C-143143).
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 88APS-PUM1-1 GSC Loc. No. C-154092
NTS 92O/02 Northing 5651850 Easting 501750
1 km NNW of Spruce Lake.
Unit: JKRM2
Fauna:

Buchia pacifica Jeletzky

Age: Valanginian
Reference: Poulton, Report No. J1-1988-TPP

Field No. 88APS-PUM1-2 GSC Loc. No. C-154094
NTS 92O/02 Northing 5651950 Easting 501700
1 km north of Spruce Lake.
Unit: JKRM2
Fauna:

Buchia pacifica Jeletzky

Buchia inflata (Toula)
Age: Middle Valanginian
Reference: Poulton, Report No. J1-1988-TPP

Field No. 88APS-PUM8-1-1 GSC Loc. No. C-154095
NTS 92J/15 Northing 5644950 Easting 500450
Between Leckie and Gun creeks.
Unit: JKRM2
Fauna:
Buchia concentrica (Sowerby) (?)
Age: Late Oxfordian through Valanginian, most likely Late Oxfordian. The single fragment is too poorly preserved to warrant detailed dating and identification.
Reference: Poulton, Report No. J1-1988-TPP

Field No. 88APS-PUM8-8 GSC Loc. No. C-154093
NTS 92J/14 Northing 5646380 Easting 499350
Leckie Ridge, south of Gun Creek.
Unit: JKRM2
Fauna:
Buchia concentrica (Sowerby) (?)
Age: Late Oxfordian through Valanginian, most likely Early Kimmeridgian. The specimens are too poorly preserved to warrant detailed identification and dating.
Reference: Poulton, Report No. J1-1988-TPP

Field No. 88-JIG-41-8 GSC Loc. No. C-154098
NTS 92O/03 Northing 5670350 Easting 497270
Upper Relay Creek, 3 km southeast of Dash Hill.
Unit: JKRM2
Fauna:
Buchia tolmatschowi (Sokolov) (?)
Buchia pacifica Jeletzky
ammonite, indet.
Age: Early or Middle Valanginian
Reference: Poulton, J8-1990-TPP

Field No. 88-PPS-15-3 GSC Loc. No. C-154096
NTS 92O/02 Northing 5657150 Easting 513820
Confluence of Relay and Tyaughton creeks.
Unit: JKRM2
Fauna:
probable beriasellid ammonite, comparable to *Kilianella*
fragment of terebratulid brachiopod
Age: A tentative age of Berriasian to Valanginian is suggested
Reference: Haggart, JWH-1989-03

Relay Mountain Group: Unit lKRM3

Field No. 86PS-18-7-01 GSC Loc. No. C-150230
NTS 92O/03 Northing 5663880 Easting 489520
Cliff 800 m east of north end of Lorna Lake.
Unit: lKRM3
Fauna:
Inoceramus sp.
Age: Hauterivian through Aptian (?)
Reference: Poulton, Report No. J8-1987-TPP

Field No. 86PS-18-7-01 GSC Loc. No. C-150239
NTS 92O/03 Northing 5663880 Easting 489520
Cliff 800 m east of north end of Lorna Lake.
Unit: lKRM3
Fauna:
heteromorph ammonite, cf. *Anisoceras charlottense* (Anderson 1958)
Age: The specimen is flattened and fragmentary, but still shows ribbing and nodes similar to that seen on Anderson's species. The original *A. charlottense* comes from the Queen Charlotte Islands, probably from Albian age strata. The specimen from loc. C-150239 could also be an anisoceratid ammonite, however; a general Early Cretaceous age is suggested for the locality.
Reference: Haggart, Report No. JWH-1989-02

Field No. 86PS-18-7-01 GSC Loc. No. C-150243
NTS 92O/03 Northing 5663880 Easting 489520
Cliff 800 m east of north end of Lorna Lake.
Unit: lKRM3
Fauna:
Inoceramus sp.
belemnites
Age: Middle Jurassic or Cretaceous, probably Hauterivian
Reference: Poulton, Report No. J8-1987-TPP

Field No. 87-PU-67 GSC Loc. No. C-143134
NTS 92O/02 Northing 5661890 Easting 504900
NE of Cardtable Mountain
Unit: lKRM3
Fauna:
Acroteuthis (Boreioteuthis) cf. *impressa* (Gabb) (a fragment)
Inoceramus (s. lato) sp. indet. (shell fragments)
Age: Hauterivian to Barremian
Reference: Jeletzky, Km-6-1988-JAJ

Taylor Creek Group: Paradise Formation

Field No. 86JG-16 GSC Loc. No. C-149604
NTS 92O/03 Northing 5666287 Easting 499689
ENE of elbow in SE drainage of Red Hill, elev. 2080 m.
Unit: lKTCP
Fauna:
desmoceratid ammonite, possibly *Brewericeras* sp.
Age: A general Albian age is tentatively suggested as the specimen is too poorly preserved for positive identification.
Reference: Haggart, JWH-1989-02

Field No. 86JG-18 GSC Loc. No. C-117050
NTS 92O/02 Northing 5661528 Easting 500821
West branch of Paradise Creek.
Unit: lKTCP
Fauna:
Cylindroteuthis (?) sp.
Age: Middle Jurassic through Cretaceous, undifferentiable
Reference: Poulton, J5-1987-TPP

Paradise Formation - Fossils From Clasts in Conglomerate

Field No. 86JG-12 GSC Loc. No. C-117049
NTS 92O/02 Northing 5661551 Easting 502671
Prominent ribs on western Cardtable Mountain, elev. 2085 m.
Unit: lKTCP
Fauna:
Buchia sp. aff. *blanfordiana* (Stoliczka)
Age: probably late Early Volgian
Comment: Clast in conglomerate of the Paradise formation.
Reference: Poulton, J5-1987-TPP

Field No. 86JG-31 GSC Loc. No. C-149601
NTS 92O/02 Northing 5660850 Easting 502707
South of Cardtable Mountain at first rib on south-flowing gully above prominent triple confluence at 2080 m elev.
Unit: lKTCP
Fauna:

Buchia sp.aff. *volgensis* (Lahusen)
Buchia sp.aff. *uncitoides* (Pavlow)

Age: probably Middle to Late Berriasian
Comment: Clast in conglomerate of the Paradise formation.
Reference: Poulton, J5-1987-TPP

Field No. 86JG-87B GSC Loc. No. C-149603
NTS 92O/02 Northing 5663163 Easting 501881
SSE of Relay Mountain summit, elev. 2175 m.
Unit: lKTCP
Fauna:

Buchia(?) sp.

Age: probably Middle Oxfordian through Valanginian
Comment: Clast in conglomerate of the Paradise formation.
Reference: Poulton, J5-1987-TPP

Field No. 86JG-317A GSC Loc. No. C-149612
NTS 92O/02 Northing 5662549 Easting 500428
South flanks of Relay Mountain, elev. 2225 m.
Unit: lKTCP
Fauna:

Buchia sp. aff. *keyserlingi* (Lahusen) (?)
Buchia sp. aff. *sublaevis* (Keyserling) (?)

Age: Valanginian probably, possibly younger Lower Cretaceous if the poorly preserved bivalves are actually some buchiiform species of *Inoceramus*.
Comment: Clast in conglomerate of the Paradise formation.
Reference: Poulton, J5-1987-TPP

Taylor Creek Group: Dash Formation

Field No. 86JG-53C GSC Loc. No. C-149602
NTS 92O/02 Northing 566709 Easting 504313
Eastern knob, NE of Relay summit and peak 8222, elev. 2230 m.
Unit: lKTCD
Fauna:

Pterotrigonia (Pterotrigonia) sp.
Entolium sp.

Age: Albian, or younger Cretaceous
Reference: Poulton, J5-1987-TPP

Field No. 86JG-119B GSC Loc. No. C-149606
NTS 92O/03 Northing 5666442 Easting 498232
NE of elbow in SE drainage of Red Hill, elev. 2195 m.
Unit: lKTCD
Fauna:

Tetragonites cf. *bearskinense* (McLearn 1972)

Age: Middle Albian to Cenomanian
Comment: The specimen is poorly preserved and fragmentary, but is definitely of the genus *Tetragonites* Kossmat which ranges from Middle Albian through the Cenomanian. It bears a resemblance to *T. bearskinense* from the Queen Charlotte Islands (McLearn, 1972).
Reference: Haggart, JWH-1989-02

Field No. 86JG-210C GSC Loc. No. C-149609
NTS 92O/03 Northing 5666781 Easting 498951
East side of Red Hill, up from NE drainage that flows SSE.
Unit: lKTCD
Comment: Lot C-149609 was examined by Poulton and Haggart.
Fauna:

ammonite, indet., poorly preserved, small fragments, could be a species of *Gastroplites*, such as *G. canadensis*.

Age: possibly late Middle Albian
Reference: Poulton, J5-1987-TPP
Fauna:

ammonite fragment, possibly *Douvilleiceras*? sp.
ammonite fragment, possibly *Ptychoceras*? sp.

Age: The material is too poorly preserved to suggest an age beyond a general Cretaceous one.
Reference: Haggart, JWH-1989-02

Field No. 87-JG-58 GSC Loc. No. C-143126
NTS 92J/15 Northing 5647835 Easting 511509
approx. 800 m NE of peak 7418, Taylor Basin.
Unit: lKTCD
Fauna:

?*Marshallites* sp. indet. juven.
?*Desmoceras (Pseudouhligella)* sp. indet. juven.
Inoceramus cf. *concentricus* (Parkinson)
Inoceramus ex gr. *anglicus* Woods
Lima (s. lato) sp. indet.
Indogrammatodon sp indet.
Acila (s. lato) sp. indet.
pelecypods (more than one genus), indet.
gastropods (more than one genus), indet.
sponge ?, indet.

Age: Almost certainly some part of the Albian stage. However, the Cenomanian age of this rich but poorly preserved fauna cannot be ruled out. Its only generically identifiable ammonites are known to range up into the basal Upper Cretaceous (*i.e.* Cenomanian) and the same is true of the only tentatively identified *Inoceramus concentricus* Parkinson.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-JG-60 GSC Loc. No. C-143122
NTS 92O/02 Northing 5646075 Easting 513700
South side of North Cinnabar Creek, 600 m NE of peak 7260.
Unit: lKTCD
Fauna:

trigoniid?, indet.
Leda (s. lato) sp. indet.
pelecypods (more than one genus), indet.

Age: presumably Jurassic or Cretaceous.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-JG-74 GSC Loc. No. C-143124
NTS 92O/02 Northing 5659560 Easting 523750
2.5 km SE of Quartz Mountain, 200 m SW of peak 7049.
Unit: lKTCD
Fauna:

Cleoniceras (*Grycia*) cf. *perezianum* (Whiteaves) (a slender, feebly ribbed variant)

Age: Presumably mid-Albian. However, this date is tentative because of poor preservation of the only fragment available.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 87-JG-210C GSC Loc. No. C-143118
NTS 92O/02 Northing 5667000 Easting 499000
Red Hill, 3.4 km NW of Relay Mountain.
Unit: lKTCD
Fauna:

Cleoniceras (Grycia) perezianum (Whiteaves); an extremely coarsely and sparsely ribbed, somewhat *Gastroplites*-like variant; compare McLearn (1972)

Age: mid-Albian; some part of the *Cleoniceras (Grycia) perezianum* Zone
Comment: Same locality as C-149609.
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 88-JIG-13-2B GSC Loc. No. C-154087
NTS 92J/15 Northing 5645950 Easting 514340
Ridge between North Cinnabar Creek and Crane Creek.
Unit: lKTCD
Fauna:
Pseudhelicoceras? sp.
Age: tentatively middle or late Albian
Reference: Haggart, JWH-1989-03

Field No. 88-JIG-26-5-1 GSC Loc. No. C-168255
NTS 92O/03 Northing 5666400 Easting 498410
Red Hill, approx. 3 km NW of Relay Mountain. Southwest gully 10 m downsection from GSC Loc. No. C-168256.
Unit: lKTCD
Fauna:
Cymatoceras? sp.
Puzosia sp. juv.
hamitid ammonite, new genus?
Age: Probably Albian
Reference: Haggart, JWH-1989-03

Field No. 88-JIG-26-5-2 GSC Loc. No. C-168256
NTS 92O/03 Northing 5666400 Easting 498410
Red Hill, approx. 3 km NW of Relay Mountain. Southwest gully 10 m stratigraphically above GSC Loc. No. C-168255.
Unit: lKTCD
Fauna:
desmoceratid? ammonite fragment
hamitid ammonite, new genus?
bivalve fragments, indet.
Age: Indeterminate, probably Early Cretaceous
Reference: Haggart, JWH-1989-03

Field No. 88-JIG-41-1 GSC Loc. No. C-168253
NTS 92O/03 Northing 5666720 Easting 498550
Red Hill, approx. 3 km NW of Relay Mountain.
Unit: lKTCD
Fauna:
Cymatoceras sp. (nautiloid)
Age: Upper Jurassic to Oligocene
Reference: Haggart, JWH-1989-03

Field No. 88-JIG-41-2 GSC Loc. No. C-168254
NTS 92O/03 Northing 5666800 Easting 498480
Red Hill, approx. 3 km NW of Relay Mountain.
Unit: lKTCD
Fauna:
Puzosia? sp.
heteromorph ammonites, genus indet.
hoplitid ? ammonite, genus indet.
trigoniid bivalve, genus indet.
Age: A general Lower to mid-Cretaceous (Albian to Turonian) age is suggested by the possible occurrence of *Puzosia*, otherwise the lot is undatable beyond Late Jurassic to Cretaceous
Reference: Haggart, JWH-1989-03

Taylor Creek Group: Lizard Formation

Field No. 87-JG-238B GSC Loc. No. C-143121
NTS 92O/02 Northing 5667780 Easting 498800
Red Hill, 6.2 km SE of Dash Hill.
Unit: lKTCL
Fauna:
Inoceramus cf. *anglicus* Woods
Age: tentative middle to upper Albian
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 88-JIG-41-4 GSC Loc. No. C-168252
NTS 92O/03 Northing 5667500 Easting 498450
Red Hill, approx. 4 km NW of Relay Mountain.
Unit: lKTCL
Fauna:
Bivalve, possibly *Inoceramus* sp. In general outline the valve bears some resemblance to the *I. anglicus* group.
Age: Indeterminate, possibly Cretaceous
Reference: Haggart, JWH-1989-03

Field No. 88-JKG-18-2-1 GSC Loc. No. C-154080
NTS 92O/02 Northing 5660130 Easting 517280
On Mud Creek road (at junction with another logging road that crosses Mud Creek) 5.5 km NNW of confluence of Tyaughton and Mud creeks.
Unit: lKTCL
Fauna:
Inoceramus ex. gr. *anglicus* (Woods 1911)
Age: Albian, probably middle or late.
Reference: Haggart, JWH-1989-03

POWELL CREEK FORMATION - FOSSILS FROM CLAST IN CONGLOMERATE

Field No. 86KG-36-2-02 GSC Loc. No. C-150223
NTS 92O/03 Northing 5657520 Easting 492080
On ridge 4 km southwest confluence of Tyaughton and Lizard creeks.
Unit: uKPCbs
Fauna:
Buchia uncitoides (Pavlow)
Age: Upper Berriasian
Comment: clast in conglomerate
Reference: Poulton, Report No. J7-1987-TPP

METHOW TERRANE
Jurassic Rocks

Field No. F2-4TD66 GSC Loc. No. 74830
NTS 92O/01 Northing 5650708 Easting 542583
Near mouth of Retaskit Creek, north side of Yalakom River.
Unit: lmJys
Fauna:
Ammonite resembling Hauterivian *Simbirskites* or Bajocian *Stephanoceras*
Age: Hauterivian or Bajocian.
Reference: Jeletzky, Report No. Km-13-1967-JAJ

Field No. 87KG-PS-35-4GSC Loc. No. C-154056
NTS 92O/02 Northing 5673080 Easting 520610
Lone Valley Creek.
Unit: mJcs
Fauna:
serpulids(?), spiral form, small
Camptonectes sp. small
Age: undeterminable
Reference: Poulton, Report No. J14-1987-TPP

Field No. 87KG-PS-35-6 GSC Loc. No. C-154057
NTS 92O/02 Northing 5673350 Easting 520660
Lone Valley Creek.
Unit: mJcs
Fauna:

Stephanoceras sp. cf. *skidegatensis* (Whiteaves)

Age: Early Bajocian
Reference: Poulton, Report No. J14-1987-TPP

Jackass Mountain Group: Unit lKJMY1

Field No. F2-2TD66 GSC Loc. No. 74815
NTS 92O/01 Northing 5652857 Easting 540909
South side of Yalakom Mountain.
Unit: lKJMy1
Fauna:

Ancyloceras (*Acrioceras*) sp. indet.
Lytoceras (*Protetragonites*) sp. indet.
Shasticrioceras? sp. indet.
indeterminate belemnite
Pleuromya cf. *vancouverensis* Whiteaves
Trigonia sp. indet.
pectinid pelecypods

Age: Barremian (possibly lower part of the stage ?)
Reference: Jeletzky, Report No. Km-13-1967-JAJ

Field No. 89APS-31-8-3 GSC Loc. No. C-168109
NTS 92J/16 Northing 5634600 Easting 564150
About 4 km ENE of the confluence of Antoine Creek and the Bridge River.
Unit: lKJMy1
Fauna:

Cylindroteuthis sp.

Age: Middle Jurassic to Early Cretaceous, not differentiable
Reference: Poulton, J8-1990-TPP

Jackass Mountain Group: Unit lKJMY2

Field No. 87-JG-302 GSC Loc. No. C-143127
NTS 92O/02 Northing 5670700 Easting 522250
Churn Creek.
Unit: lKJMy2
Fauna:

Brewericeras (=*Leconteites*) *deansi* (Whiteaves)
Brewericeras (=*Leconteites*) *lecontei whiteavesi* Jones, Murphy and Packard
Anagaudryceras cf. *sacya* (Forbes)
Anagaudryceras? sp. indet.
Aucellina gryphaeoides (J. de C. Sowerby)
Indeterminate pelecypods
Belemnitida Zittel emend. Jeletzky 1966 (a poor fragment)

Age: basal Albian, *Brewericeras lecontei* Zone
Reference: Jeletzky, Km-6-1988-JAJ

Field No. 89APS-42-10-2 GSC Loc. No. C-168110
NTS 92O/01 Northing 5652440 Easting 542765
2 km north of the confluence of Retaskit Creek with the Yalakom River.
Unit: lKJMy2
Fauna:

Apiotrigonia(?) sp.
Columbitrigonia(?) sp.
bivalves, indet.
belemnite, indet.

Age: Early Cretaceous: Hautervivian to Albian, not differentiable
Reference: Poulton, J8-1990-TPP

APPENDIX 4A

Upper Triassic (Late Norian) Biostratigraphy of the Tyaughton Group, Taseko Lakes Map Area, British Columbia Geological Survey of Canada Contribution No. 25595

By H.W. Tipper
Geological Survey of Canada
100 West Pender Street
Vancouver, B.C. V6B 1R8

INTRODUCTION

The Tyaughton Group is exposed on the ridges around Castle Peak and southward to the hills immediately east of Spruce Lake. The group is entirely sedimentary with a low metamorphic grade and, as a result, has a rich fauna comprised of macrofossils and microfossils. Preservation is poor to excellent. Ammonoids and conodonts are by far the most important fossils in the group for structural, stratigraphic and age interpretations. Bivalves are abundant but are of a somewhat lesser value for precise correlation, although some are critical such as *Monotis subcircularis.*

This report is a synopsis of a more extensive compilation (Umhoefer and Tipper, in press) of results obtained by F.H. McLearn, E.T. Tozer and M.J. Orchard from their biostratigraphical studies. The writer first mapped the rocks in 1963 and made extensive collections which were submitted to Tozer. The biostratigraphy was interpreted by Tozer and Orchard.

PREVIOUS AND PRESENT WORK

C.E. Cairnes in 1937 and C.H. Crickmay in 1939 mapped and named the Tyaughton Group (Cairnes, 1943) and many collections were made from this group. From a study of the bivalves collected by Cairnes and Crickmay, F.H. McLearn published a paper on the *Cassionella* fauna (1942). In 1963 E.T. Tozer and the writer mapped this group in greater detail and many collections were made systematically. Tozer published a bulletin (1967) in which he described two measured sections which together form the type section of the group. The ammonoid fauna was listed and assigned to zones. Later he revised the zonation (Tozer, 1979) and presented a North American scheme in which he defined the highest stage of the Triassic as Norian; the upper

Zones	Members	Lithology	Ammonoids	Bivalves	Conodonts
Crickmayi	Upper Green clastics		*Choristoceras crickmayi, C.* cf. *C. marshi, Arcestes* sp.	*Meleagrinella* sp., *Modiola* cf. *M. strigillata, Myophoria suttonensis, Tutcheria* sp.	*Misikella posthernsteini*
Amoenum	*Cassionella* beds		*Paracochloceras amoenum, Rhabdoceras suessi, Placites polydactylus, Arcestes* sp. *Rhacophyllites* sp.	*Cassionella lingulata, Pecten* spp., *Myophoria* spp., *Lima* sp., *Modiola* cf. *M. strigillata, Oxytoma* sp., *Mytilus* sp.	*Epigondolella* ex. gr. *bidentata, Neogondolella* sp., *Epigondolella* sp., *E. englandi, E. mosheri, Parvigondolella* sp.
	Lower green clastics member		none	rare bivalves at the top	none
	Limestone cobble conglomerate				
Cordilleranus	*Monotis* limestone		*Halorites* cf. *H. americanus, Metasibirites* sp.	*Monotis subcircularis*	none
	Massive limestone		none	*Neomegalodus canadensis*	*Epigondolella bidentata, E. englandi*
	Basal red conglomerate		none	none	Early Norian conodonts are in limestone clasts

Dominant Lithologies Present

conglomerate — limestone — limy siltstone/sandstone — sandstone

Figure 46. Upper Triassic (Upper Norian) Biostratigraphy of Tyaughton Group.

Norian is essentially the time range of the Tyaughton Group (Figure 46). The upper Norian substage was defined as comprising three zones. The highest two, the Amoenum and Crickmayi, were defined from the Taseko Lakes map area; the presence of the lower zone, the Cordilleranus zone, is indicated by the occurrence of *Monotis subcircularis*. M.J. Orchard collected samples for conodont extraction and samples were submitted to him by Umhoefer and by the writer. As a result conodonts were recovered from three lithologic units which represented each of the three ammonoid zones (Figure 46). Despite further mapping, study, and collecting Tozer's biostratigraphic (1979) and lithostratigraphic interpretations (1967) of the Tyaughton Group have remained essentially intact. In a current study by Umhoefer and Tipper (in press) the Tyaughton Group has been reduced to a formation and the lithologic units have been defined as seven members (Figure 46).

DISCUSSION OF THE STRATIGRAPHIC UNITS AND THEIR FAUNAS

The basal red conglomerate is in fault contact with older rocks, the Cadwallader Group. However clasts from this group are the main clasts of the conglomerate. No fossils precisely date this unit.

The massive limestone is characterized by numerous bivalves; the large *Neomegalodus canadensis* is one species that is readily identified. Conodonts have also been recovered and identified by Orchard (Figure 46). The overlying *Monotis* limestone is present in the type section but commonly is missing or not recognized elsewhere. No conodonts are associated.

The limestone cobble conglomerate and the lower green clastics are devoid of fossils except near the top of the latter member where a few bivalves indicate the advent of the bivalve fauna of the overlying *Cassionella* beds.

The calcareous sandstone of the *Cassionella* beds are replete with a diverse bivalve fauna. *Cassionella lingulata* is the characteristic and distinctive form but the fauna is abundant and well-preserved. Conodonts were extracted at several levels. Ammonoids are not abundant but are well-preserved and useful guide fossils. The upper green clastics have few fossils. The heteromorphic ammonoid *Choristoceras crickmayi* and the conodont *Misikella posthernsteini* are the two forms that clearly indicate the Crickmayi zone, the latest Triassic zone. Until recently this was the only rock unit in Canada of this age defined by fossils. This fauna now has been identified in Queen Charlotte Islands.

APPENDIX 4B

Lower Jurassic Ammonite Biostratigraphy of the Last Creek Formation, Taseko Lakes Map Area, British Columbia
Geological Survey of Canada Contribution No. 25495

By H.W. Tipper
Geological Survey of Canada
100 West Pender Street
Vancouver, B.C. V6B 1R8

INTRODUCTION

The Last Creek Formation of Early and Middle Jurassic age is exposed at the headwaters of Last Creek, north of Castle Peak, and on the ridges and valleys south and southwest of Relay Mountain. Ammonoids are the most important fossils for the interpretation of age, structure, and stratigraphy of the formation. Bivalves, gastropods, coleoids, and nautiloids do occur sparingly or, in places, abundantly but none, at present, are particularly valuable as guide fossils. So far no microfossils have been helpful in the biostratigraphical interpretation of these Jurassic strata and radiolarians or foraminifers have not been extracted from any collection.

PREVIOUS AND PRESENT WORK

Frebold (1967) published his study of the faunas of the Canadensis zone which is now believed to straddle the Sinemurian-Hettangian boundary (Figure 47). This is the only published biostratigraphic study of the Lower Jurassic faunas of Taseko Lakes map area. Frebold (1951) described a few Sinemurian forms and C.H. Crickmay identified a few Lower Jurassic forms during the course of mapping (Crickmay *in* Cairnes, 1943). Since beginning work in the area in 1963, the writer has collected an abundant fauna from the Last Creek Formation and some of these have been identified in internal reports by Frebold, G.K. Jakobs, and the writer. Other collectors, particularly P.J. Umhoefer, J.A. O'Brien (1985) and T.P. Poulton, have provided important material. The current studies of the Lower Jurassic faunas from this map area are based on all the material available in the collections of the Geological Survey of Canada and this report is a synopsis of a much more complete report on the stratigraphy, sedimentation, and biostratigraphy of the Last Creek Formation (Umhoefer and Tipper, in press).

GEOLOGICAL SETTING

The Last Creek Formation has been included in the Cadwallader Terrane. It is a unit resting with an erosional or non-depositional hiatus upon latest Triassic sandstone of the Tyaughton Group; a slight angular tectonic relation possibly exists. The formation has been folded and faulted into slices so that a restored section from many short sections is the only means of obtaining a meaningful interpretation. A total thickness of 250 to 400 metres is considered possible. It ranges in age from Late Hettangian to Early Bajocian; the Aalenian to Lower Bajocian strata discussed by Poulton in Appendix 4c of this bulletin are part of the formation.

The strata of the Last Creek Formation first was an unnamed unit (Cairnes, 1943), later it was included with the Tyaughton Group, (Tipper, 1978; Glover and Schiarizza, 1987; Glover *et al.*, 1988a). O'Brien (1985) informally referred to Sinemurian and Hettangian beds above the Tyaughton Group as the Last Creek Formation (1985). Umhoefer and Tipper (in press) formalized the name and described the Last Creek Formation as "a transgressive sequence comprising Hettangian to Sinemurian shallow-marine coarse clastic rocks that grade up into Upper Sinemurian to Bajocian deeper-marine shales".

DISCUSSION OF THE AMMONITE BIOSTRATIGRAPHY OF THE LAST CREEK FORMATION

The ammonite fauna of the Last Creek Formation is diverse, relatively abundant, and well-preserved. In Figure 47 the more important genera and species are listed according to the stage and zone in which they appear. This is not a complete listing as the studies of the faunas are not complete and there are several unidentified genera and species that may be new or endemic to the east Pacific faunal realm.

The Hettangian stage is represented by forms characteristic of Late Hettangian time. Their position is determined largely by a comparison with forms from Nevada and Oregon studied by J. Guex (1980) and David Taylor. The oldest fauna is referred to the informal "*Oregonensis*" assemblage and the most significant forms are *Sunrisites sunrisensis* Guex, *Pseudaetomoceras* sp., and a new species of *Badouxia* which together indicate a Late Hettangian age. These appear to be older than the Canadensis zone but the *Sunrisites* and *Badouxia* n. sp. may continue into the earliest beds of this zone.

The Canadensis zone was the first established Early Jurassic zone in North America. It was studied and described by Frebold (1967) who believed it to be of Hettangian age. The material collected was all from the Last Creek Formation. The age of the zone became controversial when Guex and Taylor (1976) argued that a comparison with European biostratigraphy would indicate that the zone was Sinemurian. This was disputed by Gert Bloos (1983) who argued for an Hettangian age. Although the question of age is not fully resolved, the current interpretation is that the zone straddles the Hettangian-Sinemurian boundary (Taylor,

Stages		Zones and Assemblages*	Main Jurassic Ammonite Fauna Present	Lithology
TOARCIAN	U	Yakounensis	*Dumortieri(?) phantasma, Hammatoceras* sp.	
		Hillebrandti	probably present	
	M	Crassicosta	*Phymatoceras* cf. *P. rude, P.* cf. *P. hillebrandti*	
		Planulata	probably present	
	L	Kanense	*Cleviceras* cf. *C. chrysanthemum, Dactylioceras* cf. *commune*	
PLIENSBACHIAN	U	Carlottense	not recognized, probably present	
		Kunae	*Fanninoceras* sp. *Protogrammoceras* sp.	
	L	Freboldi	*Dubariceras freboldi, Metaderoceras* sp., *Oistoceras* sp., *Fuciniceras* sp., *Fanninoceras* sp., *Phricodoceras* sp., *Aveyroniceras* sp., phylloceratids	
		Whiteavesi	*Acanthopleuroceras* sp., *Metaderoceras* sp., *Tropidoceras* sp., *Gemmellaroceras?* sp.	
		Imlayi	not recognized, probably absent	
SINEMURIAN	U	"Tetraspidoceras"		
		"Harbledownensis"	*Paltechioceras* spp., phylloceratids	
		"Varians"	*Asteroceras* sp., *Epophioceras* sp., *Arnioceras* sp., oxynoticeratids	
	L	"Arnouldi"	*Arnioceras arnouldi, A. miserabile*, arietitids, *Caenisites turneri, C. brooki, Hypasteroceras(?)* sp., *Aegasteroceras* sp.	
		"Coroniceras"	*Coroniceras* sp., *Arietites bisulcatum, Tmaegoceras* sp., *Arnioceras* sp., *Vermiceras* sp.	
		Canadensis	*Badouxia columbiae, B. canadensis, B. occidentalis, Eolytoceras tasekoi, Canavarites(?)* sp.	
HETTANGIAN	U		*Badouxia canadensis, B. occidentalis, Metophiceras rursicostatum, Angulaticeras marmoreus*	
		"Oregonensis"	*Badouxia* n. sp. *Sunrisites sunrisensis, Schlotheimia* sp., *Pseudaetomoceras* sp., *Eolytoceras* sp., *Paracaloceras* sp.	
		Absent		
Triassic		Present		

Dominant Lithologies Present

conglomerate — hiatus — sandstone — siltstone, shale

* Informal assemblage names are shown in quotes (e.g., "Arnouldi").

Figure 47. Lower Jurassic ammonoid zones and assemblages of the Last Creek Formation.

1986; Pálfy, 1991); this interpretation is tentatively accepted by the writer but further studies are in progress.

The Canadensis zone is presently defined as the range of the species *Badouxia canadensis* (Frebold). The lower part of the zone, the Hettangian part, is characterized by the common and abundant occurrence of this species as well as *Angulaticeras marmoreus*, *Eolytoceras tasekoi*, *Metophioceras rursicostatum* and *Badouxia occidentalis*. The upper part of the zone, the earliest Sinemurian part, is marked by the incoming of *Badouxia columbiae* and, together with *Badouxia canadensis*, define the upper range of the zone. Several of the genera and species of the lower (Hettangian) part continue into the upper part. A few forms, such as *Canavarites?* sp. and *Vermiceras* sp. occur infrequently in the Sinemurian upper part.

The "Coroniceras" assemblage is made up of several species of arietitids and *Coroniceras* spp. which are generally well-preserved and of moderate to large size, up to 50 cm. *Tmaegoceras* sp., *Arnioceras* sp., and possible new genera are uncommon but characteristic of this assemblage. The beds in which they are found are greywackes and together with the earlier conglomerates and grits of the Last Creek Formation form most of the coarse clastic beds of the formation. This assemblage name and the younger Sinemurian assemblage names were suggested by Pálfy (1991) from Queen Charlotte Islands.

The "Arnouldi" assemblage is characterized by several species of *Arnioceras*, the two most common being *A. arnouldi* and *A. miserabile*. The upper part of the assemblage is marked by the incoming and dominance of asteroceratids such as *Caenisites*. This latter fauna is uncommon in North America.

Late Sinemurian assemblages (Figure 47) are generally not diverse and occurrences are few. The "Varians" assemblage is represented by rare *Asteroceras*, *Epophioceras* sp., and oxynoticeratids. The "Harbledownensis" assemblage is dominated by echioceratids of which *Paltechioceras* and *Plesechioceras(?)* species are dominant and locally abundant.

The youngest assemblage of the Sinemurian, "Tetraspidoceras", and the first zone of the Pliensbachian stage, the Imlayi zone, are not recognized in the faunas of this area. Ammonoids of the later Early Pliensbachian zones, Whiteavesi and Freboldi, are present in coarser clastic beds which may indicate a short period of non-deposition or erosion at about the boundary between Sinemurian and Pliensbachian time.

Upper Pliensbachian and Toarcian strata are entirely black shale or fine siltstone and fossils are sparse and poorly preserved. As indicated in Figure 47, several zones are present but there is no reason to believe the lack of evidence of the presence of some zones suggests that hiatuses exist. The uniformly fine clastic nature of these strata and the overlying Aalenian and Lower Bajocian beds, which are also part of the Last Creek Formation (*see* Poulton, Appendix 4? of this volume) characterize the upper part of the formation.

APPENDIX 4C

Middle Jurassic to Lower Cretaceous Macrofossil Biostratigraphy, Taseko Lakes Map Area, British Columbia Geological Survey of Canada Contribution No. 24892

By T.P. Poulton
Geological Survey of Canada
3303 33rd St. NW
Calgary AB T2L 2A7

INTRODUCTION

Jurassic and Lower Cretaceous strata are preserved in those parts of the Taseko Lakes map area that are assigned to Bridge River, Cadwallader and Methow terranes, and the Tyaughton basin. Ammonites are the leading guide fossils in most of these successions; they have been invaluable tools in the interpretation of the stratigraphy, structure and tectono-stratigraphic history of the area. In Tyaughton basin, bivalves of the genus *Buchia* are exceptionally abundant and valuable for biostratigraphic age determinations and correlations. The fossils found in the area have provided much of the basis for a regional zonation of the Upper Jurassic through Early Cretaceous (*e.g.* Jeletzky, 1965) and give important data regarding the faunal associations and their paleobiogeographic affinities throughout the entire Jurassic. Other fossils are important for correlations in special cases, including particularly radiolaria in the oceanic Bridge River Complex (Cordey, 1986; Cordey and Schiarizza, 1993).

PREVIOUS WORK

Frebold *et al.* (1969) described and illustrated various Aalenian and Early Bajocian ammonites, and Poulton and Tipper (1991) reviewed the Aalenian ammonites and illustrated additional specimens. Frebold and Tipper (1967) described and illustrated a number of Middle Callovian ammonites. Late Jurassic and Early Cretaceous fossils have been the subject of intensive study by J.A. Jeletzky who has illustrated, described and zoned many species of the dominant guide bivalve *Buchia* and of the uncommon associated ammonites (Jeletzky, 1965, 1984). Identifications of Jurassic fossils were included in geological reports by Cairnes (1943), Jeletzky and Tipper (1968) and compiled by Frebold and Tipper (1970).

CADWALLADER TERRANE

The Aalenian and Early Bajocian shales and siltstones, with minor sandstones, appear to occur in continuous sequence above the Lower Jurassic. They are included in the Last Creek Formation.

AALENIAN

Fossiliferous marine Aalenian strata occur in a unit of variably calcareous shale, siltstone and sandstone in the Tyaughton Creek and Taseko River areas (Frebold *et al.*, 1969; Poulton and Tipper, 1991). The ammonites present suggest that much of the Aalenian stage is present in the Tyaughton Creek sequence, although the lowermost and uppermost parts are not proven.

TYAUGHTON CREEK AREA

Aalenian strata are exposed between Tyaughton and Relay creeks, documented by fossils collected in four primary areas (*see also* Frebold *et al.*, 1969 and Poulton and Tipper, 1991). These include *Tmetoceras* sp. cf. *T. scissum* (Benecke), together with ostreiid bivalves, from Tyaughton Creek, above the mouth of Bonanza Creek. The ammonites *Erycitoides* sp. aff. *E. howelli* (White), *Tmetoceras* sp. cf. *T. scissum*, *T. kirki* Westermann, *Pseudolioceras*, *Planammatoceras*(?), together with the bivalve Inoceramus and ostreiids have been found at a locality about 6 kilometres east of Castle Peak, on the ridge extending eastward from that peak. The col just south of the peak of Cardtable Mountain has produced the ammonite *Erycitoides kialagvikensis* (White). The precise relations with nearby *Dumortieria* of probable Late Toarcian age are uncertain. *Tmetoceras scissum* (Benecke), *T. kirki* Westermann, *T.* sp. cf. *T. flexicostatum* Westermann, *Erycitoides howelli* (White), *E. kialagvikensis* (White), *E. levis* Westermann, *Erycitoides*(?) sp. indet., *Pseudolioceras*, *Planammatoceras*(?), *Zurcheria*(?), *Lissoceras*(?), *Phylloceras*, and *Holcophylloceras*, together with ostreiid and other bivalves (including *Pleuromya* and *Inoceramus*), gastropods and rhynchonellid brachiopods occur on the ridges southwest of Relay Mountain, near the head of the southwest branch of Relay Creek. Two assemblages are present there, a Lower Aalenian one dominated by *T. scissum* and an Upper Aalenian one characterized by *E. howelli*.

TASEKO RIVER AREA

Lower to Middle Jurassic strata correlated with the Last Creek Formation that outcrop to the northwest of the Taseko - Bridge River map area occur as an east-trending belt between Chilko Lake and the Taseko River (Tipper, 1978; Riddell *et al.*, 1993a,b). A collection of fossils from the west side of the Taseko River, north of Taseko Lake, contains a large ammonite fragment that may represent the Upper Aalenian genus *Erycitoides*, together with the bivalves *Lima*, *Myophorella* and *Mclearnia*(?) among others. Farther west, poorly preserved ammonites that may be Aalenian *Tmetoceras* occur with bivalves north of Mount Tatlow, above Nemaia Lake.

EARLY BAJOCIAN

The Bajocian is not richly fossiliferous in Taseko Lakes area. The stratigraphic relationships of the few assemblages that occur are unclear; the positions shown in Figure 48 are unproven, based primarily on stratigraphic relations established elsewhere. The youngest Jurassic fossils in the Cadwallader Terrane are Early Bajocian, occurring in apparently continuous sequence above the Aalenian, in a thin and sporadically recognized, but perhaps widespread concretionary shale unit.

Frebold *et al.* (1969) describe Early Bajocian ammonites from the area southwest of Relay Mountain, near the head of Relay Creek: *Stephanoceras* (*Skirroceras*) sp. cf. *S. kirschneri* Imlay, *Witchellia*(?), and *Holcophylloceras* sp. cf. *H. costisparsum* Imlay. Other species of *Stephanoceras* (sensu lato) and other ammonites, probably species of *Chondroceras* and of *Sonninia*, *Pseudolioceras* or *Eudmetoceras* also occur near the head of Relay Creek. Aptychi are associated as are fish scales(?) and the bivalve *Inoceramus*. These fossils are found in limestone concretions in a dominantly shale unit. A coarse-grained volcaniclastic bed in the same vicinity yields *Chondroceras*, together with small fragments of stephanoceratid(?) ammonites, gastropods and the bivalve *Myophorella yellowstonensis* Imlay.

Shale with limestone concretions exposed in the vicinity of the head of Relay Creek contain other ammonites of probable Early Bajocian age. Their relationship to the ammonite-bearing strata described above remains uncertain. The dominant ammonites are stephanoceratids, of which the most common is probably a species of *Kumatostephanus*, and a less common form resembles *S.* (*Skirroceras*), or a similar stephanoceratid. Associated ammonites include abundant specimens of probable *Asthenoceras*, and less common specimens that may represent *Phylloceras*, *Lissoceras*, *Dorsetensia*, *Fontannesia*, and other sonniniids. Ammonite aptychi are relatively abundantly preserved. Other fossils are rare, including bivalves such as *Inoceramus*, ostreiids and pectinaceans, fish scales(?) and belemnites, some of which were identified by J.A. Jeletzky as *Acrocoelites*.

Tyaughton Creek, between the mouths of Spruce Lake Creek and Bonanza Creek, has yielded *Chondroceras marshalli* (McLearn), described by Frebold *et al.* (1969). They also identified *Oedania*(?) sp. from Spruce Lake Creek south of Tyaughton Creek. This last single fragment may represent *Pseudolioceras*.

METHOW TERRANE

AALENIAN

A section through marine Aalenian strata is exposed along Yalakom River, northward from the mouth of Blue Creek, directly northeast of the Yalakom fault (Leech, 1953; Poulton and Tipper, 1991). The strata are primarily thin-platy siltstones rich in ammonites. The fauna is dominated by ammonites, on many of which small ostreiid bivalves are attached. They seem to form a continuous sequence above similar Toarcian strata.

The lowest ammonites that are possibly Aalenian are *Pleydellia*(?) sp. cf. *P. argentina* Maubeuge and Lambert. Some 23 metres above them, are the lowest occurrences of the Aalenian guide ammonite *Tmetoceras*, so that the *Pleydellia*(?) may in fact represent the Late Toarcian. Younger Aalenian ammonites from Yalakom River include *T. kirki* Westermann, *T. flexicostatum* Westermann, *Erycitoides* sp. aff. *E. howelli* (White), *Pseudolioceras* sp. cf. *P. whiteavesi* (White) and *Planammatoceras*. Other fossils are uncommon in these beds. They include ostreiid bivalves as well as *Inoceramus*, *Oxytoma*(?), *Astarte*, *Propeamussium*(?), belemnites, and rhynchonellid brachiopods. A complete, but somewhat sheared sequence through the Aalenian stage may be present here, although there is no paleontologic evidence for the latest Aalenian. Further stratigraphic details are given by Frebold *et al.* (1969) and Poulton and Tipper (1991).

Poorly preserved specimens of probable *Tmetoceras* have been found in the sparsely fossiliferous sequence north of Konni Lake in western Taseko Lakes area (Poulton and Tipper, 1991). Associated fossils are the bivalves *Oxytoma*, *Inoceramus*, and belemnites. These strata are interpreted as the northern extension of the section exposed along the Yalakom River, offset along the Yalakom fault (Riddell *et al.*, 1993a).

EARLY BAJOCIAN

The Early Bajocian ammonite *Skirroceras* has been found in a road outcrop near the mouth of Blue Creek (see Photo 46 of this bulletin), in rocks that are stratigraphically above the Aalenian section described along the Yalakom River. Frebold *et al.* (1969) identified *Stephanoceras* and *Stemmatoceras* from the ridge top north of Nemaia Lake, in the northern counterpart of the Yalakom River belt, offset along the Yalakom fault (Riddell *et al.*, 1993a).

Stephanoceras sp. cf. *S. skidegatensis* (Whiteaves) occurs in fine-grained sandstones exposed along the lower reaches of Lone Valley Creek. These Lower Bajocian rocks occupy the core of an east-plunging anticline, and are stratigraphically(?) overlain by Lower Cretaceous rocks of the Churn Creek facies of the Jackass Mountain Group.

TYAUGHTON BASIN

The Relay Mountain Group contains Callovian ammonites at several localities in Taseko Lakes map area. They are the oldest fossils in the Tyaughton basin. The Callovian ammonites, of Early and Middle Callovian age, occur in a thick, monotonous shale and siltstone complex of 'deeper water' character, which may be the basal, fine grained early component of a sequence which becomes shallower and coarser in the Upper Jurassic.

The possible presence of Upper Callovian strata cannot be proved or disproved by the small and poorly preserved ammonite fragments at some localities south of Relay Mountain. If any Upper Callovian strata are present, they are certainly very thin, and a hiatus may separate the Lower Oxfordian from the Middle Callovian.

The contact interval with the Oxfordian is not well known. The Lower Oxfordian through Valanginian sequence is a thick and richly fossiliferous, shelf sandstone and shale sequence with minor conglomeratic and coquinoid limestone units. Richly fossiliferous Hauterivian sandstones and shales occur in sequence above the Valanginian in much of the area, but a local sub-Hauterivian tectonic event is suggested by the unconformity in the vicinity of Lorna Lake, where Hauterivian strata overlie Middle Callovian shales.

EARLY AND MIDDLE CALLOVIAN

A specimen of the genus *Cadoceras*, probably of Early Callovian age, has been found on Tyaughton Creek, above the junction with Spruce Lake Creek.

Lilloettia lilloetensis Crickmay, was described from three localities west of Relay Mountain and south or southeast of Elbow Mountain, and assigned a Middle Callovian age by Frebold and Tipper (1967). The long-ranging ammonite *Adabofoloceras* (formerly assigned to *Partschiceras*) is associated, as are the bivalves *Pleuromya* and *Goniomya*. *Xenocephalites*, the supposed microconch dimorph of *Lilloettia*, occurs with *L.* sp. cf. *L. lilloetensis* southeast of Elbow Mountain.

Other ammonites, also assigned to the Middle Callovian, were described (Frebold and Tipper, 1967) from south of Relay Mountain: *Cadoceras* (*Stenocadoceras*) *striatum* Imlay, *C.* (*S.*) sp. cf. *S. striatum*, *C.* (*S.*) sp. cf. *S. iniskinense* Imlay, and their supposed microconch dimorphs *Pseudocadoceras petelini* (Pompeckj) and *P.* sp. cf. *P. grewingki* (Pompeckj). No association of these cadoceratid ammonites with the eurycephalitinids such as *Lilloettia* has been documented with certainty, so that the ranges of the species of the latter group are not calibrated precisely with the boreal time scale established for the former. The bivalve *Myophorella* sp. cf. *M. packardi* (Crickmay) is associated.

Poorly preserved small ammonites that may represent a cadoceratid such as *Stenocadoceras*, occur in some abundance in the beds outcropping on the ridges east of Lorna Lake. Associated bivalves include *Myophorella*, *Astarte*, and *Pholadomya*, and belemnites are not uncommon. To the southeast, in the ridge overlooking Lizard Creek to the southeast, ammonites that may represent the cadoceratids *Stenocadoceras* and *Pseudocadoceras*, as well as *Adabofoloceras* have been found.

The relative ages and stratigraphic positions of *Lilloettia* and the cadoceratid faunas have long been a problem (*e.g.* Crickmay, 1930) and are still not very well known. The range of *Lilloettia* has been interpreted as Early Callovian by Callomon (1984), based on data from Alaska described by Imlay (1953). Preliminary data from northern Bowser basin in Spatsizi map area support this interpretation, and suggest that one species may occur in the Late Bathonian as well (Poulton *et al.*, 1991). The age of *Stenocadoceras* remains unclear also; it is currently assigned to the Middle Callovian on inconclusive grounds. The appearance of *Lilloettia*, an East Pacific genus of the Eurycephalitinae, within the Early Callovian range of the Boreal cadoceratid *Cadoceras*, but their apparent failure to occur together anywhere, suggests strong differentiation of the two faunal provinces in Callovian time and alternation, but not mixing, of watermasses from the Pacific and Arctic in western British Columbia.

EARLY AND MIDDLE OXFORDIAN

The general vicinity of the head of Big Creek offers well exposed sections of a thin succession with a sequence of *Cardioceras* faunas, and there are *Cardioceras*-bearing localities north of Tyaughton Creek, east of Grizzly Creek. These ammonites are still unstudied, but species resembling *C. martini* Reeside and *C. cordiforme* (Meek and Hayden) suggest that a complete, condensed sequence is present starting about the base of the Oxfordian. Some of the sandstones in this thin, mainly siltstone, sequence are richly fossiliferous, and contain a small quantity of other ammonites occasionally, including perisphinctids, oppeliids(?), *Lytoceras* and phylloceratids. Among the rich bivalve faunas, *Astarte* dominates. *Myophorella* is conspicuous in some lower beds. Probable *Amoeboceras* occurs in the upper *Cardioceras*-bearing beds, where there is also an early species of *Buchia*, closely similar to *B.* (*Anaucella*) *concentrica* (Sowerby). The overlap of *Cardioceras* with generally younger *Buchia* is unusual in North America, indicating what is probably the late Middle Oxfordian or the earliest Late Oxfordian.

The only published description of Early or Middle Oxfordian fossils from the area is by Reeside (1919), in a major early monograph of American *Cardioceras*. He described *C. lilloetense* Reeside and listed what he identified as *C. canadense* Whiteaves and *C. whiteavesi* Reeside, from the *Cardioceras*-bearing beds at the head of Big Creek. *C. lilloetense* may indicate a later part of the Early Oxfordian (Callomon, 1984). The presence of the last two species cannot now be confirmed, but if correctly identified suggest a Middle Oxfordian age. The ammonites were identified from a single collection, in which a belemnite and a species of *Aucella* related to *A. bronni* [now included in *Buchia concentrica* (Sowerby)] also occur. The lithology of the matrix surrounding the *Buchia* specimen led Reeside to suggest that it comes from a different horizon from the ammonites.

LATE OXFORDIAN TO EARLY KIMMERIDGIAN

A sequence comprising siltstones with lesser quantities of shale and immature sandstone is characterized by the bivalve *Buchia concentrica* (Sowerby), nominate species for the important and widespread *B. concentrica* Zone which comprises this interval. Other fossils are uncommon, and include belemnites, a small variety of long-ranging bivalves, and rare and poorly preserved ammonites that include, but are not restricted to, the cardioceratid genus *Amoeboceras*. One specimen of *B. concentrica* (var. *erringtoni*) was illustrated by Jeletzky (1965); the characteristics of the strata were described by Jeletzky and Tipper (1968).

YOUNGER LATE JURASSIC TO VALANGINIAN

Because of the particularly extreme degree of faunal provincialism in the latest Jurassic and earliest Cretaceous, distinct zonations have been erected for different parts of the world and correlation between them remains difficult.

Bivalves of the genus *Buchia* are the dominant faunal element in northern and western Canada, almost to the exclusion of other fossils, in contrast to northern Europe and Asia where abundant associated ammonites of boreal character have provided independent zonations. The buchias are characteristic of the northern parts of the northern hemisphere (Boreal Realm), and are useful tools for correlation within this area.

The Taseko Lakes area has provided a major part of the basis for the succession of *Buchia* zones erected by J.A. Jeletzky for the Late Jurassic and Early Cretaceous of the western Cordillera. The zones and their contained fossils, described in other reports (Jeletzky, 1964, 1965, 1984; Jeletzky and Tipper, 1968), are summarized in Figure 48. Some of the *Buchia* species, such as *B. terebratuloides* (Lahusen), *B. okensis* (Pavlow) and *B. pacifica* Jeletzky, exhibit a distinctive and readily identifiable external form. The majority are more difficult, however, because of their generally similar external form and the intergradation as well as repetition of form among them. Jeletzky (1965) has indicated the importance of having available large and well preserved collections in which the hinge line and curvature of the beak can be seen. Individual morphological species have ranges beyond their nominal zones in some cases, and occur sporadically within larger assemblages in most cases, the zonal boundaries being somewhat arbitrarily located within gradational or repeated sequences. Because of the widespread distribution and distinctive chatacter of *B. okensis*, it is a widely used, near-basal Cretaceous marker species throughout the boreal realm.

Occasional beds in the thick sequence in Taseko Lakes and other areas contain a small variety of other fossils, some of them Tethyan in character. *Meleagrinella* is one of the bivalves, *Turbotrigonia*(?) another.

Of particular importance, some of the ammonites that occur uncommonly within the interval dominated by *Buchia* are critical for international correlation and deserve special mention. However, there are still controversies about their taxonomy and stratigraphic significance, so that worldwide correlations are still under discussion (*e.g.* Jeletzky, 1984; Zeiss, 1984).

		Stages	Fossil Assemblages	
Cretaceous	Lower	Hauterivian	*Craspedodiscus* sp., *Simbirskites* sp.	Tyaughton Trough
			Inoceramus colonicus	
			Simbirskites spp., *Speetoniceras* sp.	
			Homolsomites oregonensis, *Inoceramus* sp. aff. *I. quatsinoensis*	
		Valanginian	*Valanginites* aff. *V. nucleus*	
			Buchia crassicollis, *Homolsomites quatsinoensis*, *Olcostephanus pecki*	
			Buchia pacifica, *Dichotomites* cf. *giganteus*	
			Buchia tolmatschowi	
		Berriasian	*Buchia uncitoides*, *Spiticeras* sp.	
			Buchia okensis, *B. uncitoides*, *Berriasella* spp., *Protothurmannia* spp.	
Jurassic	Upper	Tithonian	*Buchia terebratuloides*, *B. fischeriana*, *Parodontoceras reedi*, *Substeueroceras*(?)	
			Buchia fischeriana, *B.* spp.	
			Buchia piochii, *B. lahuseni*	
			Buchia sp. cf. *B. blanfordiana*, *B.* sp. cf. *B. piochii*	
			Buchia sp. aff. *B. piochii*, *B. piochii*, *B.* sp. aff. *B. mosquensis*	
		Kimmeridgian	*Buchia mosquensis*	
			Buchia concentrica	
		Oxfordian	*Cardioceras* spp.,	
	Middle	Callovian		
			Cadoceras (Stenocadoceras) striatum, *Pseudocadoceras*	
			Lilloettia lilloetensis, *Xenocephalites*, *Adabofoloceras*	
			Cadoceras sp.	
		Bathonian		
		Bajocian		
			Chondroceras, *Stephanoceras*	Cadwallader Methow
			Stephanoceras sp. cf. *S. kirschneri*, *Witchellia*(?)	
			Kumatostephanus, *Stephanoceras*, *Asthenoceras*, sonniniids	
		Aalenian	*Erycitoides howelli*, *Tmetoceras flexicostatum*, *Planammatoceras*, *Pseudolioceras whiteavesi*	
			Tmetoceras scissum	

Figure 48. Middle Jurassic to Hauterivian macrofossil assemblages, Taseko Lakes map area.

Important ammonites that have been described from Taseko Lakes area include *Parodontoceras reedi* (Anderson) and *Substeueroceras*(?) in the latest Tithonian upper *B. terebratuloides* zone, *Argentiniceras* cf. *noduliferum* (Steuer) and *Protothurmannia* spp. in the late Early Berriasian upper *B. okensis* zone, and *Dichotomites* cf. *D. giganteus* (Imlay) in the mid-Valanginian *Buchia pacifica* zone (Jeletzky, 1964, 1965, 1984). *Valanginites* sp. aff. *V. nucleus* (Roemer) may be from the uppermost Valanginian (Jeletzky, 1973). Additionally, Jeletzky and Tipper (1968) listed *Berriasella* spp. from the probably lowest Cretaceous lower *B. okensis* zone, and *Homolsomites quatsinoensis* (Whiteaves) and *Olcostephanus pecki* from the Late Valanginian lower *B. crassicollis* zone.

Ongoing research intended to resolve correlations of the fossil zones, stages, and even the Jurassic-Cretaceous boundary, between the Boreal and Tethyan major faunal realms increasingly involves the detailed study of a variety of microfossils, as well as magnetostratigraphy and other techniques. One microfossil group that has indicated potential for correlation of the Jurassic-Cretaceous boundary interval is the calpionellids. They are apparently absent in the western Canadian Cordillera, following a search by the author in company with A. Zeiss and J. Jeletzky, which involved the preparation of thin sections from the scarce limestones in sequences from Taseko Lakes area and elsewhere.

APPENDIX 5

Plant Fossil Identifications

By J.F. Basinger
Department of Geological Sciences,
University of Saskatchewan,
Saskatoon, Saskatchewan.

Taylor Creek Group - Lizard formation/Beece Creek succession

Field No. 86JG-178 GSC Loc. No. C-149608
NTS 92O/03 Northing 5667460 Easting 497340

North of most prominent drainage in centre of Red Hill massif. North of eastern fork, near headwaters, elev. 7730 feet. Collection comes from area of gradational contact between Lizard formation and overlying Beece Creek succession.
Unit: lKTCL/luKTCB
Flora:

Sphenopteris sp.
Cladophlebis (*Gleichenites*) cf. *C. usheri* Bell
Cladophlebis sp.
Menispermites cf. *M. potomacensis* Berry
cf. *Myricaephyllum*
misc. unidentifiable angiosperm leaf fragments

Comments: The remains generally conform to those expected from mid-Cretaceous deposits. Identification to the species level is not possible due to the limited amount of material available and to the generally poor quality of preservation. Bell figures similar fossil material in his reports on the Kingsvale Group (Bell, 1956) and his flora of the Nanaimo Group (Bell, 1957).

There are a few very small leaves that I had difficulty with. Poorly preserved material has been figured in a number of Albian through Campanian reports, but until I am able to properly identify it, let's just leave it at cf. *Myricaephyllum.*

The fossil flora is typical of the Albian - Cenomanian mid latitude floras. On the basis of the material available, and indeed on the basis of Bell's more extensive collections, it is probably not possible to be more precise on the age. Bell assigns the Kingsvale flora to the Albian, but it is my opinion that the flora could be younger.

The similarity with the Nanaimo flora should not be taken as an indication of a post-Cenomanian age, for the taxa in common are long-ranging.

Reference: written report by J.F. Basinger, Jan. 22, 1988.

Silverquick formation

Field No. JG87-19B GSC Loc. No. C-143128
NTS 92J/15 Northing 5647770 Easting 514480

Ridge between Taylor and North Cinnabar creeks.
Unit: luKSQ
Flora:

Sphenopteris sp.
Menispermites sp.
cf. *Araliaephyllum*
misc. unidentifiable angiosperm leaf fragments

Comment: The sample preserves several leaf fragments within a siltstone matrix. Details of higher order venation are not apparent. It has not been possible to identify the specimens to the specific level, but generic assignment has been possible for two of the taxa, *Sphenopteris* and *Menispermites.* A questionable generic assignment of one leaf fragment to cf. *Araliaephyllum* is based upon the apparently lobed nature of the leaf; however, since venation is not well preserved, it is not possible to be sure that the leaf margin is truly lobed or has been damaged.

The taxa present are typical of the flora of mid-Cretaceous strata of the middle latitudes. Since the few specimens available are not well preserved, it is not possible to assign an age with any great degree of confidence. However, they are consistent with an Albian/Cenomanian age, which has been suggested for sedimentary beds of the Kingsvale Group. Bell (1956) figures similar fossil material in his report on the Lower Cretaceous Floras of Western Canada, which includes specimens from the Kingsvale Group. Note that Bell indicated an Albian age for the plant-bearing beds, but that it is my opinion that the flora cannot be used to exclude a Cenomanian age.

Reference: written report by J.F. Basinger, Feb. 24, 1988.

Powell Creek formation

Field No. 86PS-13-6-1 GSC Loc. No. C-150219
NTS 92O/03 Northing 5663760 Easting 471340

Lower Powell Creek
Unit: uKPCm2
Flora:

Elatocladus sp.

Comment: Only fragments of the leafy shoots of this conifer are present. This is a form taxon that is preferred for the assignment of this type of taxodiaceous vegetative material. It is abundant throughout the Cretaceous and is difficult to use in biostratigraphy.

Reference: written report by J.F. Basinger, Jan. 22, 1988.

Field No. 86KG-18-2 GSC Loc. No. C-150216
NTS 92O/03 Northing 5663160 Easting 469320

North bank of the Taseko River, 1.5 km west of Powell Creek.
Unit: uKPCm2
Flora:

Cladophlebis alberta (Dawson) Bell

Comment: See general comments. Numerous taxa of ferns of the *Cladophlebis* type occur in Jurassic through to Late Cretaceous rocks. Although generally not an easy group to deal with, this specimen conforms to that figured by Bell (1956) as *Cladophlebis alberta.*

Field No. 86KG-22-3 GSC Loc. No. C-150217
NTS 92O/03 Northing 5662860 Easting 477440

Southeast side of Battlement Creek.
Unit: uKPCm2
Flora:

Araliaephyllum sp.
unidentifiable stem impressions

Comment: Only half of a leaf is present, but enough to recognize this leaf form. This represents a morphological type that appears first in mid to late Albian, and becomes important in the Cenomanian.

General comments on lots C150216 and C-150217:

Araliaephyllum sp. and *Cladophlebis alberta* occur in mid-Cretaceous strata of the middle latitudes and have been reported from the Kingsvale Group by Bell (1956). Since the few specimens available are not well preserved, it is not possible to assign an age with any great degree of confindence. However, they are consistent with an Albian/Cenomanian age, which has been suggested for sedimentary beds of the Kingsvale Group. Note that Bell indicated an Albian age for the plant-bearing beds, but that it is my opinion that the flora cannot be used to exclude a Cenomanian age.

Reference: written report by J.F. Basinger, Jan. 22, 1988.

APPENDIX 6

Palynomorph Identifications

By A.R. Sweet
Paleontology Subdivision
Institute of Sedimentary and Petroleum Geology,
Geological Survey of Canada,
Calgary, Alberta.

Silverquick Formation

Report on four samples from a partial section beginning 2.5 km south-southeast of Eldorado Mountain (88JIG-21-1) and extending (upsection) 0.7 km to the east (88JIG-21-8).

Field No. 88JIG-21-1 GSC Loc. No. C-171084
NTS 92O/02 Northing 5650000 Easting 513070
2.5 km south-southeast of Eldorado Mountain.
Unit: luKSQ
Selected flora:
Acanthotriletes sp. (a-116.3x7.2, 116.0x12.4, 118.8x4.2; b-113.3x11.6)
Biretisporites sp. (a-120.2x18.4)
Classopollis sp. (b-129.5x13.6)
Cyathidites sp. (abundant; a-113.0x10.9)
Cycadopites sp. (rare; b-107.4x21.0)
Distaltriangulisporites sp. (rare; a-130.2x11.7; 117.3x19.3)
Eucommiidites minor Groot and Penny, 1960 (a-116.0x7.7)
Gleicheniidites sp. (common; a-113.2x11.2; b-110.6x18.0)
Laevigatosporites sp. (common; a-113.0x10.9, 125.8x20.2)
Lycopodiumsporites sp. (a-119.9x18.4)
Stereisporites sp. (a-127.4x13.3)
tricolpate pollen (?a-117.6x20.3, 126.5x12.3)
Vitreisporites sp. (a-142.8x5.8)
Comments: Recovery good; preservation poor; sample highly carbonized; the abundant exinite is black to translucent white; modern contamination abundant.

Field No. 88JIG-21-3 GSC Loc. No. C-171086
NTS 92O/02 Northing 5650000 Easting 513450
2.75 km south-southeast of Eldorado Mountain.
Unit: luKSQ
Selected flora:
Classopollis sp. (abundant; c-11.4x4.4, 123.2x7.3, 124.6x9.3)
Cyathidites sp. (common; c-119.9x18.6)
fungal spores (scarce; b-134.4x17.3)
Eucommiidites minor Groot and Penny, 1960 (c-115.8x16.3)
Klukisporites sp. (c-114.1x13.4)
Vitreisporites pallidus (Reissinger) Nilsson, 1958 (c-114.1x10.2)
Comments: Recovery and preservation poor; fusinite abundant; degree of carbonization is high.

Field No. 88JIG-21-7 GSC Loc. No. C-171090
NTS 92O/02 Northing 5650030 Easting 513640
2.95 km south-southeast of Eldorado Mountain.
Unit: luKSQ
Selected flora:
Classopollis sp. (scarce; c-109.4x9.7, 112.9x18.3)
Cyathidites sp. (abundant; c-109.4x14.0)
Laevigatosporites sp. (b-123.3x13.3; c-116.8x4.2, 120.1x13.7, 132.4x10.2)
Comments: Recovery and preservation poor; fusinite abundant; degree of carbonization high

Field No. 88JIG-21-8 GSC Loc. No. C-171091
NTS 92O/02 Northing 5650100 Easting 513750
3.05 km south-southeast of Eldorado Mountain.
Unit: luKSQ
Selected flora:
Cicatricosisporites sp. (?b-115.2x17.6)
Concentricystes sp. (rare; a-114.6x7.3)
fungi (b-119.8x5.6)
Vitreisporites pallidus (Reissinger) Nilsson, 1958) (rare; b-114.2x11.2)
Comments: Recovery and preservation poor; fusinite abundant; degree of carbonization high

Age: The most probable age for section 88JIG-21 is an unrefined middle Cretaceous. Unfortunately none of the species listed above differentiate between an Albian and a Cenomanian or somewhat younger age. Indeed it is only on the basis of two questionable specimens of tricolpate pollen in sample C-171084 that one is able to restrict the age from a more general Early to mid Cretaceous age.
Reference: Report AS-88-09

Powell Creek Formation

Field No. 86PS-13-6-2 GSC Loc. No. C-150212
NTS 92O/03 Northing 5663769 Easting 471327
Lower Powell Creek.
Unit: uKPCm2
Palynoflora:
Cicatricosisporites sp. (b-124.2x13.4)
Cyathidites sp. (b-139.7x20.1)
fungal spores (b-133.0x15.1)
Gleicheniidites sp. (a-124.6x14.3)
Osmundacidites sp. (b-132.7x18.0)
Comments: Recovery sparse, preservation poor. Organic residue moderately carbonized.
Age: Cretaceous or younger. Most probably Cretaceous.
Reference: Report AS-1987-07

APPENDIX 7

Ar-Ar Radiometric Dates

By D.A. Archibald
Department of Geological Sciences
Queen's University
Kingston, Ontario

$^{40}Ar/^{39}Ar$ ANALYTICAL METHODS

Mineral separates were prepared using a Frantz magnetic separator, heavy organic liquids and, where appropriate, by hand-picking.

Samples and four to six flux monitors (standards) were irradiated with fast neutrons in position 5C of the McMaster Nuclear Reactor (Hamilton, Ontario) for either 25 or 30 hours. The monitors were distributed throughout the irradiation container, and J-values for individual samples were determined by interpolation.

Both step-heating experiments and analysis of the monitors were done in a quartz tube heated using a Lindberg furnace. The bakeable, ultra-high vacuum, stainless-steel argon extraction system is operated on-line to a substantially modified A.E.I. MS-10 mass-spectrometer run in the static mode. Total-fusion analyses were done using a custom, five-position turret system and resistively-heated, tantalum-tube crucibles. Measured mass spectrometric ratios were extrapolated to zero-time, corrected to an $^{40}Ar/^{36}Ar$ atmospheric ratio of 295.5, and corrected for neutron induced ^{40}Ar from potassium, and ^{39}Ar and ^{36}Ar from calcium. Ages and errors were calculated using formulae given by Dalrymple *et al.* (1981) and the constants recommended by Steiger and Jäger (1977). The errors represent the analytical precision at 2-sigma assuming that the error in J-value is zero.

PRESENTATION OF THE DATA

Presented in this appendix are isotopic data for 18 $^{40}Ar/^{39}Ar$ total-fusion determinations on 15 samples, and 31 step-heating experiments on 30 samples, including 3 which also have total fusion dates. The locations of the samples are plotted in Figure 49. Total fusion data is presented in Table 2 and the step-heating data are presented as individual data tables and age spectra in the following section. The final section summarizes the dates and geological context of each dated sample.

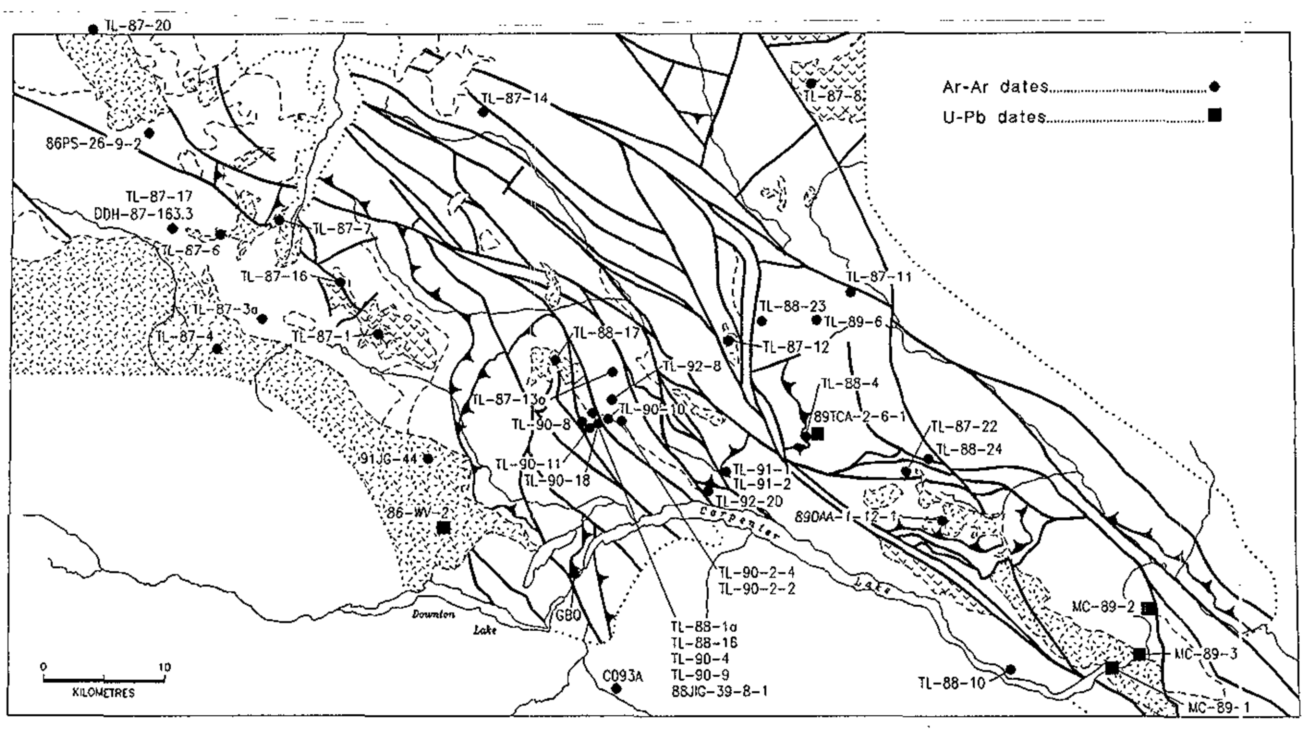


Figure 49. Ar-Ar and U-Pb isotopic date locations, Taseko - Bridge river map area.

TABLE 2
$^{40}Ar/^{39}Ar$ TOTAL FUSION DATA

Sample No.	Mineral	$^{40}Ar/^{39}Ar$	$^{36}Ar/^{39}Ar$	$^{37}Ar/^{39}Ar$	Vol. ^{39}ArK $x10^{-7}$ cm^3NTP	% ^{40}Ar rad	Date ±2σ Ma
TL-87-1	Hb	7.4950	0.0087	6.1320	0.1645	71.5	57.2 ±1.4
TL-87-3a	Ser	7.8370	0.0014	0.0080	1.2146	94.4	78.1 ±0.6
TL-87-4	Hb	11.3620	0.0144	8.6470	0.2080	68.1	82.1 ±2.0
TL-87-4	Bi	8.6060	0.0061	0.0460	1.7620	78.8	71.8 ±0.6
TL-87-6	Hb	12.1500	0.0239	13.0800	0.1080	49.8	64.7 ±2.1
TL-87-7	Bi	5.5040	0.0048	0.0270	1.7910	74.2	43.5 ±0.3
TL-87-8	Hb	7.6710	0.0108	7.2450	0.1547	65.3	53.5 ±0.3
TL-87-8	Bi	6.5770	0.0072	0.2350	1.0650	67.7	47.4 ±0.5
TL-87-11	Hb	15.6900	0.0320	11.6900	0.0926	45.2	75.6 ±2.8
TL-87-12	Ser	3.2790	0.0024	0.0130	2.9810	77.9	27.3 ±0.2
TL-87-13a	Maf.	21.9700	0.0067	127.1000	0.0204	52.6	131.0 ±7.4
TL-87-14	A.P.	9.0620	0.0095	2.1390	0.2680	70.3	67.6 ±0.6
TL-87-16	Hb	10.4120	0.0274	12.3400	0.1460	30.9	34.7 ±1.9
TL-87-17	Maf.	56.9100	0.1841	140.6000	0.0144	22.9	148.8 ±14.1
TL-87-17	F.P.	10.4350	0.0121	6.3550	0.2020	70.2	77.6 ±1.5
TL-87-17	W.R.	6.8420	0.0059	0.5810	0.9887	74.6	54.4 ±0.3
TL-87-20	Bi	5.3560	0.0042	0.0710	1.2250	76.8	43.9 ±0.6
DH-87-163.3	Aln	8.2440	0.0042	0.0110	6.1280	84.6	73.7 ±0.5

Abbreviations: Maf. = mafic concentrate obtained by heavy liquids and Frantz magnetic separator; F.P. = fresh plagioclase; A.P. = altered (sericitized) plagioclase; W.R. = whole-rock; Ser = sericite ± quartz; Aln = alunite, nearly pure; Bi = biotite separate; Hb = hornblende separate.

True ratios corrected for fractionation and discrimination ($^{40}Ar/^{36}Ar$ atmos.=295.5)
Ratios are not corrected for system blank, Ar, but:
Vol. of blank ^{40}Ar is $1x10^{-8}$ cc STP for 500°C<T<1050°C and $2.2x10^{-8}$ cc STP for T=500°C and T>1050°C.
Vol. of blank ^{36}Ar is $3x10^{-12}$ cc STP for 500°C<T<1050°C and $7.4x10^{-12}$ cc STP for T=500°C and T>1050°C.

$^{37}Ar/^{39}Ar$ is corrected for the decay of 37Ar during and after irradiation (λ137=1.975x10-2 days-1).

Volume of ^{39}Ar determined using the equilibration peak height and mass spectrometer sensitivity.

Isotope production ratios for the McMaster Reactor (Masliwec, 1981):
(40/39)K=0.0156
(36/39)Ca=0.390169
(37/39)Ca=1536.1

Ages calculated using the constants recommended by Steiger and Jäger (1977). Errors represent the analytical precision only (*i.e.* error in J-values=0). Flux monitor used: DA-83-48-BB biotite (97.5 Ma) referenced to mmHb-1 hornblende and LP-6 biotite.

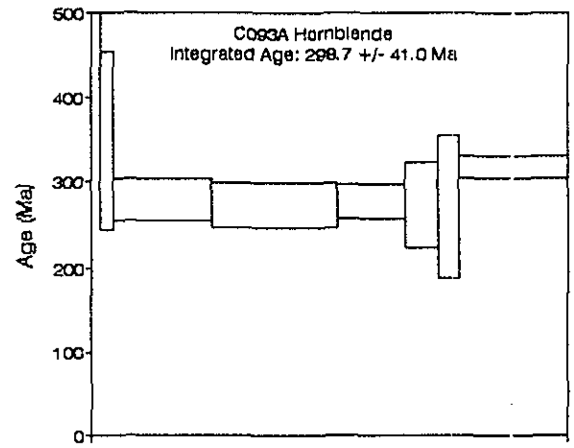
STEP HEATING DATA

C093A Hornblende

Run: D-603
Date: June 27, 1988

Mass: 250 mg
J Value: 0.00849

Total 39Ar: 6.999 E-9 cm3 NTP
Approx. 0.47% K
Integrated Age: 298.7 +/- 41.0 Ma
Plateau Age: 275.5 +/- 29.8 Ma (72.5% of Ar39, steps marked by *)



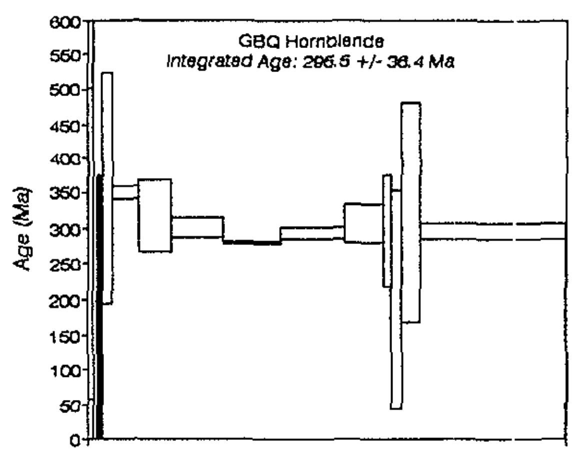
	Temp C	40/39	36/39	37/39	Vol 39Ar E-9 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	560	629.10	1.9670	0.9	0.103	0.015	7.6	614	+/-	750
	650	268.60	0.7580	984.0	0.023	0.003	33.5	1466	+/-	542
	750	382.00	1.3510	2833.0	0.014	0.002	15.1	1574	+/-	354
	840	69.01	0.1650	163.2	0.192	0.027	38.0	348	+/-	104
*	900	25.41	0.0419	147.0	1.453	0.208	73.8	279	+/-	24
*	925	23.46	0.0337	69.6	1.846	0.264	78.8	273	+/-	26
*	960	22.99	0.0298	64.3	0.985	0.141	81.8	277	+/-	20
*	975	24.08	0.0361	71.1	0.489	0.070	76.8	274	+/-	49
*	1020	27.45	0.0480	70.9	0.298	0.043	66.8	272	+/-	83
	1200	23.96	0.0389	122.9	1.596	0.228	87.8	318	+/-	13

GBQ Hornblende

Run: D-632
Date: December 8, 1989

Mass: 360 mg
J Value: 0.00701

Total 39Ar: 119.898 E-10 cm3 NTP
Approx. 6.7% K
Integrated Age: 295.5 +/- 36.4 Ma
Plateau Age: 279.0 +/- 2.0 Ma (12.1% of Ar39, steps marked by *)

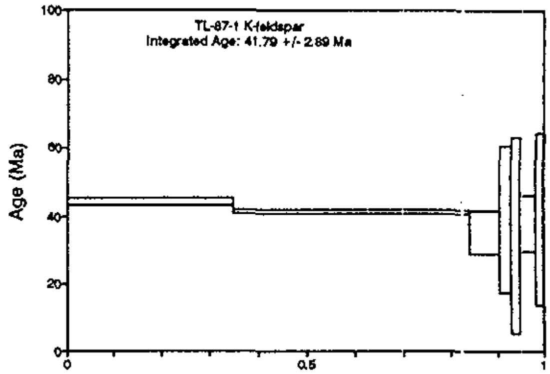


	Temp C	40/39	36/39	37/39	Vol 39Ar E-10 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	600	132.530	0.3845	56.800	1.407	0.012	17.36	279.0	+/-	222.0
	700	231.260	0.7498	61.470	0.557	0.006	6.10	176.0	+/-	514.0
	775	238.830	0.7632	71.040	0.439	0.004	7.70	228.0	+/-	852.0
	845	130.070	0.4224	56.890	0.606	0.006	7.20	119.0	+/-	267.0
	875	68.220	0.2324	75.030	0.966	0.008	7.30	65.0	+/-	176.0
	900	46.160	0.0723	72.240	2.168	0.018	64.90	358.0	+/-	164.0
	920	35.150	0.0344	59.020	6.892	0.057	83.21	348.0	+/-	9.0
	940	31.920	0.0318	54.400	7.920	0.066	82.83	317.0	+/-	60.0
	960	31.370	0.0337	51.000	13.089	0.109	80.04	301.0	+/-	13.0
*	980	31.730	0.0414	50.030	14.461	0.121	72.84	279.0	+/-	2.0
	1000	30.640	0.0316	44.850	16.106	0.134	80.17	294.0	+/-	8.0
	1020	36.720	0.0436	38.670	9.788	0.082	71.91	306.0	+/-	27.0
	1040	50.560	0.0951	34.200	1.695	0.014	49.35	296.0	+/-	78.0
	1070	77.920	0.2007	36.560	2.840	0.024	22.33	199.0	+/-	154.0
	1100	60.070	0.1202	39.600	4.358	0.036	45.66	325.0	+/-	156.0
	1200	27.590	0.0192	38.940	36.584	0.305	89.73	296.0	+/-	11.0

TL-87-1 K-feldspar

Run: D-698 C34/P21 Mass: 54 mg
Date: Oct. 4, 1991 J Value: 0.005982

Total 39Ar: 3.910 E-8 cm3 NTP Approx. 1.7% K
Integrated Age: 41.79 +/- 2.89 Ma
Plateau Age: 36.83 +/- 14.10 Ma (15.9% of 39Ar, steps marked by *)
44.44 +/- 1.05 Ma (34.8% of Ar39, steps marked by -)

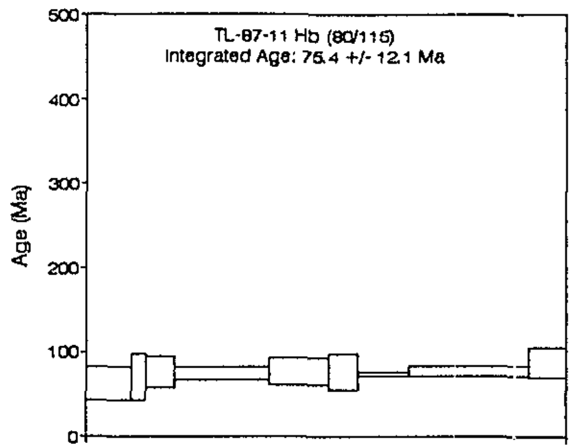


	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
-	500	7.061	0.0097	0.000	1.362	0.348	59.04	44.44	+/-	1.05
	650	4.320	0.0014	0.000	1.927	0.493	90.05	41.51	+/-	0.59
*	750	5.370	0.0068	0.000	0.252	0.064	61.90	35.52	+/-	6.43
*	850	10.096	0.0217	0.000	0.096	0.025	36.18	39.00	+/-	21.55
*	950	12.360	0.0309	0.000	0.077	0.020	25.96	34.30	+/-	28.96
*	1050	8.697	0.0173	0.000	0.127	0.032	41.04	38 11	+/-	8.45
*	1200	32.736	0.0983	0.000	0.069	0.018	11.18	39.08	+/-	25.44

TL-87-11 Hb (80/115)

Run: D-626 Mass: 200 mg
Date: July 8, 1989 J Value: 0.00718

Total 39Ar: 29.166 E-9 cm3 NTP Approx. 2.9% K
Integrated Age: 75.4 +/- 12.1 Ma
Plateau Age: 76.5 +/- 9.6 Ma (53.6% of Ar39, steps marked by *)

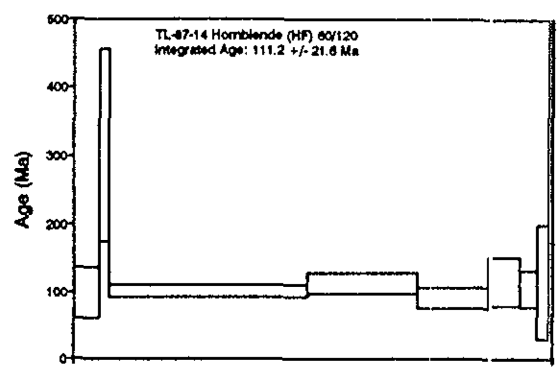


	Temp C	40/39	36/39	37/39	Vol 39Ar E-9 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	725	52.752	0.1630	4.401	2.853	0.098	9.27	62.4	+/-	20.1
	825	19.175	0.0494	12.066	0.843	0.029	28.58	70.2	+/-	26.8
	925	18.164	0.0433	8.749	1.751	0.060	33.04	76.5	+/-	18.8
	975	7.548	0.0089	12.086	5.759	0.197	77.12	74.4	+/-	8.2
*	1000	8.640	0.0116	11.837	3.656	0.125	69.98	76.4	+/-	15.8
*	1025	11.485	0.0216	11.346	1.691	0.058	51.72	75.9	+/-	20.6
*	1050	10.654	0.0197	12.528	3.067	0.105	53.83	73.4	+/-	2.8
*	1100	8.585	0.0116	12.921	7.233	0.248	71.10	78.0	+/-	6.8
	1200	11.424	0.0182	11.156	2.313	0.079	60.11	87.5	+/-	17.8

TL-87-14 Hornblende (HF) 60/120

Run: D-663 C76/P42 Mass: 439 mg
Date: Jan. 5 1991 J Value: 0.0069

Total 39Ar: 1.449 E-8 cm3 NTP Approx. 0.068% K
Integrated Ag 111.2 +/- 21.6 Ma
Plateau Age: 104.5 +/- 16.6 Ma (91.7% of Ar39, steps marked by *)

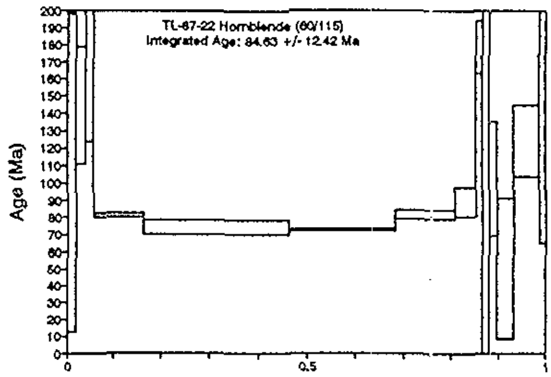


	Temp C	40/39	36/39	37/39	Vol 39A E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	118.213	0.4126	164.150	0.079	0.054	8.26	96.8	+/-	38.4
	650	21.090	-0.0219	3.401	0.030	0.021	131.60	315.8	+/-	140.0
*	750	14.029	0.0193	2.089	0.596	0.413	80.23	101.9	+/-	9.3
*	850	27.348	0.0641	13.260	0.333	0.230	34.23	113.4	+/-	15.6
*	920	21.993	0.0525	13.730	0.215	0.149	33.98	91.1	+/-	15.6
*	970	39.396	0.1079	27.440	0.095	0.065	24.11	118.0	+/-	36.2
*	1010	62.570	0.1927	39.880	0.052	0.036	13.60	106.0	+/-	27.4
*	1050	77.070	0.2341	20.315	0.036	0.025	12.14	113.8	+/-	85.0
	1100	220.773	0.6213	6.459	0.011	0.008	17.05	416.3	+/-	175.0
	1200	**********								

TL-87-22 Hornblende (60/115)

Run: D-574 C34/P16 Mass: 250 mg
Date: April 11, 1988 J Value: 0.005982

Total 39Ar: *1.395 E-8 cm3 NTP* *Approx. 0.13% K*
Integrated Age: 84.63 +/- 12.42 Ma
Plateau Age: 73.46 +/- 2.57 Ma (51.9% of 39Ar, steps marked by *)

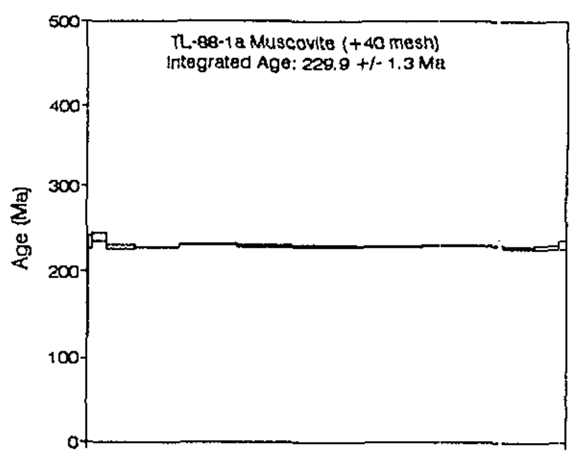


	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	550	177.290	0.5691	13.225	0.026	0.018	5.69	105.30	+/-	92.90
	650	30.846	0.0605	14.051	0.028	0.020	45.42	144.50	+/-	34.10
	750	38.028	0.0731	5.581	0.021	0.015	44.26	171.30	+/-	47.50
	830	10.616	0.0124	10.875	0.150	0.107	72.96	81.10	+/-	1.40
*	890	9.007	0.0097	12.760	0.416	0.298	78.36	74.10	+/-	4.10
*	920	9.042	0.0102	11.934	0.308	0.221	76.48	72.60	+/-	0.50
	940	9.677	0.0093	11.803	0.176	0.126	80.33	81.40	+/-	2.70
	960	16.391	0.0303	14.529	0.063	0.045	51.92	89.00	+/-	8.50
	980	35.188	0.0635	20.607	0.020	0.015	49.49	178.50	+/-	15.40
	1005	48.282	0.1363	24.281	0.019	0.014	16.83	81.60	+/-	185.90
	1025	42.277	0.1165	48.723	0.025	0.018	22.99	102.20	+/-	33.00
	1055	27.969	0.0839	20.296	0.049	0.035	16.63	49.60	+/-	41.30
	1100	27.792	0.0582	17.726	0.076	0.054	42.79	123.90	+/-	20.60
	1200	81.121	0.2281	16.673	0.019	0.014	18.43	153.80	+/-	88.80

TL-88-1a Muscovite (+40 mesh)

Run: D-636 Mass: 100 mg
Date: May 17, 1990 J Value: 0.00689

Total 39Ar: 35.163 E-8 cm3 NTP Approx. 7.2% K
Integrated Age: 229.9 +/- 1.3 Ma
Plateau Age: 229.8 +/- 1.0 Ma (94.0% of Ar39, steps marked by *)



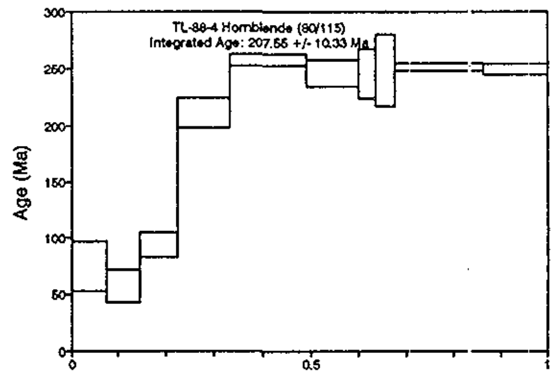
	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	38.243	0.0846	0.692	0.156	0.004	34.81	158.3	+/-	33.4
	575	27.209	0.0254	4.707	0.326	0.009	73.71	234.1	+/-	7.3
	675	22.104	0.0050	0.919	1.061	0.030	93.56	240.4	+/-	4.3
*	725	20.909	0.0043	0.130	2.056	0.059	93.96	229.0	+/-	2.5
*	775	20.631	0.0034	0.017	3.294	0.094	96.00	228.5	+/-	0.4
*	800	20.440	0.0018	0.009	4.310	0.123	97.36	231.8	+/-	0.7
*	825	20.364	0.0022	0.015	8.643	0.246	96.78	229.6	+/-	0.8
*	850	20.497	0.0027	0.014	4.832	0.137	96.07	229.5	+/-	0.8
*	875	20.609	0.0025	0.006	5.920	0.168	96.37	230.3	+/-	0.8
*	900	20.236	0.0021	0.015	2.220	0.063	96.88	228.5	+/-	1.3
*	1000	20.507	0.0027	0.028	1.796	0.061	96.11	229.7	+/-	2.4
	1200	21.908	0.0066	0.250	0.560	0.016	91.18	232.6	+/-	5.0

TL-88-4 Hornblende (80/115)

Run: D-678 C79/P28 Mass: 300 mg
Date: Sept. 1, 1991 J Value: 0.005015

Total 39Ar: 1.296 E-8 cm3 NTP Approx. 0.12% K
Integrated Age: 207.55 +/- 10.33 Ma
Plateau Age: 251.11 +/- 8.13 Ma (66.8% of 39Ar, steps marked by *)

	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	700	39.315	0.1097	19.226	0.096	0.074	21.11	74.47	+/-	21.96
	800	21.395	0.0549	16.429	0.093	0.071	29.77	57.33	+/-	14.16
	875	20.539	0.0387	19.460	0.102	0.079	51.19	93.84	+/-	10.90
	925	36.466	0.0478	27.942	0.140	0.108	66.81	211.53	+/-	13.03
*	975	37.285	0.0318	29.175	0.204	0.157	80.52	257.49	+/-	5.09
*	1005	37.615	0.0369	26.951	0.144	0.111	76.22	246.33	+/-	11.71
*	1035	49.597	0.0789	31.282	0.044	0.034	57.56	245.98	+/-	21.83
*	1065	45.927	0.0657	32.219	0.054	0.042	62.79	248.46	+/-	31.49
*	1100	35.134	0.0273	29.899	0.243	0.187	83.25	251.42	+/-	3.42
*	1200	37.389	0.0361	30.899	0.177	0.136	77.47	249.30	+/-	4.65

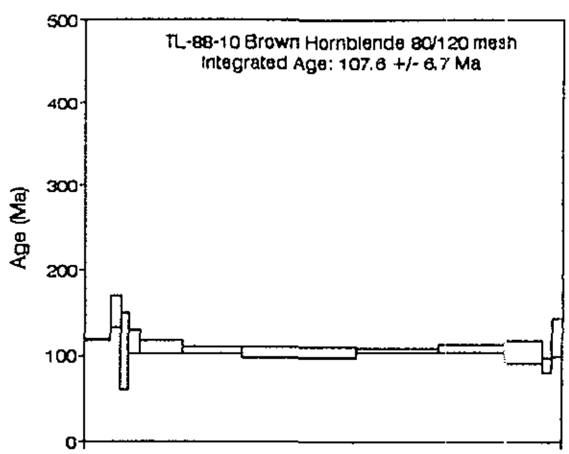


TL-88-10 Brown Hornblende 80/120 mesh

Run: D-633 Mass: 200 mg
Date: December 19, 1989 J Value: 0.007

Total 39Ar: 3.565 E-8 cm3 NTP Approx. 0.36% K
Integrated Age: 107.6 +/- 6.7 Ma
Plateau Age: 105.2 +/- 5.7 Ma (79.3% of Ar39, steps marked by *)

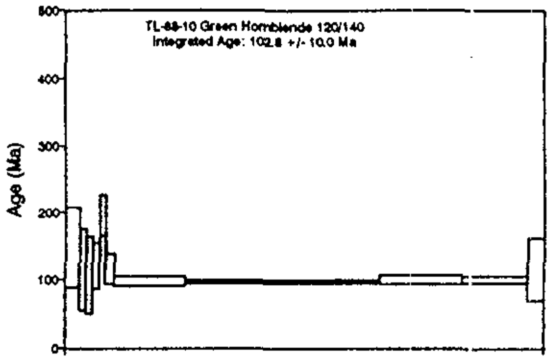
	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	825	26.987	0.0582	11.421	0.2009	0.056	37.00	118.4	+/-	1.1
	900	20.062	0.0337	28.618	0.0803	0.023	60.87	150.6	+/-	18.4
	925	19.529	0.0417	16.726	0.0563	0.016	43.20	104.6	+/-	43.9
	960	14.652	0.0210	13.807	0.0798	0.022	64.25	115.4	+/-	13.8
	980	10.346	0.0080	12.278	0.3226	0.090	86.97	109.8	+/-	7.7
*	1010	9.735	0.0067	11.043	0.4535	0.127	87.83	105.6	+/-	4.7
*	1040	9.672	0.0067	9.207	0.8371	0.236	86.52	103.3	+/-	6.2
*	1070	10.260	0.0080	9.627	0.6117	0.172	83.62	106.9	+/-	1.7
*	1100	11.189	0.0107	9.633	0.6013	0.141	77.99	107.6	+/-	4.4
*	1130	13.090	0.0179	9.299	0.2760	0.077	64.68	104.5	+/-	12.6
*	1160	21.174	0.0497	9.066	0.0760	0.021	33.82	88.8	+/-	8.1
*	1200	22.816	0.0461	9.699	0.0702	0.020	43.36	121.5	+/-	22.1



TL-88-10 Green Hornblende 120/140

Run: D-658 C76/P44 Mass: 250 mg
Date: Dec. 29/90 J Value: 0.0069

Total 39Ar: 3.593 E-8 cm3 NTP Approx. 0.30% K
Integrated Ag 102.8 +/- 10.0 Ma
Plateau Age: 98.5 +/- 4.4 Ma (86.1% of Ar39, steps marked by *)

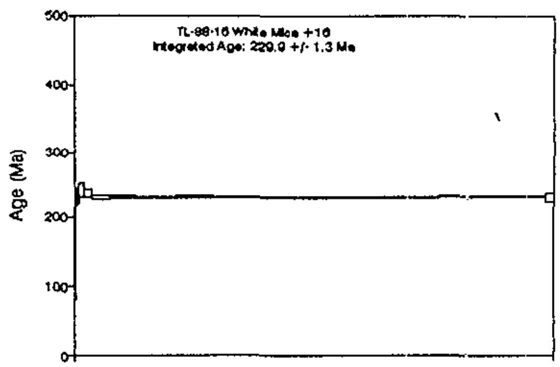


Temp C	40/39	36/39	37/39	Vol 39A E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
700	60.232	0.1642	10.064	0.109	0.030	20.62	148.3	+/-	59.0
800	23.940	0.0492	3.526	0.050	0.014	40.26	115.7	+/-	60.0
900	19.685	0.0414	19.552	0.051	0.014	45.03	107.7	+/-	56.0
950	20.859	0.0465	38.275	0.058	0.016	47.43	121.2	+/-	34.0
980	22.795	0.0271	22.470	0.038	0.011	72.04	195.1	+/-	30.0
1010	18.006	0.0254	14.909	0.072	0.020	59.95	116.0	+/-	22.0
* 1040	10.074	0.0099	12.482	0.539	0.150	79.92	97.6	+/-	7.0
* 1070	9.435	0.0072	10.107	1.446	0.402	85.19	97.3	+/-	2.5
* 1100	9.980	0.0080	9.630	0.620	0.173	83.15	100.4	+/-	6.1
* 1130	10.380	0.0092	9.339	0.490	0.136	80.20	100.7	+/-	4.8
1200	15.481	0.0220	9.395	0.121	0.034	62.44	116.4	+/-	46.0

TL-88-16 White Mica +16

Run: D-661 78/52 Mass: 113 mg
Date: January 2, 1991 J Value: 0.00598

Total 39Ar: 29.348 E-8 cm3 NTP Approx. 6.1% K
Integrated Age: 229.9 +/- 1.3 Ma
Plateau Age: 230.1 +/- 1.0 Ma (96.2% of Ar39, steps marked by *)



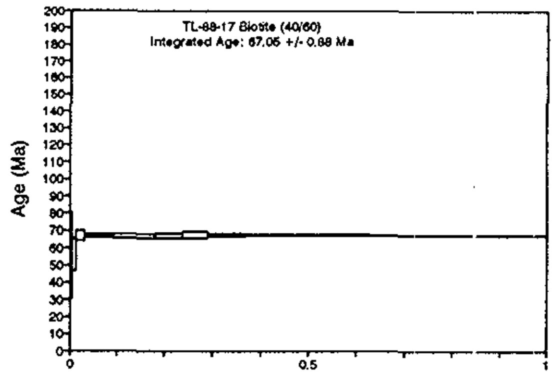
Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
525	43.784	0.1131	1.286	0.089	0.003	23.63	109.2	+/-	28.6
625	26.898	0.0141	1.994	0.232	0.008	84.96	231.2	+/-	12.1
675	26.033	0.0077	1.085	0.266	0.009	91.43	240.0	+/-	10.4
725	24.630	0.0044	0.253	0.536	0.018	94.65	235.3	+/-	5.0
* 775	23.359	0.0021	0.026	1.105	0.038	97.21	229.5	+/-	3.3
* 800	23.153	0.0012	0.000	1.577	0.054	98.37	230.2	+/-	1.3
* 820	23.026	0.0008	0.002	2.456	0.084	98.79	229.9	+/-	1.1
* 840	23.007	0.0007	0.002	2.334	0.080	98.96	230.1	+/-	1.8
* 865	22.946	0.0006	0.006	4.265	0.145	99.12	229.9	+/-	0.7
* 890	23.032	0.0010	0.003	3.594	0.122	98.64	229.4	+/-	0.8
* 940	22.935	0.0006	0.000	5.890	0.201	99.10	229.7	+/-	0.7
* 990	23.029	0.0004	0.001	6.478	0.221	99.34	231.1	+/-	0.4
* 1200	23.499	0.0026	0.066	0.528	0.018	96.66	229.6	+/-	6.9

TL-88-17 Biotite (40/60)

Run: D-670 C79/P25 Mass: 100 mg
Date: July 1, 1991 J Value: 0.00501

Total 39Ar: 27.263 E-8 cm3 NTP Approx. 7.7% K
Integrated Age: 67.05 +/- 0.88 Ma
Plateau Age: 67.21 +/- 0.69 Ma (98.7% of 39Ar, steps marked by *)

	Temp C	40/39	36/39	37/39	Vol 39A E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	40.742	0.1168	0.276	0.116	0.004	15.23	55.24	+/-	25.16
	570	23.347	0.0577	0.058	0.250	0.009	28.90	55.89	+/-	9.32
*	620	14.301	0.0227	0.034	0.472	0.017	52.84	67.04	+/-	2.82
*	670	9.547	0.0067	0.007	1.614	0.059	78.99	66.91	+/-	0.86
*	720	8.106	0.0018	0.010	2.454	0.090	93.00	66.88	+/-	1.19
*	770	8.053	0.0016	0.009	1.578	0.058	93.71	66.95	+/-	1.29
*	820	7.989	0.0012	0.013	1.405	0.052	95.37	67.58	+/-	1.99
*	900	8.092	0.0016	0.087	2.136	0.078	94.00	67.48	+/-	1.04
*	1000	7.890	0.0009	0.067	7.069	0.259	96.43	67.49	+/-	0.44
*	1200	7.868	0.0010	0.049	10.169	0.373	96.09	67.08	+/-	0.29

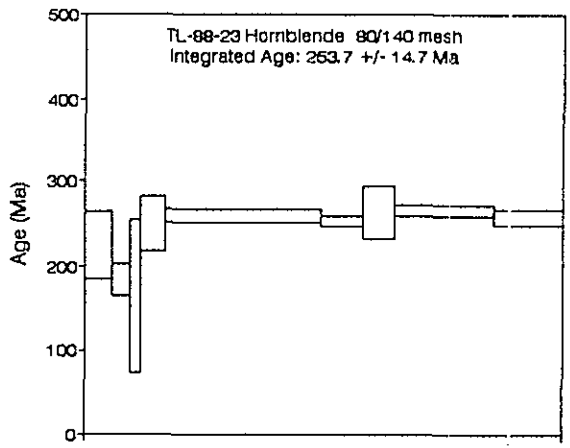


TL-88-23 Hornblende 80/140 mesh

Run: D-635 Mass: 200 mg
Date: May 16, 1990 J Value: 0.007

Total 39Ar: 1.491 E-8 cm3 NTP Approx. 0.15% K
Integrated Age: 253.7 +/- 14.7 Ma
Plateau Age: 260.8 +/- 10.7 Ma (88.1% of Ar39, steps marked by *)

	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	* Age Ma	+/-	Error 2 sigma
	700	100.838	0.2808	12.947	0.0897	0.060	18.65	224.8	+/-	40.4
	800	34.480	0.0682	11.829	0.0624	0.036	44.03	183.6	+/-	19.8
	870	41.565	0.0981	13.367	0.0349	0.023	32.59	164.7	+/-	91.0
*	940	35.333	0.0556	26.631	0.0780	0.052	59.03	249.8	+/-	32.0
*	1000	27.030	0.0246	28.050	0.4842	0.326	80.68	260.6	+/-	8.1
*	1040	31.048	0.0391	24.846	0.1333	0.089	68.64	254.7	+/-	6.8
*	1070	35.363	0.0612	26.984	0.0966	0.064	62.59	263.9	+/-	30.1
*	1100	28.684	0.0285	28.741	0.3090	0.207	77.96	266.9	+/-	6.3
*	1200	29.893	0.0348	28.069	0.2144	0.144	72.44	259.0	+/-	8.8

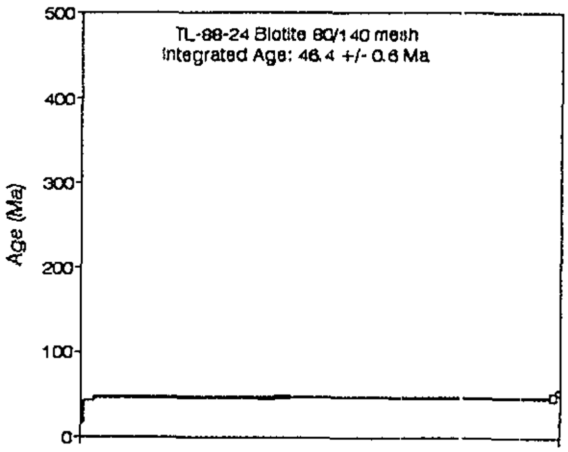


TL-88-24 Biotite 80/140 mesh

Run: D-637 — Mass: 185 mg
Date: May 25, 1990 — J Value: 0.007

Total 39Ar: 62.105 E-8 cm3 NTP — Approx. 6.8% K
Integrated Age: 46.4 +/- 0.6 Ma
Plateau Age: 46.6 +/- 0.5 Ma (96.3% of Ar39, steps marked by *)

	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	22.217	0.0697	0.156	0.623	0.008	7.26	20.27	+/-	3.82
	540	6.845	0.0116	0.118	1.263	0.020	50.06	42.76	+/-	0.77
*	580	4.789	0.0037	0.083	3.698	0.058	76.98	45.96	+/-	0.64
*	625	4.196	0.0015	0.023	7.742	0.126	89.39	46.75	+/-	0.35
*	670	4.079	0.0012	0.001	6.764	0.109	90.99	46.28	+/-	0.26
*	710	4.299	0.0019	0.000	3.360	0.054	86.68	46.46	+/-	0.72
*	760	4.662	0.0034	0.000	2.001	0.032	77.89	46.29	+/-	1.30
*	810	4.594	0.0027	0.000	2.127	0.034	82.18	47.06	+/-	1.53
*	860	4.221	0.0014	0.000	3.819	0.061	89.65	47.17	+/-	0.51
*	910	4.011	0.0008	0.000	9.026	0.146	93.82	46.91	+/-	0.36
*	960	3.959	0.0007	0.000	11.216	0.181	94.38	46.58	+/-	0.31
*	1010	4.073	0.0011	0.010	9.331	0.150	91.95	46.69	+/-	0.42
*	1060	6.298	0.0050	0.341	0.809	0.013	72.40	47.82	+/-	4.55
	1200	7.299	0.0105	0.765	0.536	0.009	57.94	62.66	+/-	3.65

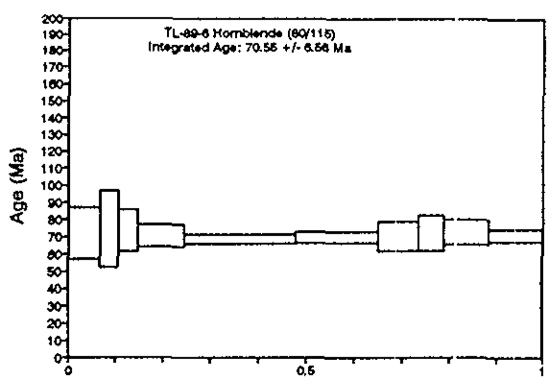


TL-89-6 Hornblende (80/115)

Run: D-669 C79/P30 — Mass: 250 mg
Date: June 30, 1991 — J Value: 0.005015

Total 39Ar: 2.795 E-8 cm3 NTP — Approx. 0.31% K
Integrated Age: 70.55 +/- 6.56 Ma
Plateau Age: 70.27 +/- 5.25 Ma (89.4% of 39Ar, steps marked by *)

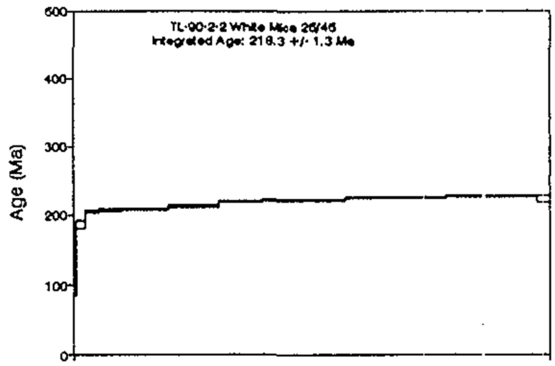
	Temp C	40/39	36/39	37/39	Vol 39A E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	700	36.523	0.0974	5.119	0.188	0.067	22.13	71.93	+/-	14.99
	800	20.648	0.0428	5.263	0.109	0.039	40.57	74.51	+/-	22.12
*	875	14.263	0.0246	16.421	0.112	0.040	57.43	73.39	+/-	12.01
*	925	12.391	0.0197	17.755	0.274	0.098	63.51	70.62	+/-	6.41
*	975	11.086	0.0151	14.126	0.654	0.234	68.91	68.44	+/-	2.72
*	1000	10.359	0.0119	12.930	0.479	0.171	74.98	69.50	+/-	3.10
*	1030	10.898	0.0136	13.619	0.239	0.085	72.24	70.47	+/-	8.43
*	1060	13.081	0.0214	17.552	0.145	0.052	61.33	71.97	+/-	10.45
*	1100	11.768	0.0161	15.411	0.269	0.096	69.13	72.86	+/-	7.48
*	1200	12.438	0.0194	16.154	0.326	0.117	63.36	70.65	+/-	3.66



TL-90-2-2 White Mica 25/45

Run: D-660 78/53 Mass: 111 mg
Date: January 1, 1991 J Value: 0.00598

Total 39Ar: 28.025 E-8 cm3 NTP Approx. 6.0% K
Integrated Age: 218.3 +/- 1.3 Ma
Plateau Age: 224.9 +/- 1.0 Ma (51.5% of Ar39, steps marked by *)

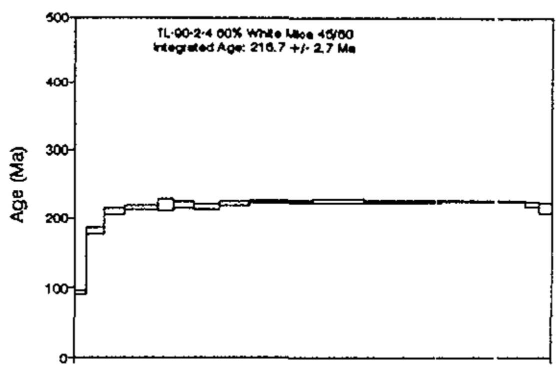


Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
525	23.217	0.0429	0.214	0.181	0.006	45.33	110.1	+/-	25.1
625	20.893	0.0093	0.906	0.535	0.019	87.07	186.3	+/-	5.4
675	21.849	0.0059	0.082	0.837	0.030	91.93	204.5	+/-	1.9
725	22.211	0.0069	0.055	1.324	0.047	92.02	207.9	+/-	1.8
775	22.041	0.0054	0.025	2.839	0.101	92.61	207.7	+/-	0.8
800	22.429	0.0047	0.019	2.964	0.106	93.68	213.4	+/-	1.1
820	22.790	0.0037	0.020	2.528	0.090	95.03	219.6	+/-	1.1
840	22.849	0.0032	0.027	2.377	0.085	95.74	221.7	+/-	1.0
* 860	22.742	0.0030	0.017	2.364	0.084	96.04	221.4	+/-	1.6
* 880	22.927	0.0026	0.024	2.544	0.091	96.70	224.6	+/-	1.0
* 910	22.799	0.0018	0.024	3.382	0.121	97.49	225.0	+/-	0.7
* 1010	22.879	0.0016	0.046	5.446	0.194	97.95	226.8	+/-	0.6
* 1200	23.634	0.0058	2.320	0.705	0.025	93.36	223.8	+/-	4.4

TL-90-2-4 60% White Mica 45/60

Run: D-662 78/54 Mass: 187 mg
Date: January 4, 1991 J Value: 0.00598

Total 39Ar: 17.962 E-8 cm3 NTP Approx. 2.3% K
Integrated Age: 216.7 +/- 2.7 Ma
Plateau Age: 223.9 +/- 1.8 Ma (66.5% of Ar39, steps marked by *)



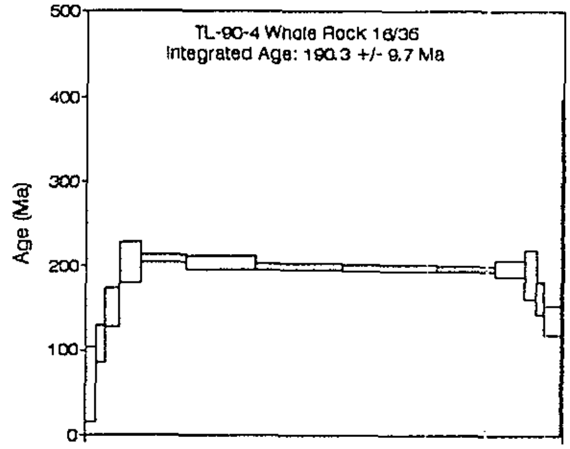
Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
525	17.159	0.0281	0.540	0.476	0.027	51.63	93.2	+/-	3.4
600	20.358	0.0091	1.293	0.684	0.038	87.13	182.1	+/-	3.7
675	21.766	0.0041	1.265	0.799	0.044	94.77	210.1	+/-	5.6
720	22.162	0.0031	0.316	1.233	0.069	95.90	216.0	+/-	3.2
745	22.434	0.0028	0.166	0.609	0.034	96.29	219.3	+/-	8.1
775	22.377	0.0025	0.088	0.784	0.044	96.59	219.4	+/-	3.9
805	22.211	0.0029	0.074	0.985	0.055	96.07	216.8	+/-	3.6
* 830	22.543	0.0026	0.050	1.097	0.061	96.62	221.0	+/-	2.5
* 860	22.659	0.0019	0.036	2.347	0.131	97.40	223.7	+/-	2.1
* 890	22.725	0.0016	0.033	1.920	0.107	97.78	225.2	+/-	2.6
* 920	22.439	0.0013	0.032	2.832	0.158	98.18	223.4	+/-	1.7
* 960	22.606	0.0012	0.063	3.196	0.178	98.30	226.2	+/-	0.8
* 1000	23.346	0.0053	0.422	0.556	0.031	93.30	221.0	+/-	3.2
1200	27.216	0.0219	5.243	0.443	0.025	77.60	215.3	+/-	7.5

TL-90-4 Whole Rock 16/35

Run: D-657
Date: December 27, 1990

Mass: 288 mg
J Value: 0.00599

Total 39Ar: 3.991 E-8 cm3 NTP
Approx. 0.33% K
Integrated Age: 190.3 +/- 9.7 Ma
Plateau Age: 197.2 +/- 4.3 Ma (56.3% of Ar39, steps marked by *)



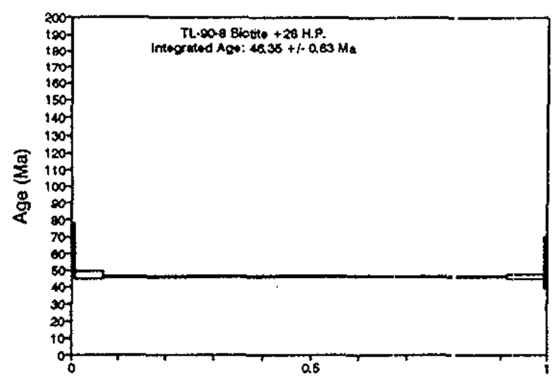
	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	33.120	0.0935	2.290	0.091	0.023	17.00	69.9	+/-	44.0
	550	27.633	0.0592	1.718	0.079	0.020	37.08	107.5	+/-	22.0
	600	24.436	0.0346	4.215	0.117	0.029	69.32	150.5	+/-	23.0
	650	30.578	0.0627	59.058	0.170	0.043	62.94	203.9	+/-	26.0
	700	22.137	0.0090	11.901	0.387	0.097	91.92	208.9	+/-	4.8
	750	20.582	0.0032	3.701	0.578	0.145	96.56	203.3	+/-	8.2
*	780	20.151	0.0030	1.884	0.713	0.179	96.09	198.1	+/-	4.2
*	810	19.981	0.0027	1.096	0.796	0.200	96.31	196.9	+/-	3.4
*	830	20.120	0.0033	1.154	0.487	0.122	96.38	196.3	+/-	3.2
*	850	20.180	0.0034	2.257	0.249	0.062	96.65	197.6	+/-	9.2
	875	20.956	0.0097	6.653	0.097	0.024	88.18	189.9	+/-	29.0
	900	21.798	0.0240	12.155	0.062	0.016	71.53	162.2	+/-	19.0
	1000	21.687	0.0364	26.403	0.146	0.037	69.26	136.0	+/-	18.0
	1200	133.250	0.4111	91.248	0.017	0.004	13.68	197.3	+/-	200.0

TL-90-8 Biotite +28 H.P.

Run: D-673 C79/P26
Date: July 6, 1991

Mass: 101 mg
J Value: 0.005014

Total 39Ar: 27.084 E-8 cm3 NTP
Approx. 7.5% K
Integrated Age: 46.35 +/- 0.63 Ma
Plateau Age: 46.14 +/- 0.50 Ma (98.8% of 39Ar, steps marked by *)

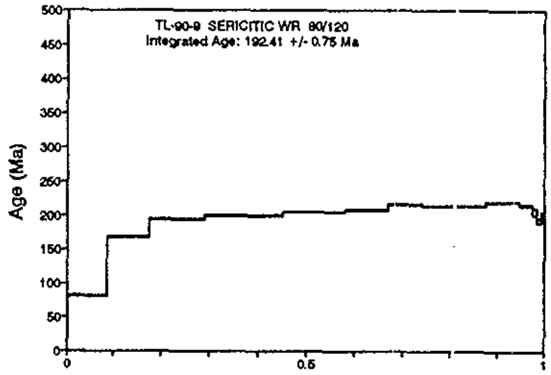


	Temp C	40/39	36/39	37/39	Vol 39A E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	550	41.216	0.1129	0.412	0.191	0.007	19.09	69.81	+/-	7.77
*	650	8.986	0.0126	0.127	1.584	0.058	58.45	46.90	+/-	2.08
*	750	5.549	0.0013	0.009	4.833	0.178	92.65	45.92	+/-	0.45
*	850	5.344	0.0005	0.006	4.109	0.152	96.56	46.08	+/-	0.35
*	950	5.417	0.0007	0.009	6.154	0.227	95.42	46.16	+/-	0.33
*	1025	5.326	0.0004	0.009	7.856	0.290	97.10	46.18	+/-	0.22
*	1100	5.425	0.0009	0.088	2.217	0.082	94.96	46.01	+/-	1.22
	1200	8.638	0.0095	4.184	0.141	0.005	70.63	54.50	+/-	15.38

TL-90-9 SERICITIC WR 80/120

Run: D-753 93/11 Mass: 276 mg
Date: September 27 1992 J Value: 0.006536

Total 39Ar: 34.447 E-8 cm3 NTP Approx. 2.7% K
Integrated Age: 192.41 +/- 0.75 Ma
Plateau Age: 219.27 +/- 0.43 Ma (7.4% of 39Ar, steps marked by *)

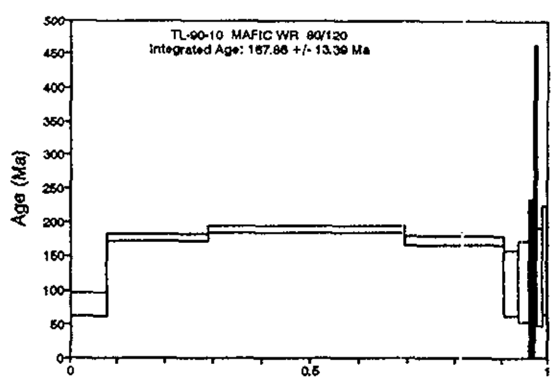


	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	9.300	0.0078	0.545	2.937	0.085	75.22	80.82	+/-	0.72
	540	15.873	0.0029	0.040	3.106	0.090	94.54	168.53	+/-	0.80
	580	18.129	0.0025	-0.005	3.931	0.114	96.00	194.06	+/-	0.62
	620	18.520	0.0020	-0.082	5.555	0.161	96.77	199.46	+/-	0.55
	660	18.996	0.0021	-0.094	4.482	0.130	96.80	204.36	+/-	0.51
	700	19.521	0.0025	-0.071	3.070	0.089	96.15	208.40	+/-	0.86
	740	20.301	0.0026	-0.182	2.426	0.070	96.22	216.31	+/-	0.87
	790	19.904	0.0019	-0.040	4.619	0.134	97.17	214.41	+/-	0.43
*	840	20.521	0.0024	-0.092	2.548	0.074	96.53	219.27	+/-	0.43
	890	21.198	0.0061	0.002	0.891	0.026	91.52	215.08	+/-	1.39
	950	22.521	0.0136	0.087	0.315	0.009	82.21	205.86	+/-	5.46
	1050	23.019	0.0196	0.450	0.348	0.010	74.81	192.54	+/-	3.60
	1186	28.704	0.0372	0.675	0.219	0.006	61.68	197.86	+/-	7.02

TL-90-10 MAFIC WR 80/120

Run: D-750 93/12 Mass: 276 mg
Date: September 24 1992 J Value: 0.006536

Total 39Ar: 1.891 E-8 cm3 NTP Approx. 0.15% K
Integrated Age: 167.86 +/- 13.39 Ma
Plateau Age: 189.19 +/- 5.43 Ma (40.5% of 39Ar, steps marked by *)

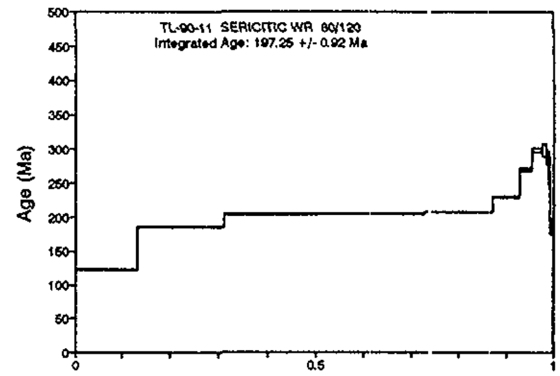


	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	50.090	0.1473	4.069	0.147	0.078	13.10	79.08	+/-	17.30
	600	25.851	0.0385	14.710	0.400	0.212	55.95	176.11	+/-	5.43
*	700	23.553	0.0238	5.001	0.767	0.405	70.12	189.19	+/-	5.43
	770	21.674	0.0220	2.079	0.401	0.212	70.04	172.26	+/-	7.06
	820	35.992	0.0921	10.892	0.059	0.031	24.38	110.17	+/-	47.16
	870	38.466	0.1042	27.266	0.043	0.023	19.92	112.61	+/-	58.49
	920	59.296	0.1893	50.686	0.014	0.007	5.65	84.89	+/-	148.90
	970	72.400	0.2492	56.442	0.009	0.005	-1.71	36.00	+/-	148.39
	1010	128.825	0.3882	136.607	0.011	0.006	10.95	292.31	+/-	169.94
	1070	92.651	0.3177	143.502	0.025	0.013	-1.32	119.83	+/-	71.88
	1186	*92.751*	*0.3418*	*252.061*	*0.017*	*0.009*	*-8.85*	*144.81*	+/-	*79.85*

TL-90-11 SERICITIC WR 80/120

Run: D-759 93/13
Mass: 196 mg
Date: October 10 1992
J Value: 0.006536

Total 39Ar: 21.856 E-8 cm3 NTP Approx. 2.4% K
Integrated Age: 197.25 +/- 0.92 Ma
Plateau Age: 299.10 +/- 4.83 Ma (3.0% of 39Ar, steps marked by *)
229.71 +/- 0.94 Ma (5.9% of Ar39, steps marked by -)
206.09 +/- 0.51 Ma (36.5% of Ar39, steps marked by +)

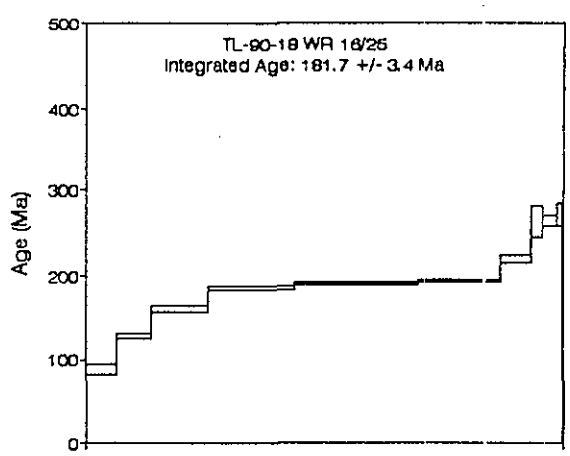


	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	11.697	0.0032	-0.140	2.870	0.131	91.84	121.98	+/-	0.49
	540	17.357	0.0024	-0.100	3.916	0.179	95.90	185.91	+/-	0.43
	580	19.067	0.0024	-0.145	4.275	0.196	96.33	204.11	+/-	0.66
+	620	19.220	0.0027	-0.185	4.814	0.220	95.89	204.73	+/-	0.48
+	660	19.645	0.0030	-0.114	3.158	0.145	95.45	208.18	+/-	0.56
-	700	21.813	0.0034	-0.127	1.280	0.059	95.43	229.71	+/-	0.94
	740	26.623	0.0063	-0.193	0.545	0.025	93.04	270.23	+/-	2.41
*	780	29.298	0.0055	-0.373	0.477	0.022	94.41	299.19	+/-	3.20
*	820	31.474	0.0128	-1.070	0.177	0.008	87.99	298.87	+/-	9.23
	860	33.471	0.0241	1.928	0.097	0.004	78.71	288.14	+/-	9.67
	900	33.881	0.0302	-4.083	0.081	0.004	73.63	268.43	+/-	20.47
	1200	33.499	0.0571	0.030	0.165	0.008	49.65	185.89	+/-	10.65

TL-90-18 WR 16/25

Run: D-656
Mass: 159 mg
Date: December 24, 1990
J Value: 0.00683

Total 39Ar: 13.848 E-8 cm3 NTP Approx. 1.8% K
Integrated Age: 181.7 +/- 3.4 Ma
Plateau Age: 192.0 +/- 1.5 Ma (42.8% of Ar39, steps marked by *)

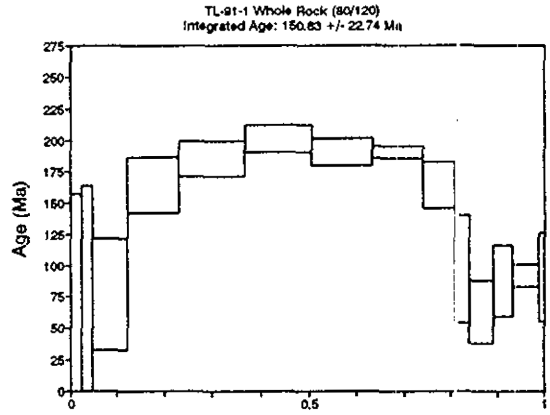


	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	9.172	0.0061	0.065	0.909	0.066	80.13	88.4	+/-	6.8
	550	11.260	0.0014	0.040	1.024	0.074	95.99	128.5	+/-	3.4
	600	14.146	0.0016	0.066	1.677	0.121	96.58	161.0	+/-	3.0
	650	16.369	0.0018	0.194	2.489	0.180	96.60	184.9	+/-	2.1
*	700	16.840	0.0018	0.304	3.500	0.253	96.86	190.6	+/-	1.7
*	750	17.178	0.0018	0.080	2.431	0.176	96.72	193.9	+/-	1.2
	800	19.863	0.0031	0.032	0.900	0.065	96.20	219.1	+/-	4.1
	850	26.717	0.0124	0.032	0.323	0.023	86.20	263.6	+/-	18.3
	960	28.159	0.0169	0.130	0.427	0.031	82.21	264.8	+/-	5.7
	1060	69.727	0.1217	1.308	0.140	0.010	39.90	272.3	+/-	13.4
	1200	333.160	1.1152	8.126	0.028	0.002	1.25	51.0	+/-	143.0

TL-91-1 Whole Rock (80/120)

Run: D-726 C93/P14 Mass: 203 mg
Date: June 28, 1992 J Value: 0.006535

Total 39Ar: 3.369 E-8 cm3 NTP Approx. 0.36% K
Integrated Age: 150.63 +/- 22.74 Ma
Plateau Age: 194.36 +/- 8.96 Ma (37.2% of 39Ar, steps marked by *)

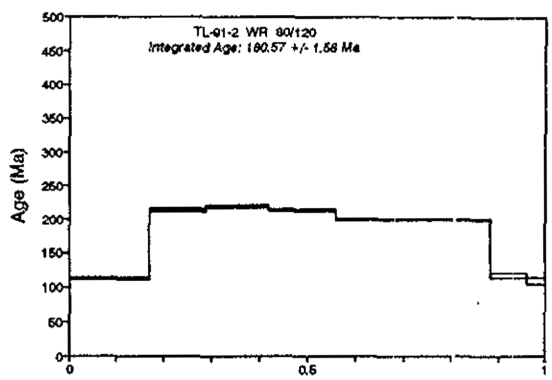


	Temp C	40/39	38/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	450	28.578	0.0822	1.964	0.080	0.024	14.89	51.25	+/-	106.51
	500	15.671	0.0442	1.079	0.080	0.024	16.47	31.13	+/-	132.71
	540	14.640	0.0273	1.955	0.253	0.075	44.67	77.25	+/-	44.84
	580	22.246	0.0325	23.112	0.366	0.109	58.75	164.19	+/-	22.07
	620	19.329	0.0108	4.903	0.462	0.137	83.39	185.15	+/-	14.13
*	655	20.404	0.0085	2.189	0.464	0.138	87.60	201.31	+/-	10.44
*	690	19.542	0.0088	1.269	0.429	0.127	86.60	190.41	+/-	10.86
*	725	19.783	0.0097	1.199	0.361	0.107	85.43	190.09	+/-	4.78
	760	18.520	0.0138	2.168	0.229	0.068	77.86	164.44	+/-	18.68
	795	15.700	0.0260	5.920	0.105	0.031	50.65	97.09	+/-	43.41
	835	11.174	0.0213	6.994	0.171	0.051	43.56	62.76	+/-	25.14
	900	12.620	0.0180	4.463	0.142	0.042	57.64	87.80	+/-	28.47
	1030	12.787	0.0236	27.628	0.185	0.055	45.20	91.80	+/-	9.01
	1200	25.973	0.0678	25.025	0.041	0.012	22.70	90.88	+/-	35.48

TL-91-2 WR 80/120

Run: D-754 93/15 Mass: 207 mg
Date: September 30 1992 J Value: 0.006532

Total 39Ar: 10.915 E-8 cm3 NTP Approx. 1.1% K
Integrated Age: 180.57 +/- 1.58 Ma
Plateau Age: 218.45 +/- 1.53 Ma (13.1% of 39Ar, steps marked by *)

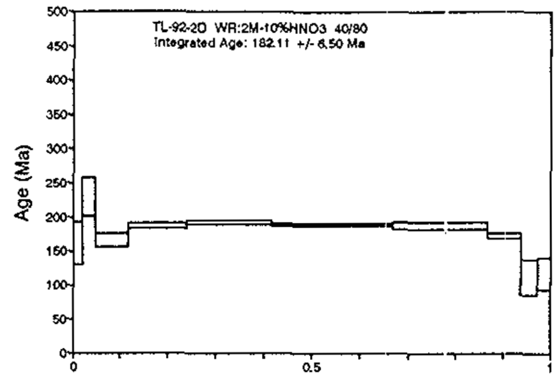


	Temp C	40/39	38/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	550	11.915	0.0074	0.968	1.862	0.171	81.54	111.56	+/-	1.46
	600	20.031	0.0033	2.489	1.271	0.116	95.10	213.55	+/-	1.96
*	650	20.530	0.0028	0.505	1.434	0.131	95.91	218.45	+/-	1.53
	700	20.064	0.0030	0.435	1.517	0.139	95.65	213.17	+/-	1.44
	800	18.585	0.0024	0.728	3.566	0.327	96.14	199.51	+/-	0.79
	900	11.173	0.0042	3.650	0.831	0.076	88.81	118.29	+/-	3.53
	1188	11.253	0.0075	5.709	0.433	0.040	80.42	108.45	+/-	4.33

TL-92-2D WR:2M-10%HNO3 40/80

Run: D-810 108/A2 Mass: 283 mg
Date: July 25 1993 J Value: 0.006425

Total 39Ar: 9.678 E-8 cm3 NTP Approx. 0.77% K
Integrated Age: 182.11 +/- 6.50 Ma
Plateau Age: 188.89 +/- 3.41 Ma (75.1% of 39Ar, steps marked by *)

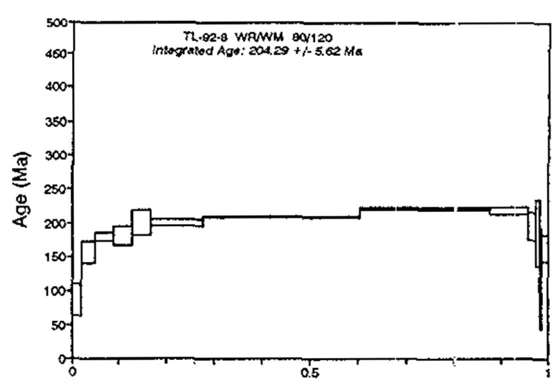


	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	32.204	0.0693	34.866	0.196	0.020	36.42	162.27	+/-	31.35
	540	31.415	0.0521	57.862	0.263	0.027	51.04	229.82	+/-	28.42
	580	17.889	0.0176	27.813	0.690	0.070	70.95	166.24	+/-	10.50
*	620	18.684	0.0067	3.947	1.212	0.123	89.37	187.10	+/-	3.46
*	660	18.585	0.0043	1.906	1.756	0.178	93.13	191.85	+/-	3.07
*	700	18.239	0.0038	0.978	2.487	0.252	93.83	188.79	+/-	2.07
*	735	17.993	0.0033	0.730	1.967	0.199	94.63	187.65	+/-	5.39
	770	17.557	0.0070	2.407	0.696	0.070	88.28	173.13	+/-	3.91
	870	13.174	0.0131	8.204	0.351	0.036	70.55	111.63	+/-	25.91
	1200	17.335	0.0292	21.223	0.260	0.026	50.24	116.88	+/-	23.83

TL-92-8 WR/WM 80/120

Run: D-799 108/A1 Mass: 260 mg
Date: July 3 1993 J Value: 0.00644

Total 39Ar: 7.204 E-8 cm3 NTP Approx. 0.61% K
Integrated Age: 204.29 +/- 5.62 Ma
Plateau Age: 220.73 +/- 2.83 Ma (35.4% of 39Ar, steps marked by *)



	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	34.318	0.0910	2.532	0.146	0.020	21.65	86.23	+/-	22.89
	540	50.169	0.1232	2.871	0.204	0.028	27.48	155.60	+/-	16.14
	580	35.218	0.0706	21.874	0.284	0.039	40.77	179.06	+/-	6.19
	620	20.856	0.0166	5.531	0.290	0.040	76.45	181.03	+/-	14.13
	670	21.540	0.0116	1.454	0.288	0.040	84.12	200.14	+/-	18.33
	720	19.877	0.0056	0.310	0.785	0.109	91.64	200.10	+/-	4.44
	780	19.990	0.0028	0.084	2.354	0.327	95.80	209.60	+/-	1.11
*	840	20.835	0.0018	0.034	1.961	0.272	97.47	221.47	+/-	2.19
*	880	21.379	0.0049	0.649	0.590	0.082	93.28	218.28	+/-	4.96
	920	22.889	0.0179	1.998	0.121	0.017	76.96	195.35	+/-	20.43
	960	26.024	0.0326	4.890	0.054	0.008	62.98	185.15	+/-	49.08
	1000	40.494	0.1047	12.221	0.032	0.004	23.58	118.27	+/-	74.24
	1200	35.141	0.0822	45.411	0.095	0.013	30.84	162.66	+/-	20.03

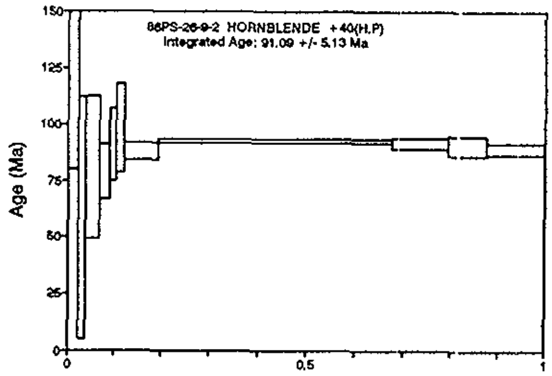
86PS-26-9-2 HORNBLENDE +40(H.P)

Run: D-736 89/36
Date: August 29 1992

Mass: 424 mg
J Value: 0.003307

Total 39Ar: 2.985 E-8 cm3 NTP
Approx. 0.30% K
Integrated Age: 91.09 +/- 5.13 Ma
Plateau Age: 91.64 +/- 1.65 Ma (80.7% of 39Ar, steps marked by *)

	Temp C	40/39	38/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	700	385.432	1.2348	5.243	0.069	0.023	5.35	121.45	+/-	41.41
	800	166.612	0.5316	5.876	0.043	0.014	5.72	58.56	+/-	53.55
	900	*240.284*	*0.7731*	*24.381*	*0.089*	*0.030*	*4.92*	*60.61*	+/-	*31.56*
	975	38.437	0.0877	12.276	0.065	0.022	32.54	78.85	+/-	12.27
	1000	34.657	0.0670	9.571	0.042	0.014	42.85	90.97	+/-	16.05
	1025	34.529	0.0631	12.426	0.055	0.018	48.02	98.29	+/-	19.57
	1050	24.604	0.0354	11.313	0.214	0.072	57.51	87.81	+/-	3.88
*	1075	19.612	0.0154	10.255	1.443	0.484	76.81	92.51	+/-	0.81
*	1100	20.113	0.0177	10.315	0.353	0.118	73.98	91.49	+/-	2.48
*	1125	26.684	0.0407	10.880	0.240	0.080	54.92	90.42	+/-	4.23
*	1200	25.634	0.0379	10.793	0.371	0.124	58.32	89.20	+/-	2.47



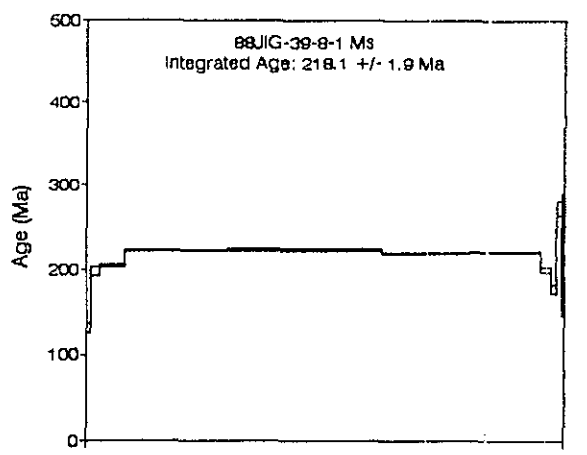
88JIG-39-8-1 Ms

Run: D-617
Date: June 24, 1989

Mass: 90 mg
J Value: 0.00718

Total 39Ar: 28.608 E-8 cm3 NTP
Approx. 6.2% K
Integrated Age: 218.1 +/- 1.9 Ma
Plateau Age: 221.0 +/- 1.2 Ma (86.8% of Ar39, steps marked by *)

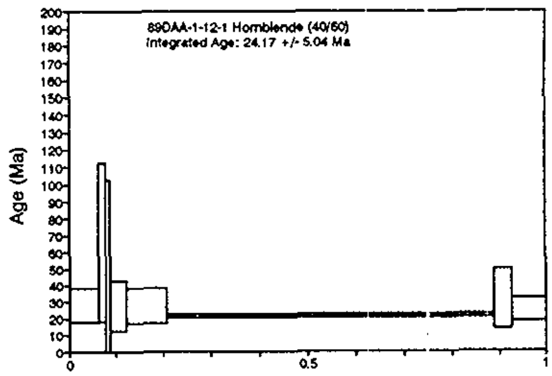
	Temp C	40/39	36/39	37/39	Vol 39Ar E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	500	26.518	0.0548	1.664	0.291	0.010	39.34	130.4	+/-	5.6
	575	18.778	0.0100	3.411	0.508	0.018	85.56	197.3	+/-	6.0
	675	17.555	0.0033	0.842	1.611	0.056	94.64	203.3	+/-	1.4
*	750	18.456	0.0007	0.019	6.208	0.217	98.78	221.8	+/-	1.1
*	800	18.391	0.0004	0.008	9.144	0.320	99.31	222.2	+/-	1.5
*	850	18.174	0.0008	0.024	5.208	0.182	98.66	218.4	+/-	0.9
*	900	18.304	0.0007	0.011	4.267	0.149	98.83	220.2	+/-	1.2
	960	17.463	0.0037	0.063	0.669	0.023	93.60	200.1	+/-	3.0
	1020	*18.733*	*0.0151*	*0.086*	*0.283*	*0.010*	*76.11*	*175.8*	+/-	*6.7*
	1070	25.391	0.0093	0.202	0.248	0.009	89.19	271.7	+/-	8.0
	1200	30.426	0.0428	0.334	0.181	0.006	58.48	216.8	+/-	72.6



89DAA-1-12-1 Hornblende (40/60)

Run: D-671 C79/P29 Mass: 251 mg
Date: July 3, 1991 J Value: 0.005015

Total 39Ar: 3.467 E-8 cm3 NTP Approx. 0.39% K
Integrated Age: 24.17 +/- 5.04 Ma
Plateau Age: 21.48 +/- 0.80 Ma (68.3% of 39Ar, steps marked by *)



	Temp C	40/39	36/39	37/39	Vol 39A E-8 cm3	f39	%40Ar Rad.	Age Ma	+/-	Error 2 sigma
	800	19.728	0.0562	0.465	0.215	0.062	15.84	28.07	+/-	10.29
	900	22.486	0.0515	1.436	0.054	0.016	32.73	65.45	+/-	47.36
	950	20.773	0.0528	2.577	0.031	0.009	25.67	47.68	+/-	54.92
	1000	12.456	0.0345	10.827	0.115	0.033	24.39	27.47	+/-	15.30
	1050	9.956	0.0264	12.563	0.301	0.087	30.61	27.58	+/-	10.76
•	1090	4.844	0.0114	12.483	2.367	0.683	48.91	21.48	+/-	0.80
	1130	12.923	0.0348	11.934	0.131	0.038	26.98	31.51	+/-	17.84
	1200	8.146	0.0213	12.581	0.252	0.073	33.79	24.94	+/-	6.91

D-861: 91JG-44 Bi 40/60

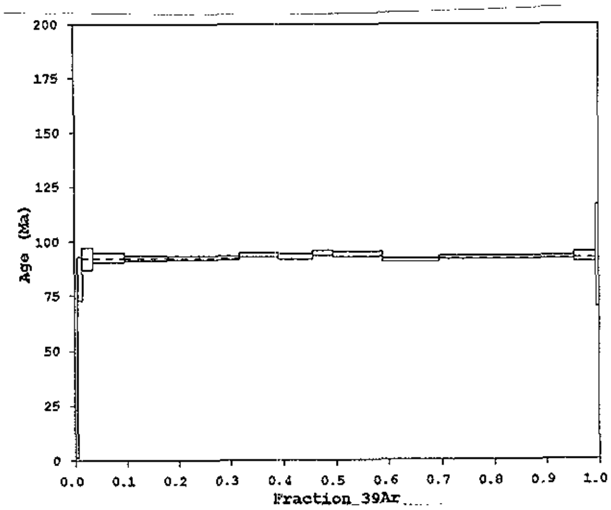
Run date: 1994/07/06 Can/Pos: 124/46 J Value: 0.007007
Recalc date: 1994/07/07 Mass: 150.0 mg ± 0.000082

Volume 39Ar: 427.72 x 1E-9 cm3 NTP Approx. 5.74% K
Integrated Age: 92.16 ± 1.13 Ma 0.17% Ca

Initial 40/36: 380.25 ± 90.77 (MSWD = 2.66, isochron between 0.50 and 2.00)
Correlation Age: 92.06 ± 0.94 Ma (95.9% of 39Ar, steps marked by >)

Plateau Age: 92.34 ± 1.15 Ma (71.1% of 39Ar, steps marked by <)

Temp	36Ar/40Ar	39Ar/40Ar	r	Ca/K	%40Ar*	%39Ar	40Ar*/39K	Age
500	0.00312752±0.00022569	0.077229±0.003186	0.318	0.03	6.78	0.64	0.982±0.878	12.37±11.03
550	0.00140995 0.00000000	0.086740 0.000000	-0.060	0.03	53.24	0.88	6.725 0.838	83.07 10.12
< 600	0.00083078 0.00000000	0.100908 0.000000	-0.112	0.03	72.01	2.15	7.477 0.441	92.13 5.29
< 650>	0.00021157 0.00003752	0.124450 0.000418	-0.091	0.03	91.60	6.06	7.533 0.181	92.80 2.17
< 700>	0.00014192 0.00000000	0.127639 0.000000	-0.087	0.03	94.07	8.47	7.506 0.093	92.47 1.12
< 750>	0.00008241 0.00000001	0.130071 0.000000	-0.076	0.03	96.29	13.80	7.501 0.076	92.41 0.31
800>	0.00001798 0.00000000	0.130633 0.000000	-0.147	0.03	97.35	7.40	7.614 0.094	93.78 1.13
850>	0.00009623 0.00000000	0.128555 0.000000	-0.211	0.03	94.82	6.45	7.558 0.112	93.09 1.34
900>	0.00028919 0.00000000	0.118968 0.000000	-0.396	0.03	88.16	3.83	7.687 0.097	94.65 1.16
950>	0.00004974 0.00006719	0.129084 0.002007	-0.100	0.02	96.62	9.33	7.633 0.103	94.00 1.24
<1000>	0.00008269 0.00006764	0.131685 0.002066	-0.191	0.03	95.71	10.75	7.408 0.066	91.30 0.30
<1050>	0.00002240 0.00005367	0.132259 0.002810	-0.065	0.03	98.25	25.69	7.511 0.057	92.53 0.59
<1100>	0.00005980 0.00031017	0.130506 0.007647	-0.265	0.03	93.23	4.14	7.527 0.188	92.73 2.26
1200	0.00035467 0.00191089	0.118507 0.040265	-0.423	0.03	53.12	0.39	7.554 1.947	93.05 23.38



SUMMARY OF $^{40}Ar/^{39}Ar$ DATES

Sample: C093A
Rock unit: Diorite, Bralorne-East Liza Complex
Material dated/age: Hornblende - Integrated age of 298.7±41.0 Ma; Plateau age of 275.5±29.8 Ma
Comment: The U-shaped age spectrum indicates excess argon, but the plateau segment may be a good indication of the age.

Sample: DH-87-163.3
Rock unit: Alteration, Taylor-Windfall occurrence
Material dated/age: Alunite - Total fusion date of 73.7±0.5 Ma

Sample: GBQ
Rock unit: Diorite, Bralorne-East Liza Complex
Material dated/age: Hornblende - Integrated age of 295.5±36.4 Ma; Plateau age of 279.0±2.0 Ma
Comment: As with C093A, the shape of the age spectrum suggests excess argon, but the plateau segment may be a good indication of the age.

Sample: TL-87-1
Rock unit: Hornblende-biotite-quartz-feldspar porphyry intrusion, Mount Sheba complex
Material dated/age: Hornblende - Total fusion date of 57.2±1.4 Ma. K-feldspar - Integrated age of 41.79±2.89 Ma; Plateau ages of 36.83±14.10 Ma and 44.44 ±1.05 Ma

Sample: TL-87-3a
Rock unit: Alteration, Warner occurrence
Material dated/age: Sericite - Total fusion date of 78.1±0.6 Ma

Sample: TL-87-4
Rock unit: Granodiorite, Dickson - McClure batholith
Material dated/age: Hornblende - Total fusion date of 82.1±2.0 Ma. Biotite - Total fusion date of 71.8±0.6 Ma

Sample: TL-87-6
Rock unit: Hornblende feldspar porphyry, Dorrie Peak stock
Material dated/age: Hornblende - Total fusion date of 64.7±2.1 Ma

Sample: TL-87-7
Rock unit: Quartz monzonite, Lorna Lake stock
Material dated/age: Biotite - Total fusion date of 43.5±0.3 Ma

Sample: TL-87-8
Rock unit: Hornblende-biotite-quartz-feldspar porphyry stock cutting Red Mountain volcanic complex
Material dated/age: Hornblende - total fusion date of 53.5±0.8 Ma. Biotite - total fusion date of 47.4±0.5 Ma

Sample: TL-87-11
Rock unit: Hornblende feldspar porphyry dike within Shulaps serpentinite mélange adjacent to the Yalakom fault
Material dated/age: Hornblende - Total fusion date of 75.6±2.8 Ma; Integrated age of 75.4±12.1 Ma; Plateau age of 76.5±9.6 Ma

Sample: TL-87-12
Rock unit: Silicified and sericitized volcanics underlying the summit of Big Sheep Mountain
Material dated/age: Sericite-rich separate - Total fusion date of 27.3±0.2 Ma

Sample: TL-87-13a
Rock unit: Andesite, Powell Creek formation
Material dated/age: Mafic concentrate - Total fusion date of 131.0±7.4 Ma
Comment: This date is considerably older than is geologically reasonable for the Powell Creek formation. It may reflect excess argon within the pyroxene-rich mafic concentrate that was dated (Archibald *et al.*, 1989)

Sample: TL-87-14
Rock unit: Hornblende feldspar porphyry plug that intrudes the Taylor Creek Group
Material dated/age: Sericitized plagioclase - Total fusion date of 67.6±0.6 Ma. Hornblende - Integrated age of 111.2±21.6 Ma; Plateau age of 104.5±16.6 Ma
Comment: The 104.5 Ma plateau date is a reasonable intrusive age for the plug if it is related to the Taylor Creek volcanics which it intrudes.

Sample: TL-87-16
Rock unit: Hornblende porphyry plug that intrudes the Powell Creek formation and the Chita Creek fault
Material dated/age: Hornblende - Total fusion date of 34.7±1.9 Ma

Sample: TL-87-17
Rock unit: Andesite, Powell Creek formation
Material dated/age: Mafic concentrate - Total fusion date of 148.8±14.1 Ma. Fresh plagioclase - Total fusion date of 77.6±1.5 Ma. Whole rock - Total fusion date of 54.4±0.3 Ma
Comment: The 148.8 Ma date for the mafic concentrate is considerably older than is geologically reasonable for the Powell Creek formation, and may reflect excess argon within the apparently pyroxene-rich concentrate that was dated. The younger dates may reflect post-volcanic alteration, as discussed by Archibald *et al.* (1989).

Sample: TL-87-20
Rock unit: Granodiorite, Beece Creek pluton
Material dated/age: Biotite - Total fusion date of 43.9±0.6 Ma

Sample: TL-87-22
Rock unit: Amphibolite knocker within Shulaps serpentinite mélange unit
Material dated/age: Hornblende - Integrated age of 84.63±12.42 Ma; Plateau age of 73.46±2.57 Ma
Comment: These dates probably reflect re-heating of Permian amphibolite (*e.g.* samples TL-88-4 and TL-88-23) during Late Cretaceous and/or early Tertiary thermal events in the southern Shulaps Range, as discussed in chapter 3.

Sample: TL-88-1a
Rock unit: Blueschist, Bridge River Complex
Material dated/age: White mica - Integrated age of 229.9±1.3 Ma; Plateau age of 229.8±1.0 Ma
Comment: This date is interpreted as the time of cooling following blueschist-facies metamorphism.

Sample: TL-88-4
Rock unit: Amphibolite knocker within Shulaps serpentinite mélange unit
Material dated/age: Hornblende - Integrated age of 207.55±10.33 Ma; Plateau age of 251.11±8.13 Ma
Comment: This knocker probably correlates with the Early Permian amphibolite of sample TL-88-23, but may have been partially reset during heating associated with Late Cretaceous dike emplacement, as discussed in chapter 3.

Sample: TL-88-10
Rock unit: Sheeted gabbroic dikes that intrude the Bridge River Complex
Material dated/age: Brown hornblende - Integrated age of 107.6±6.7 Ma; Plateau age of 105.2±5.7 Ma. Green hornblende - Integrated age of 102.8±10.0 Ma; Plateau age of 98.5±4.4 Ma
Comment: A correlation plot for the plateau segment of the brown hornblende spectrum yields a well-defined isochron age of 107±3 Ma (2G) which provides the best estimate of the age of this sample (Archibald *et al.* 1991). The brown hornblende is rimmed by green amphibole which yields slightly younger dates, probably reflecting autometamorphism associated with the multiple dike emplacement.

Sample: TL-88-16
Rock unit: Blueschist, Bridge River Complex
Material dated/age: White mica - Integrated age of 229.9±1.3 Ma; Plateau age of 230.1±1.0 Ma

Comment: Almost identical to sample TL-88-1a. These dates are interpreted as the time of cooling following blueschist-facies metamorphism.

Sample: TL-88-17
Rock unit: Granodiorite, Eldorado pluton
Material dated/age: Biotite - Integrated age of 67.05±0.88 Ma; Plateau age of 67.21±0.69 Ma

Sample: TL-88-23
Rock unit: Amphibolite knocker within Shulaps serpentinite mélange unit
Material dated/age: Hornblende - Integrated age of 253.7±14.7 Ma; Plateau age of 260.8±10.7 Ma
Comment: An Ar-Ar correlation analysis done for the plateau segment revealed an initial $^{40}Ar/^{36}Ar$ ratio of 257±68 (slightly less than the expected atmospheric argon ratio of 295.5) and an older age for the plateau segment of 271±16 Ma (Archibald *et al.*, 1991). This correlation plot date is considered to be a reliable cooling age for the sample.

Sample: TL-88-24
Rock unit: Biotite-rich reaction zone adjacent to a 1 to 2-metre siliceous phacoid (felsic dike fragment?) within serpentinized harzburgite of the Shulaps Ultramafic Complex.
Material dated/age: Biotite - Integrated age of 46.4±0.6 Ma; Plateau age of 46.6±0.5 Ma
Comment: The date may reflect the time of cooling following emplacement of a dike related to the Mission Ridge pluton.

Sample: TL-89-6
Rock unit: Hornblende feldspar porphyry plug (part of the Blue Creek porphyry suite) that intrudes the Shulaps harzburgite unit and hosts the Yalakom gold-quartz vein system
Material dated/age: Hornblende - Integrated age of 70.55±6.56 Ma; Plateau age of 70.27±5.25 Ma

Sample: TL-90-2-2
Rock unit: Blueschist clast within the basal conglomerate of the Dash formation
Material dated/age: White mica - Integrated age of 218.3±1.3 Ma; Plateau age of 224.9±1.0 Ma

Sample: TL-90-2-4
Rock unit: Blueschist clast within the basal conglomerate of the Dash formation
Material dated/age: Separate containing 60% white mica - Integrated age of 216.7±2.7 Ma. Plateau age of 223.9±1.8 Ma

Sample: TL-90-4
Rock unit: Blueschist, Bridge River Complex
Material dated/age: Whole rock - Integrated age of 190.3±9.7 Ma. Plateau age of 197.2±4.3 Ma

Sample: TL-90-8
Rock unit: Biotite feldspar porphyry dike that intrudes the Bridge River Complex
Material dated/age: Biotite - Integrated age of 46.35±0.63 Ma. Plateau age of 46.14±0.50 Ma

Sample: TL-90-9
Rock unit: Retrograded blueschist, Bridge River Complex
Material dated/age: Sericitic whole rock - Integrated age of 192.41±0.75 Ma. Plateau age of 219.27±0.43 Ma
Comment: Low-temperature step suggests that retrograde metamorphism/thermal overprinting occurred in Late Cretaceous time.

Sample: TL-90-10
Rock unit: Blueschist, Bridge River Complex
Material dated/age: Mafic whole rock - Integrated age of 167.86±13.39 Ma. Plateau age of 189.19±5.43 Ma

Sample: TL-90-11
Rock unit: Retrograded blueschist, Bridge River Complex
Material dated/age: Sericitic whole rock - Integrated age of 197.25±0.92 Ma. Plateau ages of 299.10±4.83 Ma, 229.71±0.94 Ma and 206.09±0.51 Ma

Sample: TL-90-18
Rock unit: Metachert, Bridge River Complex; structurally imbricated with blueschist
Material dated/age: Whole rock - Integrated age of 181.7±3.4 Ma. Plateau age of 192.0±1.5 Ma
Comment: Low-temperature step suggests that thermal overprinting occurred in Late Cretaceous time.

Sample: TL-91-1
Rock unit: Blueschist, Bridge River Complex
Material dated/age: Whole rock - Integrated age of 150.63±22.74 Ma. Plateau age of 194.36±8.96 Ma

Sample: TL-91-2
Rock unit: Blueschist, Bridge River Complex
Material dated/age: Whole rock - Integrated age of 180.57±1.58 Ma. Plateau age of 218.45±1.53 Ma

Sample: TL-92-2D
Rock unit: Blueschist, Bridge River Complex
Material dated/age: Whole rock - Integrated age of 182.11±6.50 Ma. Plateau age of 188.89±3.41 Ma

Sample: TL-92-8
Rock unit: Blueschist cobble from the base of the Silverquick conglomerate
Material dated/age: Partial separate of white mica - Integrated age of 204.29±5.62 Ma. Plateau age of 220.73±2.83 Ma

Sample: 86PS-26-9-2
Rock unit: Clinopyroxene hornblende porphyry dike that cuts the Taylor Creek Group
Material dated/age: Hornblende - Integrated age of 91.09±5.13 Ma. Plateau age of 91.64±1.65 Ma
Comment: Its age and composition suggest that the dike is part of a feeder system to the overlying Powell Creek volcanics.

Sample: 88JIG-39-8-1
Rock unit: Blueschist, Bridge River Complex
Material dated/age: White mica - Integrated age of 218.1±1.9 Ma. Plateau age of 221.0±1.2 Ma
Comment: The difference between this plateau age and the 230 Ma plateau ages of samples TL-88-1a and TL-88-16 probably reflects partial argon loss during a Cretaceous low-temperature overprint, as indicated by the 500°C step in the spectrum (Archibald *et al.*, 1990, 1991).

Sample: 89DAA-1-12-1
Rock unit: Hornblende porphyry dike that intrudes the Rexmount porphyry
Material dated/age: Hornblende - Integrated age of 24.17±5.04 Ma. Plateau age of 21.48±0.80 Ma

Sample: 91JG-44
Rock unit: Granodiorite, Dickson - McClure batholith
Material dated/age: Biotite - Integrated age of 92.16±1.13 Ma. Plateau age of 92.34±1.15 Ma
Comment: This date is very close to the U-Pb zircon age reported by Parrish (1992) from about 5 kilometres to the south (Sample 86WV-2 on Figure 49). Sample 91JG-44 has also yielded a zircon fission-track age of 90.7±13.2 Ma (Garver *et al.*, 1994). These data indicate very rapid cooling of this part of the pluton, probably at a depth of less than 9 kilometres (the approximate closure depth of fission-tracks in zircon).

APPENDIX 8

U-Pb Radiometric Dating of Shulaps Tonalite

By R.M. Friedman
Department of Geological Sciences
The University of British Columbia
Vancouver, British Columbia

U-Pb ANALYTICAL PROCEDURES

SAMPLE PREPARATION

Zircons were separated from an approximately 20 kg sample using standard crushing, Wilfley table and heavy liquid extraction techniques. Zircons were then split into specific fractions based on grain size, shape, and magnetic susceptibility, as well as physical attributes such as colour and clarity of individual crystals. Some fractions were air abraded using techniques similar to those of Krogh (1982). Prior to dissolution all zircon fractions were washed in warm 3N HNO_3 for 10-20 minutes followed by rinsing in high-purity H_2O and acetone.

U-Pb METHODS

Sample dissolution and U and Pb separation and purification are carried out using a procedure modified from Parrish (1987). The dissolution is in small-volume Teflon capsules contained in a large Parr bomb (Parrish, 1987). Both Pb and U are eluted into the same beaker and loaded and run sequentially, together on the same Re filament, using a silica gel/phosphoric acid emitter, at a temperature of 1300•C. A Daly collector is used to improve the quality of measurement of low-intensity ^{204}Pb signals. U and Pb concentrations are determined with a mixed $^{205}Pb/^{235}U$ spike (Parrish and Krogh, 1987). Pb was corrected for 0.0043/amu ±20% (Daly collector runs), and 0.0012/amu ±20% (Faraday collector runs), determined by repeated analysis of National Bureau of Standards SRM981 Pb standards. Laboratory blank amount and isotopic composition are determined from running procedural blanks with each batch of unknowns. Pb and U blanks were 5-15 pg (±30%), and

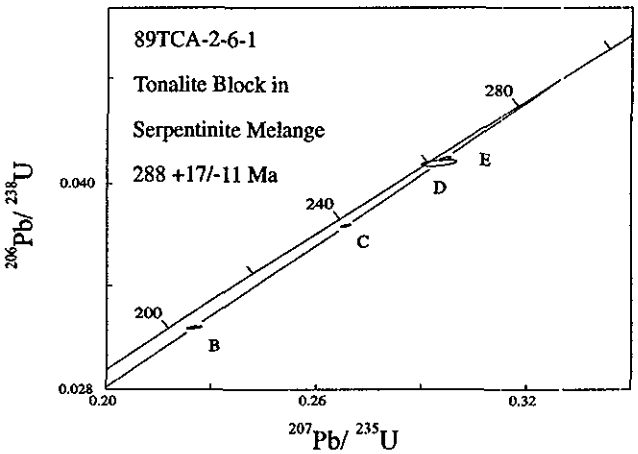


Figure 50. Concordia diagram for sample 89TCA-2-6-1 of the Shulaps serpentinite mélange unit.

TABLE 3. U-PB ZIRCON ANALYTICAL DATA

Fraction[1]	Wt.	U	Pb[2]	$^{206}Pb^3$	Pb[4]	$^{208}Pb^5$	Isotopic ratios(±1σ,%)[6]			Isotopic dates(Ma,±2σ)[6]		
	mg	ppm	ppm	^{204}Pb	pg	%	$^{238}U/^{206}Pb$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$
Shulaps melange knocker: 89TCA-2-6-1												
B m,N5,p	0.033	195	6.5	722	18	14.4	0.03154±0.13	0.2251±0.49	0.05176±0.42	200.2±0.5	206.2±1.8	274.8±19.1
C f,N5,p	0.043	229	9.2	2260	10	15.0	0.03754±0.10	0.2684±0.26	0.05186±0.19	237.6±0.5	279.3±1.1	279.3±8.5
D f,N5,p	0.024	296	13.0	573	33	15.0	0.04115±0.21	0.2950±0.76	0.05200±0.78	260.0±1.1	262.5±4.0	285.3±4.0
E f,N5,p	0.059	325	14.6	2211	22	16.7	0.04140±0.14	0.2968±0.27	0.05200±0.20	261.5±0.7	263.9±1.3	285.3±9.0

[1]All fractions are air abraded; Grain size, smallest dimension: c= >134µm, m=<134µm and >74µm, f=<74µm; Magnetic codes: Franz magnetic separator sideslope at which grains are nonmagnetic; e.g., N1=nonmagnetic at 1°; Field strength for all fractions =1.8A; Front slope for all fractions=20°; Grain character codes: p=prismatic

[2]Radiogenic Pb

[3]Measured ratio corrected for spike and Pb fractionation of 0.0043/amu ±20% (Daly collector)

[4]Total common Pb in analysis based on blank isotopic composition

[5]Radiogenic Pb

[6]Corrected for blank Pb, U and common Pb (Stacey-Kramers model Pb composition at the $^{207}Pb/^{206}Pb$ date of fraction, or age of sample)

1-3 pg (±30%), respectively, during the course of this study. *The isotopic composition of common Pb is based on the* Stacy and Kramers (1975) model. Decay constants are those recommended by the IUGS Subcommission on Geochronology (Steiger and Jäger, 1977). Ages and associated errors were calculated using the methods of Parrish *et al.* (1987) and Roddick (1987). Isotopic ratios are reported at the 1s (%) level, and dates are tabulated and plotted at the 2s level. Upper and lower intercept ages and their associated errors were calculated using a modified York II model (Parrish *et al.*, 1987) and the algorithm of Ludwig (1980).

U-Pb ANALYSIS AND INTERPRETATION

Sample 89TCA-2-6-1, from a tonalite block in the Shulaps serpentinite mélange unit, yielded a small amount (<200 µg) of high quality zircon. This zircon was clear, pale pink in colour and prismatic, with aspect ratios of about 1.5 to 3.0. Four analysed fractions (Table 3) plotted on the concordia diagram in Figure 50 are discordant, colinear, and are interpreted to define a Pb loss trend. A best-fit regression line through the data yields an upper intercept of 288 +17/-11 Ma, interpreted as the best estimate for the magmatic age of this sample.

APPENDIX 9

Mineral Occurrences, Lithogeochemistry, Moss Mat Geochemistry and Regional Stream Geochemistry of the Bralorne and Dickson Range Map Areas

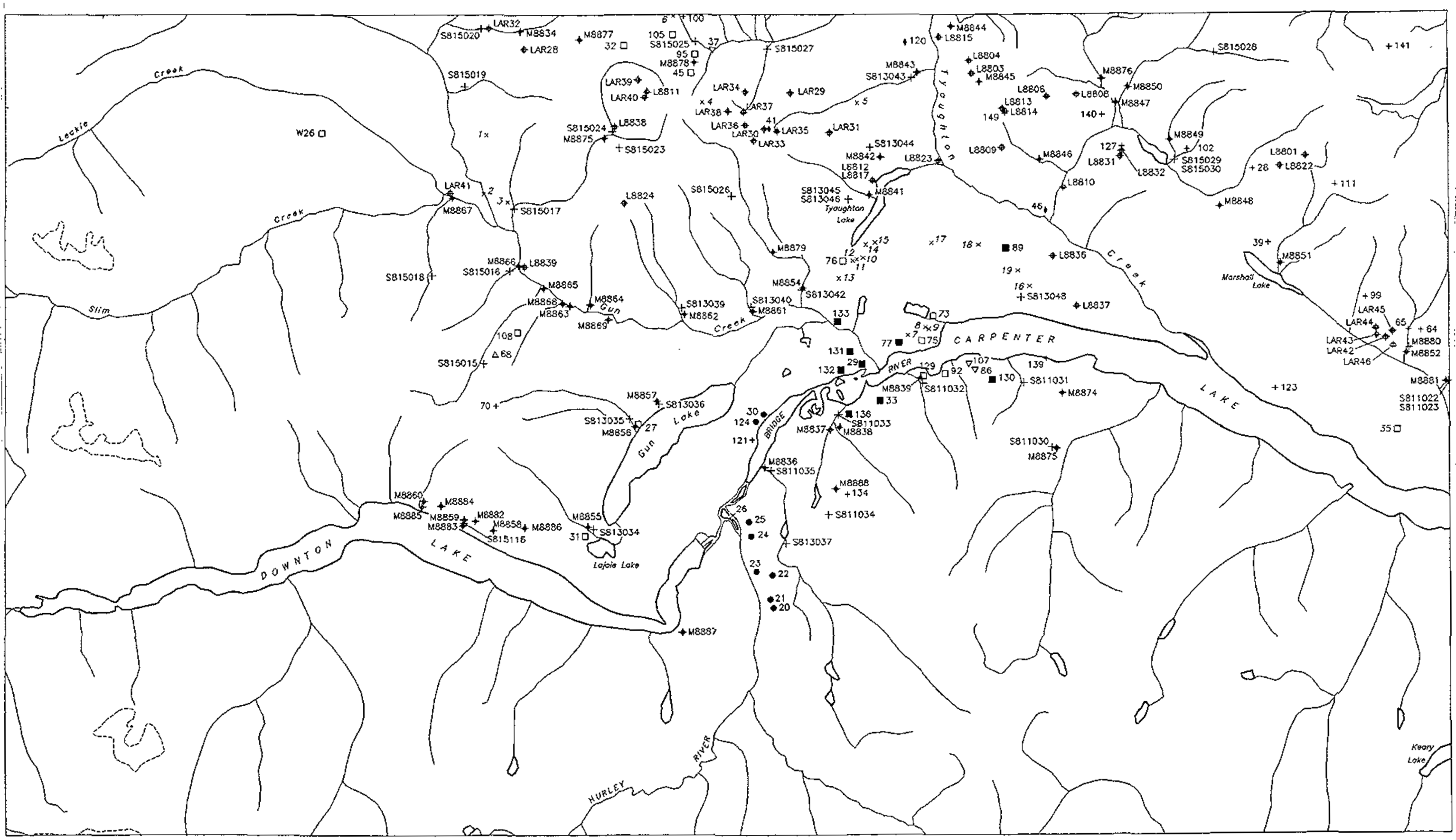


Figure 51. Mineral occurrences and geochemical sample sites in the Bralorne and Dickson Range map areas. *See* Figure 52 for list of symbols.

TABLE 4
MINFILE OCCURRENCES, 92J/14, 15

MINFILE NUMBER	NAME	DEPOSIT TYPE	DEPOSIT CHARACTER	COMMODITIES	DOMINANT METALLIC MINERALS	HOST ROCKS	STATUS	PRODUCTION (P) RESERVES (R)
92JNE-020	California	Low-sulphide (mesothermal) gold-quartz veins	vein	Au, Ag; W	py, apy; native Au, ccp, sp, sch	diorite-greenstone, tonalite	Developed Prospect	
92JNE-021	Why Not	Low-sulphide (mesothermal) gold-quartz veins	vein, stockwork	Au, Ag	py	diorite-greenstone, tonalite	Developed Prospect	
92JNE-022	Gloria Kitty	Low-sulphide (mesothermal) gold-quartz veins	vein	Au, Ag	py, apy	diorite-greenstone, albitite	Developed Prospect	(P) 467 g Au 311 g Ag
92JNE-023	Forty Thieves	Low-sulphide (mesothermal) gold-quartz veins	vein, stockwork	Au, Ag	py, tet	diorite-greenstone, dacite porphyry	Developed Prospect	
92JNE-024	Arizona	Low-sulphide (mesothermal) gold-quartz veins	vein, disseminations	Au, Ag, W; Pb, Zn	py, gn, sp, ccp; native Au, cc, mo, sch	diorite-greenstone, tonalite	Developed Prospect	(P) 425 g Au 28 g Ag
92JNE-025	Golden Gate	Low-sulphide (mesothermal) gold-quartz veins	vein	Au	apy	diorite-greenstone, albitite	Prospect	
92JNE-026	Haylmore	Placer	alluvial	Au	detrital native Au	fluvial gravels	Past Producer	(P) >28000g placer gold (total metal)
92JNE-027	Pilot	Low-sulphide (mesothermal) gold-quartz veins	vein	Au, Ag	apy	quartz diorite	Developed Prospect	
92JNE-028	Shulaps Copper	Vein	vein	Cu	ccp	greenstone-gabbro	Showing	
92JNE-029	Congress	Stibnite veins	irregular pods, veins and replacements	Au, Ag, Sb; Cu	sti, py, apy; sp, tet, cn, lm km, mar	greenstone, ribbon chert	Past Producer	(P) 2582 g Au 1306 g Ag 38 kg Cu
92JNE-030	Wayside	Low-sulphide (mesothermal) gold-quartz veins	vein	Au, Ag [Cu, Pb]	py, apy, ccp; tel, gn, tet, sp [sti, native Au]	diorite	Past Producer	(P) 166122 g Au 26064 g Ag
92JNE-031	Veritas	Polymetallic veins	vein, stockwork (quartz-dominated)	Au; Pb, Cu	py, apy, gn, ccp; tet	greenstone-diorite	Prospect	

TABLE 4
MINFILE OCCURRENCES, 92J/14, 15

MINFILE NUMBER	NAME	DEPOSIT TYPE	DEPOSIT CHARACTER	COMMODITIES	METALLIC MINERALS	HOST ROCKS	STATUS	PRODUCTION (P) RESERVES (R)
92JNE-032	Lucky Jem	Polymetallic veins	vein, disseminations	Au, Ag; Pb, Zn	apy, py, gn, sp	granodiorite	Developed Prospect	(P) 217 g Au 2116g Ag 336 kg Pb 31 kg Zn
92JNE-033	Reliance	Stibnite veins	veins and replacements	Sb, Au, Ag	sti, apy	greenstone, ribbon chert	Developed Prospect	
92JNE-035	Summit	Polymetallic vein	vein	Au, Ag; Zn, Pb	py, po, apy, sp; gn, [bn, sti]	greenstone, argillite, ribbon chert	Prospect	
92JNE-037	Wide West	Skarn	stratabound, massive, irregular	Au, Cu	po, ccp	limestone, slate, conglomerate, granodiorite	Showing	
92JNE-039	Primrose	Vein	vein	Au, Cu	py, ccp	chert, argillite serpentinite	Showing	
92JNE-041	Lillomer	Cinnabar	veins, disseminations	Hg	cn, native Hg	greenstone, ribbon chert, argillite	Prospect	
92JNE-045	Lucky Strike	Polymetallic veins	vein	Au, Ag; Zn, Cu	sp, jm, py, ccp, apy	serpentinite, chert, argillite, granodiorite	Developed Prospect	
92JNE-046	Tyaughton	Cinnabar	disseminations	Hg	cn; native Hg	argillite	Showing	
92JNE-064	4-Ton	Nephrite Jade	lenses, pods (lode)	nephrite jade		serpentinite, argillite, ribbon chert	Showing	
92JNE-065	Blue	Nephrite Jade	lenses, pods (lode)	nephrite jade		serpentinite, argillite, ribbon chert	Showing	
92JNE-068	Little Gem	Sulphide-arsenide-oxide (hypothermal) veins	veins, lenses, disseminations	Co, Au, U; Mo	dn, lo, sfl, apy; mo, ur, ery, skt [sch, native Au]	granodiorite	Prospect	
92JNE-070	Mount Penrose	Chrysotile	veins, pods	chrysotile		serpentinite	Showing	
92JNE-073	Dauntless	Polymetallic veins	veins, disseminations, breccia	Au, Ag; Zn	apy, py; sti, sp	chert, argillite, greenstone	Prospect	
92JNE-075	Minto	Polymetallic veins	banded veins, lenses	Au, Ag; Pb, Cu	apy, py, sp, ccp; sti, po, gn [tet, native Au, jm]	argillite, ribbon chert, feldspar porphyry	Past Producer	(P) 546 115 g Au 1 573 338 g Ag 56 436 kg Pb 9 674 kg Cu
92JNE-076	Peerless	Polymetallic veins	veins, pods	Au, Ag; Zn, Pb	sp, native Au, py, gn	greenstone, argillite	Prospect	
92JNE-077	Golden	Stibnite veins	veins, lenses	Sb; Au, Ag	sti; py, apy, sp	greenstone, argillite	Prospect	
92JNE-086	Manners Zone	Skarn	massive, irregular	Au, Ag; Mo	mt, ccp, mo	chert, argillite, greenstone, diorite	Prospect	

MINFILE NUMBER	NAME	DEPOSIT TYPE	DEPOSIT CHARACTER	COMMODITIES	METALLIC MINERALS	HOST ROCKS	STATUS	PRODUCTION (P) RESERVES (R)
92JNE-089	Whynot	Stibnite veins	veins, disseminations	Au, Ag	sti, apy, py	shale, conglomerate, greenstone	Showing	
92JNE-092	Leckie	Polymetallic vein	vein	Au, Ag; Cu, Pb, Zn	apy, sp, py, ccp	serpentinized peridotite, gabbro	Prospect	
92JNE-095	Northern Light 1	Polymetallic vein	vein	Au, Ag	apy, py	serpentinite, diorite	Prospect	
92JNE-099	Shulaps Range	Chromite	podiform, disseminated	Cr	chr	serpentinized peridotite	Showing	
92JNE-100	Taylor Basin	Chromite	disseminated	Cr	chr	serpentinite	Showing	
92JNE-102	Liza Lake A	Magnesite	veins, pods	magnesite		quartz-carbonate-mariposite-altered ultramafic rocks (listwanite)	Showing	
92JNE-105	Northern Light 6	Polymetallic vein	vein	Au, Ag; Cu	apy, py; sp, ccp	quartz diorite	Prospect	
92JNE-107	Biliyo Zone	Skarn	vein, massive, irregular	Au, Ag; Cu	py, po, apy, mt, ccp	greenstone, felsite	Prospect	
92JNE-108	Jewel	Polymetallic vein	vein	Au, Ag; Cu	ccp, py, apy	serpentinite, diorite	Past Producer	(P) 3732 g Au 404 g Ag 199 kg Cu
92JNE-111	Jim Creek	Nephrite Jade	tabular, irregular	nephrite		serpentinite	Showing	
92JNE-120	Paul	Cinnabar	veinlets, disseminations	Hg	cn	greenstone	Showing	
92JNE-121	New Discovery	Massive sulphide	disseminated to massive pods, lenses	Au, Cu, Zn	ccp, sp; gn, po	greenstone	Developed Prospect	
92JNE-123	Marshall Ridge	Limestone	lenses	limestone		chert, argillite	Showing	
92JNE-124	Commodore	Low-sulphide (mesothermal) gold-quartz veins	vein	Au, Ag	py, apy	tonalite	Prospect	
92JNE-127	Liza Lake B	Magnesite	veins, pods	magnesite		quartz-carbonate-mariposite-altered ultramafic rocks (listwanite)	Showing	
92JNE-129	Kelvin	Polymetallic vein	vein	Au, Ag; Cu, Zn	ccp, py, apy; sp, gn	chert, argillite, greenstone	Prospect	
92JNE-130	Hillside Zone	Stibnite veins	veins, breccia	Au, Sb	sti, apy; po	chert, argillite, greenstone, diorite	Prospect	

MINFILE NUMBER	NAME	DEPOSIT TYPE	DEPOSIT CHARACTER	COMMODITIES	METALLIC MINERALS	HOST ROCKS	STATUS	PRODUCTION (P) RESERVES (R)
92JNE-129	Kelvin	Polymetallic vein	vein	Au, Ag; Cu, Zn	ccp, py, apy; sp, gn	chert, argillite, greenstone	Prospect	
92JNE-130	Hillside Zone	Stibnite veins	veins, breccia	Au, Sb	sti, apy; po	chert, argillite, greenstone, diorite	Prospect	
92JNE-131	Lou Zone	Stibnite veins	veins, disseminations	Au, Sb; Ag, Cu	py, sti, tet, apy	chert, argillite, greenstone, feldspar porphyry	Developed Prospect	(R) Proven: 34466t: 2.74 g/t Au Probable: 89793t: 2.40 g/t Au
92JNE-132	Howard Zone	Stibnite veins	veins, breccia	Au, Sb; Ag, Cu	py, apy, sti, tet [native Au]	chert, argillite, greenstone, gabbro, feldspar porphyry	Developed Prospect	(R) Probable and Possible: 267505t: 11.31 g/t Au
92JNE-133	Paul Zone	Stibnite veins	veins	Au, Ag; Cu, Sb	py, apy, tet, sti	greenstone, feldspar porphyry	Developed Prospect	(R) Possible: 83444 t: 9.6 g/t Au
92JNE-134	Norma	Vein	vein	Au, Ag	py	greenstone	Showing	
92JNE-136	Senator	Stibnite veins	veins, pods	Sb; Au, Ag	sti	greenstone, chert	Prospect	
92JNE-139	Bill Miner	Vein	vein	Au		greenstone, chert	Showing	
92JNE-140	Liza Lake C	Magnesite	veins, pods	magnesite		quartz-carbonate-mariposite-altered ultramafic rocks (listwanite)	Showing	
92JNE-141	Peridotite Creek	Chromite	disseminated	Cr	chr	serpentinized dunite and harzburgite	Showing	
92JNE-149	Mudmain	Magnesite	banded and comb-textured veins, pods	magnesite		quartz-carbonate-mariposite-altered ultramafic rocks (listwanite)	Showing	
92JW-026	Native Son	Polymetallic vein	fracture-controlled replacement; quartz-calcite stockworks	Au, Cu, Pb, Zn	apy, py, ccp, gn, sp, po	sandstone, shale, quartz diorite	Showing	

Abbreviations: apy = arsenopyrite, bn = bornite, cc = chalcocite, ccp = chalcopyrite, chr = chromite, cn = cinnabar, dn = danaite, ery = erythrite, gn = galena, jm = jamesonite, km = kermesite, lm = limonite, lo = loellingite, mal = malachite, mar = marcasite, mo = molybdenite, mt = magnetite, py = pyrite, po = pyrrhotite, sfl = safflorite, sch = scheelite, skt = skutterudite, sp = sphalerite, sti = stibnite, tel = telluride, tet = tetrahedrite, ur = uraninite

TABLE 5
MINOR MINERAL OCCURRENCES, 92J/14, 15

OCCURRENCE NO.	DESCRIPTION (Metallic Minerals, Vein Description, Assays, etc.)	REFERENCES
1	ccp, sp (qtz vein)	AR 9526
2	apy, (cal vein)	AR 15399
3	apy (qtz-carb vein; 2.02 ppm Au over 10 cm)	AR 15399
4	cn	AR 9062
5	cn	Pearson (1975)
6	sti	AR 9062
7	gn, apy, sp (3.80 ppm Au; 28.3 ppm Ag; 1542 ppm As; 38 ppm Sb; 375 ppm Cu; 8818 ppm Pb; 1798 ppm Zn)	AR 17790
8	sti, apy, sp (massive vein 20-30 cm wide with adjacent stringers: 5.90 ppm Au; 8.9 ppm Ag; 3629 ppm As; 239 ppm Sb; 71 ppm Cu; 626 ppm Pb; 582 ppm Zn)	AR 17790
9	apy (4.67 ppm Au; 4.5 ppm Ag; 228 ppm As; 46 ppm Sb; 249 ppm Cu; 104 ppm Pb; 6685 ppm Zn)	AR 17790
10	py, gn, sp (ALPHA vein: 10.0 ppm Au and 8.91 ppm Ag over 1.0 m)	AR 17062
11	py, sp, gn (BETA vein: 3.40 ppm Au and 6.17 ppm Ag over 1.0 m)	AR 17062
12	apy, py, sp, gn (MANHATTAN vein: up to 12.0 ppm Au over 2.0 m)	Sampson
13	apy, py, sp, gn (TYAX vein: up to 40.8 ppm Au over 1.0 m)	Sampson
14	sti, py (ORO A vein: up to 13.17 ppm Au and 16.11 ppm Ag over 2.0 m)	Sampson
15	py, sti (ORO B vein: up to 9.63 ppm Au, 590 ppm Ag and 0.10% Sb)	Sampson
16	apy, py, sti (up to 4.42 ppm Au over 9.5 m)	Sampson
17	py (5.18 ppm over 1.0 m)	Sampson
18	apy, py, sti (up to 6.34 ppm Au over 2.0 m)	Sampson
19	apy, py (2.19 ppm Au over 1.0 m)	Sampson

Abbreviations: AR = BCMEMPR Assessment Report, apy = arsenopyrite, cal = calcite, carb = carbonate, ccp = chalcopyrite, cn = cinnabar, gn = galena, py = pyrite, po = pyrrhotite, qtz = quartz, sp = sphalerite, sti = stibnite
Sampson refers to unpublished data obtained by C.J. Sampson, 1991

TABLE 6
LITHOGEOCHEMICAL ANALYSES, 92J/14, 15

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	DESCRIPTION
L8801	2	< 0.5	32	< 1	0.5	86	3	93	65	< 6		lm
L8803	1	< 0.5	750	8	8	35	3	103	25	< 6	11	qtz-carb-mrp alt
L8804	1	< 0.5	0.12%	< 1	1	15	48	32	0.13%	< 6	36	qtz-carb-mrp alt
L8806	1	< 0.5	15	2	0.7	6	6	47	20	< 6		carb alt
L8808	3	< 0.5	272	12	3	107	4	191	40	< 6	56	qtz-carb-mrp alt
L8809	162	0.6	4000	570	120	128	9	62	360	< 6		lm
L8810	1	< 0.5	12000	11	< 0.5	36	15	75	8	< 6		diss py
L8811	4	< 0.5	15	2	0.3	16	4	18	23	< 6		qtz vein, lm, py
L8812	3	0.5	66	3	1	78	6	148	87	< 6		diss py-po
L8813	9	< 0.5	1500	120	1.05	3	4	6	107	< 6	-	qtz-carb-mrp alt
L8814	10	< 0.5	1400	13	378	4	3	11	96	< 6	502	qtz-carb-mrp alt
L8815	1	< 0.5	168	1	0.8	38	5	66	142	< 6		clay and carb alt
L8817	7	< 0.5	422	15	9	7	3	39	0.16%	< 6	85	qtz-carb vein
L8822	2	< 0.5	147	13	0.9	47	26	365	46	< 6		diss py
L8823	1	0.6	180	6	2	0.29	4	20	10	< 6		qtz alt, mal, ccp, py
L8824	1	< 0.5	15	1	3	212	8	220	92	< 6		diss po
L8831	1	< 0.5	404	< 1	< 0.5	8	3	16	0.13%	< 6	79	qtz-carb-mrp alt
L8832	1	< 0.5	35	< 1	< 0.5	7	50	15	570	< 6	271	qtz-carb-mrp alt
L8836	1	< 0.5	460	7	0.7	23	16	49	2	< 6		carb alt, diss py, ccp, mal
L8837	1	< 0.5	24	2	13	43	76	121	140	< 6		diss py
L8838	1	< 0.5	36	< 1	< 0.5	77	4	16	16	< 6		diss py, ccp, po
L8839	7	< 0.5	20	3	3	49	19	48	68	< 6		qtz vein, py-po
LAR28	3	0.3	3500	27	54	40	1	60		1	4	from AR 9526
LAR29	3	0.2	2800	6	14	17	1	32		2	4	from AR 9526
LAR30	3	0.2	5000	2	1	55	1	60		2	2	(from AR 9526)
LAR31	3	0.2	1600	2	1	55	1	32		1	2	from AR 9526
LAR32	3	0.2	1450	12	-	20	1	33		3	2	from AR 9526
LAR33		< 0.2	2415	8	< 2	42	4	46			< 5	qtz-carb veins (from AR 13709)
LAR34		< 0.2	> 2000	< 2	< 2	42	9	58				carb veins (from AR 13709)
LAR35		< 0.2	> 2000	8	4	22	7	42				ank alt (from AR 13709)
LAR36		< 0.2	> 4000	< 2	< 2	59	6	59			< 5	qtz alt (from AR 13709)
LAR37		0.2	350	320	48	36	16	56				qtz-carb veins, diss py (from AR 13709)
LAR38		< 0.2	1100	< 2	< 2	10	5	31				(from AR 13709)
LAR39		0.2	1560	< 2	< 2	33	8	38				diss py (from AR 13709)
LAR40		< 0.2	230	128	< 2	20	2	35				qtz veins, diss py (from AR 13709)
LAR41	58	0.6		220	3			138				trace py (from AR 14810)
LAR42	5	1.4		460		8	7	26		1	1	qtz veins in qtz-carb-mrp alt (from AR 18869)
LAR43	220	1.3		1715		56	67	92		5	7	qtz veins in qtz-carb-mrp alt (from AR 18869)
LAR44	5	0.4		156		19	3	22		1	2	qtz-carb-mrp alt (from AR 18869)
LAR45	5	0.3		113		11	21	13		1	2	qtz-carb-mrp alt (from AR 18869)
LAR46	5	1.9		181		8	30	22		1	1	qtz-carb-mrp alt (from AR 18869)

Abbreviations: AR = BCMEMPR Assessment Report, ank = ankerite, alt = alteration, carb = carbonate, ccp = chalcopyrite, lm = limonite, mal = malachite, mrp = mariposite, py = pyrite, po = pyrrhotite, qtz = quartz

L88 samples were collected by staff of the B.C. Geological Survey Branch, and analyses performed by the Analytical Sciences Section, except gold which was analysed by Acme Analytical Laboratory Limited, Vancouver, B.C.

LAR data is from B.C. Ministry of Energy, Mines and Petroleum Resources assessment reports.

Analytical Techniques: Au by fire assay and atomic absorption spectroscopy; Ag, As, Sb, Cu, Pb, Zn, Ni and Mo by atomic absorption spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy.

TABLE 7
STREAM SEDIMENT GEOCHEMICAL ANALYSES, 92J/15

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Co (ppm)	Ba (ppm)
S811022	3	0.1	10	21.5	1.0	48	1	68	260	1	1	23	770
S811023	4	0.2	10	19.0	1.0	49	1	68	260	2	1	24	800
S811030	32	0.1	90	45.0	5.0	73	4	100	110	2	1	24	790
S811031	16	0.4	80	55.0	4.2	52	14	105	300	2	1	32	650
S811032	33	1.1	110	132.5	13.8	110	12	200	240	6	1	35	1400
S811033	25	0.2	180	53.5	4.4	62	4	100	235	2	1	29	1100
S811034	8	0.1	70	18.0	1.8	63	2	92	260	1	1	29	1100
S811035	10	0.1	170	95.0	5.8	45	3	74	90	1	1	16	550
S813034	4	0.1	70	24.0	2.6	63	1	75	475	1	1	28	240
S813035	11	0.1	40	38.5	1.2	48	1	59	158	1	1	19	480
S813036	4	0.1	40	6.0	0.8	50	1	37	248	2	1	17	390
S813037	11	0.1	240	132.5	8.0	50	5	60	53	5	3	13	790
S813039	5	0.1	70	5.5	0.8	46	2	78	370	2	1	33	990
S813040	4	0.1	60	3.0	0.6	45	2	89	275	2	1	25	1100
S813042	8	0.1	1650	12.0	3.0	49	1	93	420	2	1	35	1800
S813043	7	0.2	1400	14.5	4.2	53	4	96	114	1	1	26	680
S813044	2	0.1	160	4.5	6.0	32	2	58	82	1	1	14	550
S813045	8	0.2	410	16.0	2.2	80	3	115	162	2	1	28	1600
S813046	9	0.2	230	16.5	2.0	79	5	120	171	3	1	29	1500
S813048	10	0.1	140	21.5	1.0	41	1	64	190	3	1	17	500
S815015	10	0.1	20	14.5	0.4	25	1	26	46	1	4	6	350
S815016		0.1	10	16.0	-	40	4	60	36	2	12	8	
S815017	7	0.3	80	19.0	3.0	56	1	105	100	2	1	18	510
S815018	2	0.1	50	2.0	0.4	28	1	25	8	1	1	5	670
S815019	2	0.3	480	12.0	3.8	60	2	145	24	1	1	12	1400
S815020	2	0.3	70	7.0	1.0	43	1	88	15	1	1	11	200
S815023	10	0.4	130	55.0	4.2	49	1	94	850	2	1	53	520
S815024	16	0.4	150	75.0	11.2	68	5	125	135	3	1	27	630
S815025	22	0.3	60	83.0	5.6	80	4	115	165	5	1	30	520
S815026	8	0.2	190	15.0	2.6	50	1	91	630	2	1	43	740
S815027	21	0.2	140	73.0	15.0	66	6	115	230	2	1	30	720
S815028	7	0.3	30	5.5	0.6	44	2	56	980	1	1	55	100
S815029	2	0.3	90	3.0	0.4	39	1	74	680	1	1	48	420
S815030	2	0.2	130	3.5	0.4	37	1	72	680	1	1	96	420
S815116	4	0.1	250	82.5	1.4	55	1	115	280	1	1	28	490

Data for most elements are from Regional Geochemical Survey BC RGS-9, 1981: Ag, Cu, Pb, Zn, Ni, Mo and Co by atomic absorption spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy; As by hydride generation atomic absorption spectroscopy; Sb by HCl digestion with organic extraction followed by atomic absorption spectroscopy; W by colourimetric determination using fusion followed by organic extraction.

Au and Ba data extracted from Regional Geochemical Survey BC RGS-41, 1993, which re-analysed sediment pulps saved from the 1981 program using instrumental neutron activation.

TABLE 8
MOSS MAT GEOCHEMICAL ANALYSES, 92J/14, 15

SAMPLE NUMBER	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Cr (ppm)	Pt (ppb)
M88 34	2	0.2	300	11.0	3.0	74	7	167	39	2	2	33	1
M88 36	4	0.1		185.0	5.9	43	14	57	119	3	5	73	1
M88 37	3	0.2		20.5	2.2	40	8	62	155	1	1	158	1
M88 38	212	0.2		90.7	10.3	92	13	117	271	3	1	165	2
M88 39	164	0.4		155.9	13.2	88	24	147	198	3	1	168	2
M88 40	592	0.2		62.3	9.3	68	18	102	103	1	1	88	1
M88 41	2	0.2		8.9	1.0	33	3	83	73	1	1	71	1
M88 42	2	0.1		3.7	2.3	27	3	37	35	1	2	20	1
M88 43	3	0.2		15.6	4.1	58	7	97	101	1	1	82	1
M88 44	11	0.2		10.1	1.6	49	3	117	306	1	1	23	2
M88 45	68	0.3		17.5	1.6	37	10	81	103	1	1	85	1
M88 46	1	0.1		3.7	0.7	23	2	167	58	1	1	51	1
M88 47	1	0.2		6.5	1.2	25	8	66	560	1	1	188	3
M88 48	204	0.1		4.7	0.8	56	2	60	477	1	1	363	3
M88 49	1	0.1		3.4	0.7	36	6	72	619	1	1	558	3
M88 50	1	0.1		5.4	1.0	36	9	60	603	1	1	293	2
M88 51	2	0.1		20.9	1.0	46	4	49	676	1	2	571	4
M88 52	10	0.2		20.4	0.7	56	4	49	262	1	2	274	1
M88 54	8	0.2		11.6	2.4	74	8	143	1085	2	1	493	41
M88 55	3	0.1		33.3	4.6	39	2	136	268	1	1	102	1
M88 56	14	0.3		37.2	2.7	47	4	66	164	1	1	109	1
M88 57	1	0.1		8.3	3.3	40	5	50	41	1	1	35	1
M88 58	3	0.4		166.8	2.8	108	4	152	90	1	1	25	1
M88 59	*1103.1*	*0.1*		*101.9*	3.3	63	9	141	322	1	2	*218*	2
M88 60	1347	0.4		84.7	1.3	78	7	113	47	1	5	43	1
M88 61	13	0.3		6.1	1.4	53	2	105	275	1	1	264	2
M88 62	4	0.2		7.3	1.0	49	6	89	298	1	1	248	2
M88 63	67	0.2		23.9	2.6	72	9	71	270	1	2	101	2
M88 64	3	0.2		11.8	0.8	52	3	85	676	1	1	282	5
M88 65	11	0.1		20.2	0.8	33	2	34	57	1	1	40	1
M88 66	3	0.1		15.5	1.3	30	2	53	41	3	3	34	1
M88 67	2	0.1		3.5	0.6	29	7	36	9	1	2	68	1
M88 68	4	0.1		36.2	0.7	30	4	47	311	1	2	125	1
M88 69	28	0.3		16.1	1.2	240	5	51	146	2	1	82	1
M88 74	12	0.3		47.0	6.7	50	11	102	225	1	1	177	1
M88 75	133	0.2		57.6	7.2	60	4	135	261	2	1	172	3
M88 76	225	0.1		4.9	1.0	27	2	86	777	1	1	227	3
M88 77	1	0.1		11.3	1.6	84	8	206	98	4	1	50	1
M88 78	7	0.1		116.6	1.7	30	6	78	759	1	1	717	5
M88 79	9	0.2		13.0	1.2	82	11	134	973	2	1	498	5
M88 80	2	0.1		27.5	1.6	59	5	86	280	1	1	249	3
M88 81	105	0.1		36.2	2.6	71	5	92	298	1	1	361	1
M88 82	3	0.4		266.0	2.6	111	10	229	110	5	3	28	1
M88 83	21	0.1		143.2	2.6	62	2	134	284	1	1	191	1
M88 84	3	0.1		32.7	3.0	121	17	230	102	2	4	28	1
M88 85	13	0.1		110.7	1.0	76	5	115	53	1	2	30	1
M88 86	1	0.1		39.4	6.1	31	6	48	6	1	1	8	1
M88 87	1	0.1		7.1	0.2	23	2	59	23	1	1	57	1
M88 88	5	0.1		21.0	2.5	75	6	104	294	3	1	218	1

Samples were collected by staff of the B.C. Geological Survey Branch, and analyses performed by Acme Analytical Laboratory Ltd., Vancouver, B.C. Au and Pt by fire assay and mass spectroscopy; Ag, As, Sb, Cu, Pb, Zn, Ni, Mo, W and Cr by ICP spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy.

APPENDIX 10

Mineral Occurrences, Lithogeochemistry, Moss Mat Geochemistry and Regional Stream Geochemistry of the Bridge River Map Area

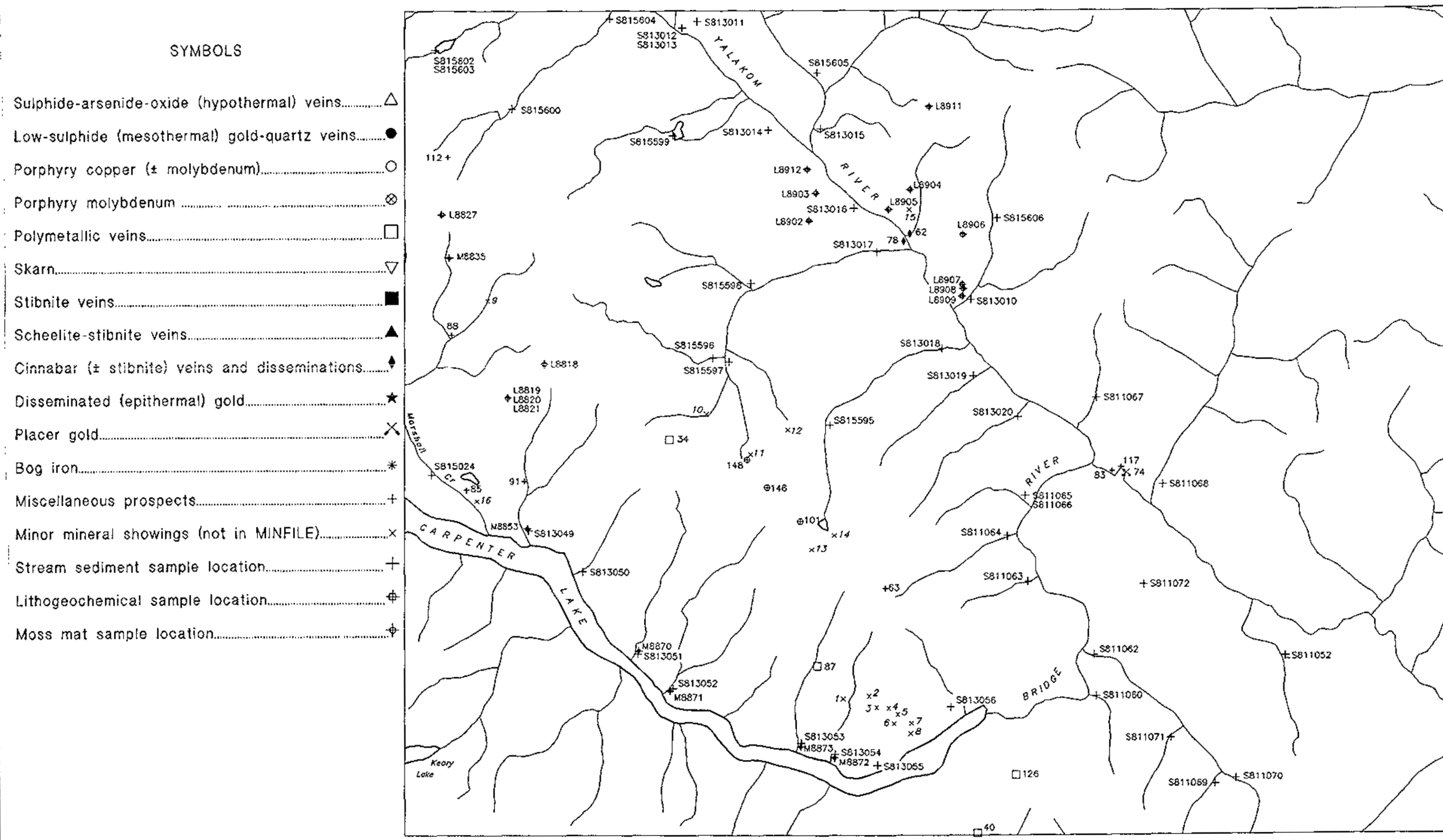


Figure 52. Mineral occurrences and geochemical sample sites in the Bridge River map area.

TABLE 9
MINFILE OCCURRENCES, 92J/16

MINFILE NUMBER	NAME	DEPOSIT TYPE	DEPOSIT CHARACTER	COMMODITIES	DOMINANT METALLIC MINERAL	HOST ROCKS	STATUS	PRODUCTION (P) RESERVES (R)
92JNE-034	Spokane	Polymetallic vein	vein	Au, Ag; Cu, Bi	ccp, po, py [native Bi, native Au]	granodiorite, hornblende feldspar porphyry	Prospect	
92JNE-040	Rhodes	Polymetallic vein	vein	Au, Ag; Cu	py, po; ccp	limestone, ribbon chert, argillite, granodiorite	Showing	
92JNE-062	Eagle	Cinnabar	veins, disseminations	Hg	cn; py	greenstone	Prospect	(P) 172 kg Hg (R) see 92JNE-078
92JNE-063	Birkenhead	Nephrite Jade	tabular lode	nephrite jade		serpentinite, ribbon chert, granodiorite	Past Producer	(P) 100 kg nephrite jade
92JNE-074	Horsehoe Bend	Placer	alluvial	Au	detrital native Au	fluvial gravels	Past Producer	(P) > 31290 g placer gold (total metal)
92JNE-078	Red Eagle	Cinnabar	veins, disseminations	Hg	cn	greenstone, greenstone breccia	Developed Prospect	(P) 232 kg Hg (R) 641702 t at 10.2 kg/t Hg (includes reserves for 92JNE-062)
92JNE-083	Moha	Vein	Vein	Au, Ag	native Au	greenstone	Showing	(P) 31g Au; 93g Ag
92JNE-085	Marshall Creek	Vein	veins, disseminations	Au, Ag	py	chert, argillite, greenstone	Prospect	
92JNE-087	Broken Hill	Polymetallic vein	veins, silicified zones, fractured zones	Au, Ag; Cu, Pb, Zn	py, gn, sp, ccp	chert-quartzite, slate, granodiorite, porphyritic dacite	Prospect	
92JNE-088	Shulaps	Vein	vein	Au, Ag; Cu	py, po	argillite, serpentinite	Showing	
92JNE-091	Jones	Lignite coal	lenses	lignite		shale, sandstone, dacitic tuff	Showing	
92JNE-101	Alpine	Porphyry	stockwork, veins, disseminations	Mo	mo; ccp	granodiorite	Showing	
92JNE-112	Shulaps Mountain	Chrysotile	fracture surface slip-fibres	chrysotile		serpentinite	Showing	
92JNE-117	Horseshoe Bend	Nephrite Jade	alluvial boulders	nephrite		serpentinite	Showing	
92JNE-126	King	Polymetallic vein	vein	Au, Ag; Pb, Zn	gn, sp, py, apy	chert, siltstone, granodiorite	Showing	
92JNE-146	Cub	Porphyry	stockwork, disseminations, veins	Mo, Au, Cu [Bi, Pb]	mo, ccp	granodiorite	Prospect	
92JNE-148	Lisa Dawn	Porphyry	stockwork, disseminations, veins	Mo, Cu, Au	mo [ccp]	granodiorite	Prospect	

Abbreviations: apy = arsenopyrite, ccp = chalcopyrite, cn = cinnabar, gn = galena, mo = molybdenite, py = pyrite, po = pyrrhotite, sp = sphalerite

TABLE 10
MINOR MINERAL OCCURRENCES, 92J/16

OCCURRENCE NO.	DESCRIPTION (Metallic Mineral, Vein Description, Assays, etc.)	REFERENCES
1	apy (5 ppb Au; 0.2 ppm Ag; 3000 ppm As; 0.3. ppm Sb)	AR 15397
2	apy (30 ppb Au; 0.1 ppm Ag; 700 ppm As; 0.5 ppm Sb)	AR 15397
3	apy (6300 ppb Au; 11.2 ppm Ag; > 10 000 ppm As; 26.0 ppm Sb)	AR 15397
4	apy, mal (510 ppb Au; 0.1 ppm Ag; > 10 000 ppm As; 3.8 ppm Sb)	AR 15397
5	apy (1650 ppb Au; 0.7 ppm Ag; > 10 000 ppm As; 15.8 ppm Sb)	AR 15397
6	apy (960 ppb Au; 0.6 ppm Ag; > 10 000 ppm As; 64.0 ppm Sb)	AR 15397
7	apy (50 ppb Au; 0.1 ppm Ag; 5400 ppm As; 1.6 ppm Sb)	AR 15397
8	apy (370 ppb Au; 0.1 ppm Ag; > 10 000 ppm As; 16.6. ppm Sb)	AR 15397
9	rusty qtz vein (2120 ppb Au)	AR 16445
10	apy, ccp (< 10 ppb Au; 9 ppm As; 85 ppm Cu)	AR 11758
11	ccp (30 ppb Au; 14 ppm As; > 10 000 ppm Cu)	AR 11758
12	apy (< 10 ppb Au; 2 ppm As; 50 ppm Cu)	AR 11758
13	ccp (< 10 ppb Au; 24.0 ppm Ag; 150 ppb Hg; 6 ppm As; 1.2. ppm Sb; 7500 ppm Cu; 4 ppm Mo)	AR 11758
14	apy, cpp (60 ppb Au; 0.8 ppm Ag; 10 ppb Hg; 340 ppm As; 0.7 ppm Sb; 180 ppm Cu; 15 ppm Pb; 79 ppm Zn; 4 ppm Mo; 45 ppm W)	AR 11758
15	cn	Stevenson (1940)
16	placer Au (production: 1906 to 1910: 6514 g; 1931-1935: 446 g; Total 6960 g Au)	Holland(1950) & McCann (1922)

Abbreviations: AR = BCMEMPR Assessment Report, apy = arsenopyrite, ccp = chalcopyrite, cn = cinnabar, mal = malachite; qtz = quartz

TABLE 11
LITHOGEOCHEMICAL ANALYSES, 92J/16

SAMPLE NUMBER	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	DESCRIPTION
L8818	1	< 0.5	<10	25	1	5	3	16	48	<6	qtz vein, lm
L8819	2	< 0.5	62	5	<0.5	0.37%	0.11%	31	17	<6	qtz vein, py, ccp, mal, az
L8820	1	< 0.5	179	22	0.5	480	46	290	315	<6	diss py
L8821	1	< 0.5	93	398	1	930	29	340	540	<6	diss py
L8827	4	< 0.5	<10	7	1	222	3	40	54	<6	mal, py
L8902	21	< 0.5	288	3	3	12	<6	27	0.17%	<8	qtz-carb-mrp alt
L8903	12	< 0.5	5100	8	2	12	<6	24	0.13%	<8	qtz-carb-mrp alt
L8904	4	< 0.5	2300	21	7	28	8	79	26	<8	qtz alt
L8905	8	< 0.5	11 000	7	33	5	<6	44	13	<8	carb alt
L8906	6	< 0.5	208	6	1	8	<6	18	9	<8	clay altered felsic dike
L8907	12	< 0.5	442	3	6	66	<6	63	65	<8	carb alt
L8908	5	< 0.5	112	6	3	13	<6	85	50	<8	carb altered felsic dike
L8909	11	0.7	45	2	5	18	<6	80	51	<8	carb alt
L8911	13	0.5	27	8	0.6	62	<6	85	22	<8	diss py
L8912	10	< 0.5	488	9	5	10	<6	48	0.16%	<8	qtz-carb-mrp alt

Abbreviations: alt = alteration, az = azurite, carb = carbonate, ccp = chalcopyrite,
diss = disseminated, lm = limonite, mal = malachite, mrp = mariposite, py = pyrite, qtz = quartz

Samples were collected by staff of the B.C. Geological Survey Branch, and analyses performed by the Analytical Sciences Section, except gold which was analysed by Acme Analytical Laboratory Limited, Vancouver, B.C.

Analytical Techniques: Au by fire assay and atomic absorption spectroscopy; Ag, As, Sb, Cu, Pb, Zn, Ni and Mo by atomic absorption spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy.

TABLE 12
STREAM SEDIMENT GEOCHEMICAL ANALYSES, 92J/16

SAMPLE NUMBER	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Co (ppm)	Ba (ppm)
S8110 24	8	0.3	90	20.5	1.2	48	2	95	300	1	1	29	600
S8110 52	3	0.1	10	5.0	2.0	41	4	85	405	3	1	35	600
S8110 60	2	0.1	10	12.5	0.6	86	3	89	175	3	1	28	570
S8110 62	5	0.2	30	21.5	0.6	49	-	87	140	1	1	21	790
S8110 63	2	0.4	30	19.5	0.2	56	-	95	150	3	1	17	650
S8110 64	4	0.4	20	18.0	0.6	105	1	115	160	2	1	32	450
S8110 65	4	0.2	20	14.5	0.6	90	3	120	90	3	1	27	690
S8110 66	6	0.2	20	16.0	0.8	92	2	120	90	4	1	26	670
S8110 67	2	0.4	120	8.5	0.2	40	3	110	40	2	1	10	410
S8110 68	2	0.3	70	3.5	0.6	60	1	89	150	2	1	23	270
S8110 69	3	0.2	30	7.5	0.6	45	1	125	240	2	1	24	940
S8110 70	3	0.2	80	7.5	0.6	47	4	103	235	2	1	27	830
S8110 71	10	0.1	20	7.5	0.8	65	5	90	160	2	1	27	800
S8110 72	2	0.4	40	5.0	0.1	28	4	70	50	2	1	12	600
S8130 10	2	0.1	870	8.5	1.8	43	3	135	21	1	1	16	600
S8130 11	2	0.1	120	7.0	1.8	53	5	150	54	2	1	17	820
S8130 12	3	0.1	90	5.5	0.6	24	1	60	830	1	1	45	360
S8130 13	2	0.1	60	5.5	0.8	24	1	60	800	1	1	45	280
S8130 14	2	0.1	180	11.5	1.0	30	5	93	345	1	1	28	590
S8130 15	2	0.1	40	4.5	0.6	23	5	75	37	1	1	11	690
S8130 16	5	0.1	40	26.5	1.2	46	2	74	430	1	1	35	430
S8130 17	13	0.2	60	16.0	1.0	50	2	70	290	1	1	27	660
S8130 18	36	0.1	30	17.5	1.2	55	2	86	360	1	1	35	610
S8130 19	3	0.1	30	8.5	1.0	40	2	94	195	1	1	25	800
S8130 20	27	0.1	30	17.5	1.2	50	5	20	222	1	1	28	610
S8130 49	8	0.2	30	15.0	1.8	54	3	86	73	2	1	17	1300
S8130 50	2	0.1	140	7.5	0.8	36	1	86	39	2	1	15	1100
S8130 51	5	0.2	260	11.5	1.2	82	5	115	101	4	1	20	1500
S8130 52	9	0.1	610	16.0	2.2	150	12	165	75	10	1	21	2400
S8130 53	3	0.1	120	10.0	1.2	82	6	92	70	2	1	32	330
S8130 54	2	0.1	100	5.0	0.4	86	1	120	72	3	1	43	190
S8130 55	3	0.1	100	7.0	0.4	38	1	50	17	1	1	9	310
S8130 56	7	0.1	40	14.5	0.4	39	3	75	50	1	1	13	760
S8155 96	5	0.4	160	9.5	1.0	45	6	92	650	2	1	49	550
S8155 97	6	0.4	50	35.5	1.0	56	1	97	340	3	2	30	810
S8155 99	7	0.2	20	13.5	1.0	20	1	42	600	1	1	40	290
S8156 00	3	0.1	10	9.5	0.4	45	1	36	300	1	1	29	100
S8156 02	2	0.3	20	8.0	0.2	20	1	33	1300	1	1	55	100
S8156 03	6	0.3	10	7.5	0.4	18	1	30	1300	1	1	52	120
S8156 04	2	0.3	20	7.5	0.2	30	1	42	1150	1	1	59	100
S8156 05	5	0.2	20	1.5	0.2	10	1	64	15	1	1	6	650
S8156 06	3	0.2	70	7.5	1.2	32	3	150	23	1	1	9	570

Data for most elements are from Regional Geochemical Survey BC RGS-9, 1981: Ag, Cu, Pb, Zn, Ni, Mo and Co by atomic absorption spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy; As by hydride generation atomic absorption spectroscopy; Sb by HCl digestion with organic extraction followed by atomic absorption spectroscopy; W by colourimetric determination using fusion followed by organic extraction.

Au and Ba data extracted from Regional Geochemical Survey BC RGS-41, 1993, which re-analysed sediment pulps saved from the 1981 program using instrumental neutron activation.

TABLE 13
MOSS MAT GEOCHEMICAL ANALYSES, 92J/16

SAMPLE NUMBER	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Cr (ppm)	Pt (ppb)
M8835	202	0.4	20	23	2	91	14	66	456	1	1	440	2
M8853	592	0.3	-	34	2	83	9	132	106	2	1	104	1
M8870	5	0.2	-	16	2	101	15	161	97	5	1	72	1
M8871	6	0.3	-	17	2	130	15	169	65	11	1	29	1
M8872	1	0.1	-	6	2	82	7	119	69	1	1	83	1
M8873	1	0.2	-	11	2	98	3	105	72	1	1	91	1

Samples were collected by staff of the B.C. Geological Survey Branch, and analyses performed by Acme Analytical Laboratory Ltd., Vancouver, B.C. Au and Pt by fire assay and mass spectroscopy; Ag, As, Sb, Cu, Pb, Zn, Ni, Mo, W and Cr by ICP spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy.

APPENDIX 11

Mineral Occurrences, Lithogeochemistry, Moss Mat Geochemistry and Regional Stream Geochemistry of the Noaxe Creek and Big Bar Creek Map Areas

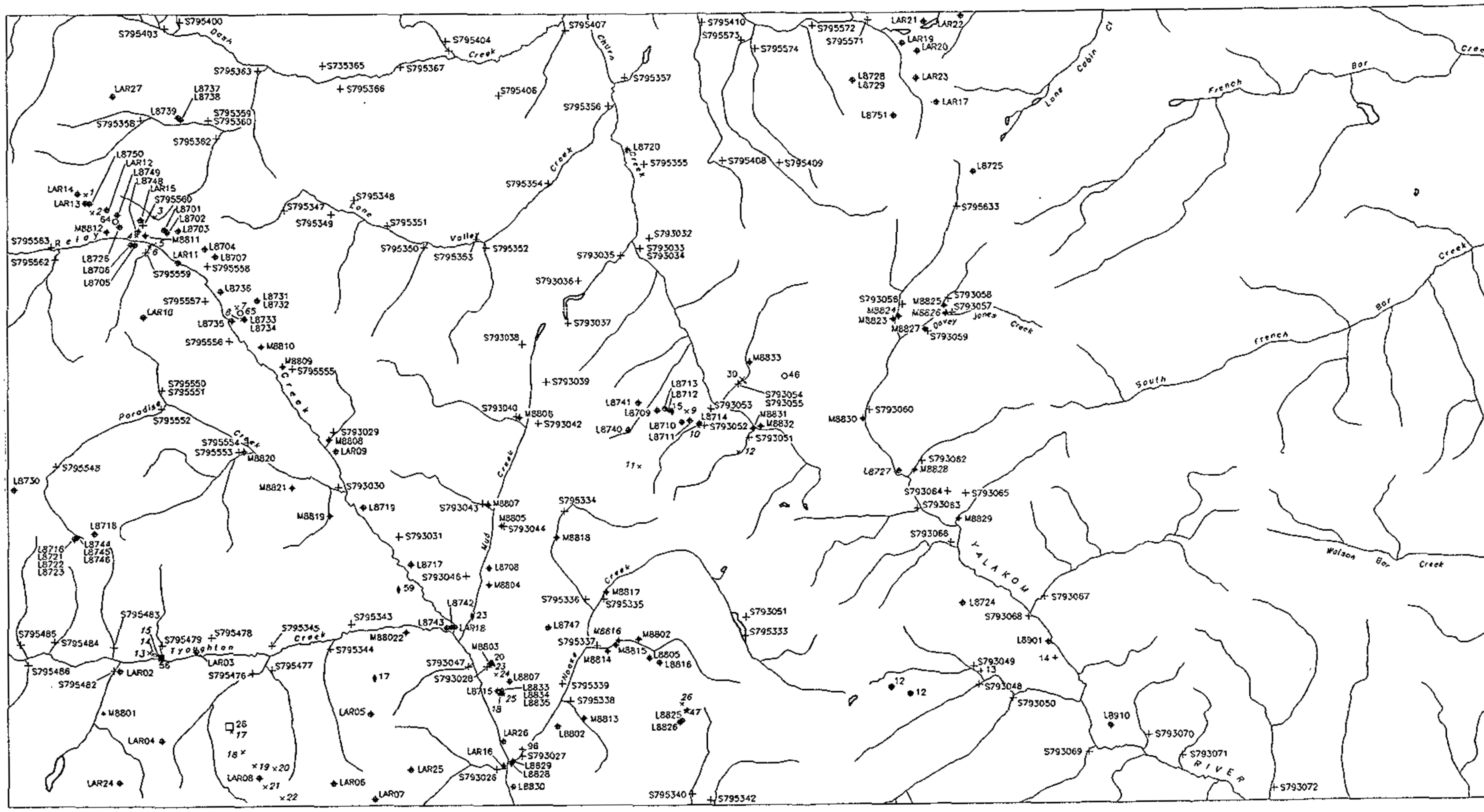


Figure 53. Mineral occurrences and geochemical sample sites in the Noaxe Creek and Big Bar Creek map areas. *See* Figure 52 for list of symbols.

TABLE 14
MINFILE OCCURRENCES, 92O/1, 2

MINFILE NUMBER	NAME	DEPOSIT TYPE	DEPOSIT CHARACTER	COMMODITIES	DOMINANT MET. MINERALS	HOST ROCKS	STATUS	PRODUCTION (P) RESERVES (R)
920-012	Elizabeth-Yalakom	Low-sulphide (mesothermal) gold-quartz veins	veins, lenses	Au, Ag; Pb, Zn	apy, py,ccp, gn, sp, native Au; po, mt, mo.	porphyritic quartz diorite	Developed Prospect	(P) 155g Au; 155g Ag; 24 kg Pb; 8 kg Zn; [from Elizabeth veins]
920-013	Blue Creek	Nephrite Jade	botryoidal pods	nephrite jade		serpentinite melange; calc-silicate alteration zones	Showing	
920-014	Sunny	Magnesite	banded and comb-textured veins	magnesite		quartz-carbonate-mariposite-altered serpentinite (listwanite)	Showing	
920-015	Apex	Cinnabar	lenses, veinlets, disseminations	Hg	cn	quartz-carbonate-mariposite-altered serpentinite (listwanite)	Prospect	
920-017	Silverquick	Cinnabar	disseminations, lenses, smears on fault planes	Hg	cn	chert-pebble conglomerate, sandstone, shale	Past Producer	(P) 3247.5 kg Hg
920-018	Tungsten Queen	Scheelite-stibnite veins	banded, crustified and comb-textured veins	W; Sb, Au	sch; sti [cn]	quartz-carbonate-mariposite-altered serpentinite (listwanite)	Past Producer	(P) 7896 kg WO_3 concentrate
920-020	Tungsten King	Scheelite-stibnite veins	banded veins	W; Sb	sch; sti [cn]	limestone-dolomite; listwanite	Past Producer	(P) 1.8 kg WO_3 concentrate
920-023	Manitou	Cinnabar	veins, disseminations, smears along foliation	Hg	cn	foliated greenstone; contacts between greenstone and chert	Past Producer	(P) 690 kg Hg
920-026	Robson	Polymetallic veins	veins and seams of solid sulphide	Au, Ag; Pb, Zn, Cu	apy,py; jm, sp, ccp, sti, blg, pya	granodiorite and related porphyritic dikes	Developed Prospect	(P) 2208 g Au 18071 g Ag 2640 kg Pb 1+l4393 kg Cu
920-030	Poisonmount Creek	Placer	alluvial	Au	detrital native Au	fluvial gravel	Past Producer	(P) 2644 g placer gold (total metal)
920-046	Poison Mountain	Pophyry	stockwork, disseminations, veins	Cu, Mo, Au	py, ccp, mo, bn, cc, cv.	hornblende-biotite quartz diorite and granodiorite, biotite hornfels	developed prospect	(R) 808 526 000 t: 0.23% Cu, 0.007% Mo, 0.122 g/t Au
920-047	Big Sheep Mountain	Disseminated (epithermal) gold	disseminations; veinlets	Au; Ag	py; tet, lm	quartz-feldspar porphyritic rhyolite	Prospect	

MINFILE NUMBER	NAME	DEPOSIT TYPE	DEPOSIT CHARACTER	COMMODITIES	DOMINANT MET. MINERALS	HOST ROCKS	STATUS	PRODUCTION (P) RESERVES (R)
920-056	Eva	Stibnite veins	veins, disseminations	Au, Sb; Cu, Bi	sti, apy, bsmn, ccp, py	conglomerate, sandstone, siltstone, feldspar porphyry	Prospect	
920-059	Mugwump	Cinnabar	disseminations; veinlets	Hg; Sb	cn; sti	chert- pebble conglomerate; quartz-carbonate-mariposite altered serpentinite (listwanite)	Developed Prospect	
920-064	XYZ	Porphyry	disseminations, veins	Cu, Mo, Au	ccp, mo; apy, sp, po.	quartz-feldspar porphyry, horneblende-feldspar porphyry, sandstone, shale	Showing	
920-065	ABC	Porphyry	disseminations	Cu	ccp, py, po	quartz-feldspar porphyry, horneblende-feldspar porphyry, sandstone, shale	Showing	
920-096	Noaxe Creek	Magnesite	irregular pods, veins	magnesite		quartz - carbonate - mariposite-altered serpentinite (listwanite)	Showing	

Abbreviations: apy = arsenopyrite, blg = boulangerite, bn = bornite, bsmn = bismuthinite, cc = chalcocite, ccp = chalcopyrite, cn = cinnabar, cv = covellite, ga = galena, jm = jamesonite, lm = limonite, mo = molybdenite, po = pyrrhotite, py = pyrite, pya = pyrargyrite, sch = scheelite, sp = sphalerite, sti = stibnite, tet = tetrahedrite,

TABLE 15
MINOR MINERAL OCCURRENCES, 92O/1, 2

OCCURRENCE NO.	DESCRIPTION	REFERENCES
1	apy (275 ppb Au)	AR 11037
2	apy, sp, po, tet (DDH RYC.001: up to 1 ppm Au over 5.0 met	AR 18780
3	ccp, mo	AR 8866
4	ccp, mo	AR 8866
5	ccp	AR 8866
6	sp	AR 8866
7	ccp	AR 4597
8	ccp	AR 4597
9	cn	AR 1916
10	cn	PF
11	cn	Leech (1953)
12	cn	PF
13	sti, apy (2700 ppb Au; 1.5 ppm Ag; 4167 ppm Sb)	AR 14932
14	wo (skarn)	AR 17331
15	sti, apy (4500 ppb Au; 0.9 ppm Ag; 8812 ppm Sb)	AR 14932
17	apy, sp	AR 5659
18	apy	AR 5659
19	apy, ccp	AR 6002
20	apy	AR 6002
21	sti (7 cm wide vein)	AR 5659
22	pn , po	Church and MacLean (1987c)
23	cn	Stevenson (1940)
24	cn	Stevenson (1940)
25	cn	AR 10948
26	sp, ccp (10 ppb Au; 23.2 ppm Ag)	AR 10925

Abbreviations: AR = BCMEMPR Assessment Report, PF = BCMEMPR Property File, apy = arsenopyrite, ccp = chalcopyrite, cn = cinnabar, mo = molybdenite, pn = pentlandite, po = pyrrhotite, sp = sphalerite, sti = stibnite, tet = tetrahedrite, wo = wollastonite

TABLE 16
LITHOGEOCHEMICAL ANALYSES, 92O/1, 2

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	DESCRIPTION
L8701	<20	<0.5	600	63	2	31	7	95	115	<10		qtz-carb vein
L8702	<20	<0.5	725	22	10	20	24	200	13	<10		qtz-carb vein
L8703	31	<0.5	810	11	4	24	8	43	61	<10		carb alt
L8704	<20	<0.5	515	15	3	22	3	36	25	<10		carb alt
L8705	<20	<0.5	110	13	0.9	400	12	12	37	<10		lm, diss po
L8706	<20	<0.5	120	6	<0.5	173	3	20	12	<10		FP, diss po-py
L8707	<20	<0.5	3400	10	7	40	8	58	57	<10		carb alt
L8708	21	<0.5	20	3	2	14	3	27	25	<10		qtz-carb vein
L8709	<20	<0.5	30	8	0	4	<3	21	0.14%	<10		qtz-carb-mrp alt
L8710	<20	<0.5	29	11	5	5	<3	28	0.16%	<10		qtz-carb-mrp alt
L8711	<20	<0.5	20	6	10	3	23	20	0.10%	<10		qtz-carb-mrp alt
L8712	<20	<0.5	25	5	0.7	18	<3	40	0.14%	<10		qtz-carb-mrp alt
L8713	<20	<0.5	10	2	<0.5	5	3	10	730	<10		qtz-carb-mrp alt
L8714	<20	<0.5	62	1	<0.5	7	<3	30	0.12%	<10		qtz-carb-mrp alt
L8715	21	<0.5	17000	133	820	5	<3	32	530	<10		qtz-carb-mrp alt
L8716	62	<0.5	15	10	5	257	<3	28	7	<10		calc-silicate alt, diss py
L8717	<20	<0.5	1880	18	6	30	7	82	190	<10		carb alt
L8718	23	<0.5	130	3	1	23	4	83	34	<10		FP carb alt
L8719	<20	<0.5	43	1	<0.5	41	4	115	18	<10		FP carb alt
L8720	<20	<0.5	830	27	18	36	180	760	12	<10		carb alt
L8721	<20	<0.5	10	22	7	27	5	54	5	<10		calc-silicate alt, diss py
L8722	<20	<0.5	<10	9	2	74	4	34	3	<10		calc-silicate alt, diss py
L8723	30	<0.5	25	3	1	90	6	28	15	<10		HFP, py
L8724	<20	<0.5	<10	<1	<0.5	13	<5	38	0.11%	<10		qtz alt
L8725	<20	<0.5	300	3	0.9	5	22	34	4	<10		lm
L8726	<20	<0.5	323	3	0.5	299	4	10	43	<10		diss py
L8727	<20	<0.5	231	12	0.8	32	7	72	20	<10		carb alt
L8728	36	<0.5	30	24	<0.5	9	12	84	4	<10		qtz vein, lm
L8729	<20	<0.5	52	22	<0.5	7	9	50	2	<10		qtz vein, lm
L8730	<20	<0.5	<10	41	5	43	6	81	<3	<10		lm alt
L8731	<20	<0.5	32	16	0.5	43	9	99	22	<10		diss py
L8732	<20	<0.5	1350	430	26	34	13	63	20	<10		altered FP
L8733	<20	<0.5	172	5	<0.5	107	7	33	43	<10		qtz alt, diss py
L8734	<20	<0.5	15	5	0.5	257	5	15	7	<10		QFP, qtz alt
L8735	<20	<0.5	92	3	0.5	35	9	74	25	<10		HFP, diss py
L8736	<20	<0.5	60	5	0.7	135	9	70	33	<10		qtz alt, py
L8737	<20	<0.5	16	6	0.5	17	<5	54	0.15%	<10		qtz-carb-mrp alt
L8738	<20	<0.5	<10	2	<0.5	3	<5	20	0.17%	<10		qtz-carb veins in qtz-carb-mrp alt
L8739	<20	<0.5	30	11	<0.5	31	<5	30	0.11%	<10		cdy veins in qtz-carb-mrp alt
L8740	<20	<0.5	310	1	0.5	45	<5	64	182	<10		mgs veins in carb-altered bx
L8741	26	<0.5	380	400	43	10	<5	25	800	<10		qtz-carb-mrp alt
L8742	<20	<0.5	2750	2	3	5	<5	33	0.15%	<10		qtz-carb-mrp alt

TABLE 16
LITHOGEOCHEMICAL LANALYSES, 92O/1,2

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	DESCRIPTION
L8743	<20	<0.5	850	11	10	15	13	58	16	<10		FP carb alt , diss py
L8744	<20	<0.5	<10	8	5	29	26	48	6	<10		calc-silicate alt, diss py
L8745	36	<0.5	<10	2	<0.5	26	7	49	23	<10		HFP, diss py
L8746	34	<0.5	<10	4	<0.5	233	8	49	20	<10		py
L8747	<20	<0.5	422	11	3	76	7	78	40	<10		FP carb alt , diss po
L8748	20	<0.5	176	3	<0.5	530	6	37	47	10		diss po- py
L8749	<20	<0.5	78	6	1	540	3	14	46	<10		diss po- py
L8750	27	<0.5	325	12	0.7	18	3	30	4	<10		HFP, carb alt
L8751	<20	<0.5	15	4	0.5	40	12	93	40	<10		altered andesite
L8802	1	<0.5	90	3	0.6	32	4	104	44	<6		lm alt, trace cn
L8805	7	0.8	200		3	234	35	24	10	<6		po, py, lm
L8807	1	<0.5	2000		<0.5	48	4	126	90	<6		mrp
L8816	1	<0.5	113		0.7	219	9	126	16	<6		qtz veins, apy, ccp, py
L8825	1	<0.5	31		2	7	15	81	11	<6		QFP, lm veins
L8826	4	<0.5	16		1	6	23	54	4	<6		QFP, py-ccp stringers
L8828	3	<0.5	156	1		5	8	24	0.16%	<6	60	carb alt, diss. py
L8829	4	<0.5	344	4	2	8	3	23	0.14%	<6	40	carb- mrp alt, trace cn
L8830	2	<0.5	16	1	0.5	16	3	38	0.17%	<6	34	qtz-carb-mrp alt
L8833	1	<0.5	200	1	0.5	8	3	28	0.17%	<6	19	qtz-carb-mrp alt, sti
L8834	1	<0.5	700	1	0.5	6	6	10	520	<6	249	qtz-carb-mrp alt, sch
L8835	1	<0.5	515	2	13	53	8	27	14	<6	287	qtz-carb-mrp alt
L8901	13	<0.5	68	4	0.7	7	<3	17	0.14%	<8		qtz-carb-mrp alt
L8910	10	<0.5	42	2	0.5	4	<6	16	0.17%	<8		qtz-carb-mrp alt
LAR02		3.2		1000	10000	42	5	32		5	3	from AR 9526
LAR03	3	0.2	5000	8	1	57	2	210		5	2	from AR 9526
LAR04	3	0.2	1300	1	3	20	1	40		1	2	from AR 9526
LAR05	3	0.2	2400	30	6	22	1	56		1	2	from AR 9526
LAR06	1100	9.8	160	1000	230	24	575	148		7	3	from AR 9526
LAR07	30	0.2	1100	20	1	28	1	47		1	4	from AR 9526
LAR08	250		5075	>1000	17							from AR 6002
LAR09	3	0.2	900	10	6	30	1	83		2	2	from AR 9438
LAR10	3	0.2	5000	58	14	27	1	85		3	6	from AR 9439
LAR11	2740			>1000		11				1		FP, qtz veins (from AR 8866)
LAR12	410	0.4										qtz-carb veins (from AR 9876)
LAR13	3900	0.7										qtz veins (from AR 9876)
LAR14	2100	5.5										qtz veins, trace apy (from AR 9876)
LAR15	2700	0.7										(from AR 9876)
LAR16	1		3300	4								from AR 10376
LAR17			1600									qtz-bio alt (from AR 17953)
LAR18	5	0.2	>5000	1	4.6							qtz-carb-mrp alt (from AR 18303)
LAR19	<5	<0.2	770	5	<5	3	18	19		1	5	clay alt, lm-hem (from AR 18214)
LAR20	10	0.4	300	72	20	10	25					shear zone (from AR 18099)
LAR21	12	1.1	490	23	3	37	18					cdy veinlets, lm (from AR 18099)
LAR22	5	0.3	71875			5	33					clay-qtz alt, carb, lm (from AR 18099)
LAR23	5	0.1	560	4	1	5	16					carb veinlets (from AR 18099)
LAR24	5	0.2	1310	40	1	11	10	19		32	4	from AR 9526

TABLE 16

LITHOGEOCHEMICAL LANALYSES, 92O/1,2

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	DESCRIPTION
LAR25	3	0.2	1600	2	1	31	3	68		1	2	from AR 9526
LAR26	3	0.2	1950	5	1	22	3	50		5	3	from AR 9526
LAR27	<5			2								qtz-carb-mrp alt (from AR 8888)

Abbreviations: alt = alteration, apy = arsenopyrite, AR = BCMEMPR Assessment Report, bio = biotite, bx = breccia, carb = carbonate, ccp = chalcopyrite, cdy = chalcedony, cn = cinnabar, diss = disseminated, FP = feldspar porphyry, hem = hematite, HFP = hornblende feldspar porphyry, lm = limonite, mgs = magnesite , mrp = mariposite, po = pyrrhotite, py = pyrite, qtz = quartz, sch = scheelite, sti = stibnite

L87, L88 and L89 samples were collected by staff of the B.C. Geological Survey Branch, and analyses performed by the Analytical Sciences Section, except gold which was analysed by Acme Analytical Laboratory Limited, Vancouver, B.C.

Analytical Techniques: Au by fire assay and atomic absorption spectroscopy; Ag by standard fire assay (L87 and L88 samples) or by atomic absorption spectroscopy (L89 samples); As, Sb, Cu, Pb, Zn, Ni and Mo by atomic absorption spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy.

LAR data is from B.C. Ministry of Energy, Mines and Petroleum Resources assessment reports.

TABLE 17
STREAM SEDIMENT GEOCHEMICAL ANALYSES, 92O/1, 2

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Co (ppm)	Ba (ppm)
S791023	2	0.1	80	2	0.4	27	3	45	49	1	1	11	570
S793026	25	0.1	400	60	10	51	8	86	196	1	1	25	610
S793027	4	0.1	370	6.5	1.5	40	1	76	445	1	1	36	700
S793028	2	0.1	6000	15	34.2	39	5	80	190	2	30	23	640
S793029	5	0.1	210	13	1.7	39	3	68	29	1	1	16	580
S793030	2	0.1	210	10	1.5	41	4	112	21	1	1	15	760
S793031	2	0.1	200	4	1.3	19	3	64	37	1	1	13	490
S793032	2	0.1	150	3.5	0.8	32	3	61	76	1	1	15	530
S793033	3	0.1	200	12	1.9	86	4	78	174	1	1	20	550
S793034	8	0.1	990	11	1.9	95	1	80	180	2	1	20	560
S793035	2	0.1	120	2.5	1	38	1	78	99	1	1	21	620
S793036	2	0.1	110	5.5	1.6	29	2	115	36	2	1	16	610
S793037	2	0.1	380	11	3	41	2	140	200	2	1	23	440
S793038	2	0.1	220	7	2.4	48	3	92	92	2	1	23	520
S793039	6	0.1	370	12	2.8	30	2	74	200	1	1	22	480
S793040	3	0.1	320	4.5	1.9	25	3	64	42	1	1	14	600
S793042	2	0.1	250	7	2.3	22	3	64	38	1	1	10	540
S793043	6	0.1	300	5	1.7	26	2	60	34	1	1	12	560
S793044	2	0.1	400	5.5	1.5	29	3	68	72	1	1	15	540
S793046	62	0.1	900	17	0.9	44	5	132	39	2	1	18	480
S793047	2	0.1	80	11	0.3	15	1	33	1700	1	1	70	100
S793048	2	0.1	80	9.5	0.4	14	1	30	1650	1	1	66	110
S793049	7	0.1	110	33	2.4	21	1	34	1800	1	1	77	110
S793050	2	0.1	80	0.5	0.2	15	1	26	2050	1	1	86	100
S793051	2	0.1	2000	7	1.7	32	3	86	210	1	1	24	600
S793052	26	0.1	330	3.5	0.8	30	1	74	550	1	1	37	610
S793053	2	0.1	600	6.5	2.6	26	3	92	260	1	1	24	490
S793054	41	0.1	180	19	2.9	400	2	72	28	3	1	17	560
S793055	28	0.1	230	21	2.8	390	2	70	24	3	1	16	570
S793056	2	0.1	60	4	0.7	22	2	60	26	1	1	13	640
S793057	2	0.1	80	3	0.6	18	1	56	26	1	1	8	560
S793058	2	0.1	100	5	1.1	24	3	60	26	1	1	11	600
S793059	2	0.1	90	3.5	0.7	26	4	70	24	1	1	13	540
S793060	2	0.1	370	3	0.8	19	4	52	32	1	1	6	490
S793062	2	0.1	90	3.5	0.7	26	4	56	44	1	1	11	530
S793063	2	0.1	80	5	0.7	19	1	44	1500	1	1	63	240
S793064	2	0.1	60	3	0.7	20	2	49	67	1	1	11	590
S793065	2	0.1	50	3.5	0.7	23	3	54	62	1	1	12	580
S793066	2	0.1	50	5	0.4	15	1	28	1900	1	1	72	100
S793067	2	0.1	40	3	0.7	22	2	58	40	1	1	12	600
S793068	2	0.1	50	7.5	2.4	29	3	198	360	1	1	27	670
S793069	12	0.1	40	5.5	0.4	32	1	34	1700	1	2	77	100

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Co (ppm)	Ba (ppm)
S793070	12	0.1	150	7	2.5	30	3	158	215	3	1	21	720
S793071	2	0.1	50	3	1.4	18	1	72	520	1	1	27	350
S793072	2	0.1	60	2.5	0.8	19	2	56	30	1	1	10	580
S793085	2	0.1	90	0.5	0.6	19	2	48	37	1	1	14	560
S795333	3	0.1	50	3.5	0.3	14	1	30	1400	1	1	68	100
S795334	2	0.1	1400	5.5	1.3	24	3	62	115	1	1	16	420
S795335	4	0.1	470	7	1.6	39	2	68	525	1	1	37	370
S795336	2	0.1	1100	6.5	1.2	34	4	76	120	1	1	20	560
S795337	2	0.1	400	6	1.3	44	1	71	435	1	1	34	260
S795338	2	0.1	380	5	1.2	38	5	74	200	1	3	20	500
S795339	7	0.1	390	5.5	1.3	38	1	68	440	1	1	33	390
S795340	30	0.1	420	5	2.4	23	5	56	915	1	1	51	250
S795342	2	0.1	240	5.5	1.1	26	2	46	1100	1	1	57	130
S795343	4	0.1	200	11	2.7	39	6	136	33	2	1	14	750
S795344	7	0.1	9200	31	3	42	5	87	75	1	1	18	360
S795345	2	0.1	230	14	2.3	43	6	135	21	3	1	14	870
S795347	4	0.1	260	7.5	1.2	27	3	83	58	2	1	17	540
S795348	9	0.1	1100	3.5	1.1	29	4	64	28	1	1	13	510
S795349	2	0.1	200	5	1.7	37	4	98	55	1	1	17	520
S795350	6	0.1	240	5.5	1.3	33	3	82	89	1	1	18	450
S795351	3	0.1	330	3	1.4	29	4	88	56	1	1	18	490
S795352	3	0.1	200	5	1.6	29	4	93	87	1	1	17	530
S795353	2	0.1	310	4.5	1.4	24	3	78	64	1	1	15	520
S795354	11	0.1	180	6.5	1.4	28	4	84	69	1	1	16	460
S795355	2	0.1	80	4	0.6	61	2	75	57	1	1	19	500
S795356		0.1	1200	16		48	4	80	45	1	1	17	
S795357	2	0.1	170	4	0.7	37	4	62	34	1	1	13	350
S795358	14	0.1	110	9.5	2.4	43	3	76	126	1	1	25	440
S795359	2	0.1	190	8	1.9	36	3	79	126	1	1	24	400
S795360		0.1	200	5		38	1	88	154	1	1	28	
S795362	588	0.1	450	16	1.7	48	4	78	82	1	1	18	580
S795363	8	0.1	240	7.5	2	33	3	71	93	1	1	19	470
S795364	2	0.1	160	5	0.9	27	4	68	49	1	1	16	450
S795365	2	0.1	110	2	0.7	17	3	48	20	2	1	9	550
S795366	2	0.1	100	2.5	0.7	24	3	55	25	1	1	10	430
S795367	3	0.1	130	5	0.7	23	4	63	33	1	1	11	430
S795394	3	0.1	120	3.5	1.1	31	4	85	98	1	1	22	350
S795400	484	0.1	100	2.5	0.9	20	3	57	28	1	1	12	570
S795403	2	0.1	180	4	1	29	5	71	49	1	1	15	500
S795404	2	0.1	160	3	0.6	28	5	68	53	2	1	12	420
S795405	3	0.1	140	5.5	1.1	25	1	64	49	1	1	13	530
S795406		0.1	160	3		25	2	64	28	1	1	12	
S795407	2	0.1	170	2.5	0.9	22	2	61	21	1	1	11	480
S795408	2	0.1	100	1	0.4	25	3	60	17	1	1	13	490
S795409	2	0.1	60	3	0.6	30	2	67	18	1	1	12	610
S795410	2	0.1	2000	2	0.4	15	1	57	24	2	1	11	530

TABLE 17

STREAM SEDIMENT GEOCHEMICAL ANALYSES, 92O/1, 2

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Co (ppm)	Ba (ppm)
S795476	16	0.1	270	115	9.2	70	9	162	24	3	1	17	790
S795477	19	0.1	500	215	13.8	53	11	120	71	2	1	16	540
S795478	3	0.1	140	9	3	43	4	260	24	2	1	14	820
S795479	2	0.1	250	9.5	1.8	37	2	129	18	1	1	15	440
S795482	2	0.1	170	8.5	1.5	41	3	123	16	2	1	13	610
S795483	6	0.1	110	9	1.2	40	1	100	14	1	1	17	330
S795484	10	0.1	100	50	3.9	41	8	96	15	1	1	13	360
S795485	2	0.1	120	10	2.8	30	1	65	7	1	1	11	290
S795486	2	0.1	160	2	0.7	64	4	82	44	1	1	20	1000
S795548	2	0.1	100	11	1.4	54	4	131	22	1	1	15	640
S795550	120	0.1	90	13	1	42	9	87	28	1	1	15	1100
S795551	2	0.1	100	11	1	40	8	84	26	1	1	15	900
S795552	3	0.1	100	10	1.5	50	8	120	26	2	1	18	640
S795553	3	0.1	110	17	3.5	54	6	186	24	3	1	16	710
S795554	2	0.1	100	10	1.4	46	5	118	27	2	1	16	670
S795555	3	0.1	120	6	1.2	32	3	72	38	1	1	12	520
S795556	2	0.1	250	2.5	0.7	23	3	66	30	1	1	12	510
S795557	3	0.1	290	4.5	1	28	4	77	30	1	1	11	520
S795558	4	0.1	480	12	2.2	42	4	82	40	1	1	17	480
S795559	2	0.1	170	15	1.5	56	5	85	29	1	1	14	510
S795560	40	0.1	930	11	2.7	122	3	76	60	2	1	16	460
S795562	2	0.1	120	13	1.3	50	8	92	32	1	1	13	770
S795563	2	0.1	130	11	1.3	44	7	99	46	1	1	17	580
S795571	2	0.1	270	5	0.6	23	4	54	24	1	1	11	700
S795572	2	0.1	60	6	0.5	36	1	62	17	1	1	14	300
S795573	2	0.1	80	3.5	0.4	37	2	60	21	1	1	14	500
S795574	2	0.1	60	2.5	0.3	42	1	66	22	2	1	16	470
S795633	2	0.1	60	2	0.5	23	2	61	31	1	1	15	700

Data for most elements are from Regional Geochemical Survey BC RGS-3, 1979: Ag, Cu, Pb, Zn, Ni, Mo and Co by atomic absorption spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy; As by hydride generation atomic absorption spectroscopy; W by colourimetric determination after pyrosulfate fusion and a dithiolcarbonate complexing.

Au, Sb and Ba data extracted from Regional Geochemical Survey BC RGS-35, 1993, which re-analysed sediment pulps saved from the 1979 program using instrumental neutron activation.

TABLE 18
MOSS MAT GEOCHEMICAL ANALYSES, 92O/1, 2

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Cr (ppm)	Pt (ppb)
M8801	2	0.1	140	9	2	58	9	147	21	2	1	18	2
M8802	4	0.1	170	10	3	78	17	91	532	1	1	282	6
M8803	4	0.1	23000	14	15	28	11	54	148	1	6	78	2
M8804	3	0.1	16000	7	2	39	19	98	90	1	27	76	2
M8805	1	0.1	880	7	2	28	12	71	62	1	1	66	2
M8806	113	0.1	6200	9	2	29	15	70	46	1	1	57	2
M8807	2	0.1	400	6	2	31	13	79	49	1	1	47	2
M8808	8	0.1	260	13	2	40	7	83	41	1	2	35	1
M8809	8	0.3	160	21	2	45	17	82	49	1	3	47	1
M8810	10	0.1	180	35	3	87	8	95	50	1	6	53	1
M8811	18	0.2	430	15	2	178	7	91	56	2	1	63	1
M8812	15	0.1	130	59	2	52	9	167	37	1	1	44	2
M8813	3	0.1	420	10	2	43	14	86	218	1	12	146	1
M8814	1	0.1	230	2	2	53	12	89	361	1	3	241	2
M8815	2	0.1	280	8	2	48	12	103	387	1	1	165	3
M8816	3	0.2	550	9	2	69	13	96	564	1	1	291	8
M8817	3	0.2	820	15	3	52	5	82	684	1	1	265	2
M8818	1	0.1	73600	10	2	35	9	84	172	1	2	130	1
M8819	2	0.2	290	13	2	39	13	153	35	1	1	29	1
M8820	1	0.2	90	12	2	41	13	174	26	1	1	24	1
M8821	34	0.1	120	11	2	44	16	125	46	1	1	38	2
M8822	1	0.2	220	31	2	43	15	136	25	1	1	17	1
M8823	40	0.1	80	14	2	31	12	116	31	1	1	32	1
M8824	1	0.1	50	7	3	35	19	92	33	1	1	40	1
M8825	1	0.4	40	9	2	39	11	100	31	1	1	36	1
M8826	129	0.3	50	9	3	32	14	72	41	1	3	45	1
M8827	1	0.3	60	10	2	26	11	64	48	1	2	47	1
M8828	2	0.4	50	12	2	32	16	73	63	1	3	58	1
M8829	1	0.3	40	12	2	33	13	68	76	1	2	66	1
M8830	7	0.5	70	15	4	43	17	124	80	1	3	63	1
M8831	4	0.2	1900	11	2	43	14	97	214	1	1	160	1
M8832	5	0.5	780	8	2	41	14	87	514	1	3	465	2
M8833	21	0.9	70	17	2	299	9	77	39	2	1	44	1

Samples were collected by staff of the B.C. Geological Survey Branch, and analyses performed by Acme Analytical Laboratory Ltd., Vancouver, B.C. Au and Pt by fire assay and mass spectroscopy; Ag, As, Sb, Cu, Pb, Zn, Ni, Mo, W and Cr by ICP spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy.

APPENDIX 12

Mineral Occurrences, Lithogeochemistry and Regional Stream Geochemistry of the Warner Pass Map Area

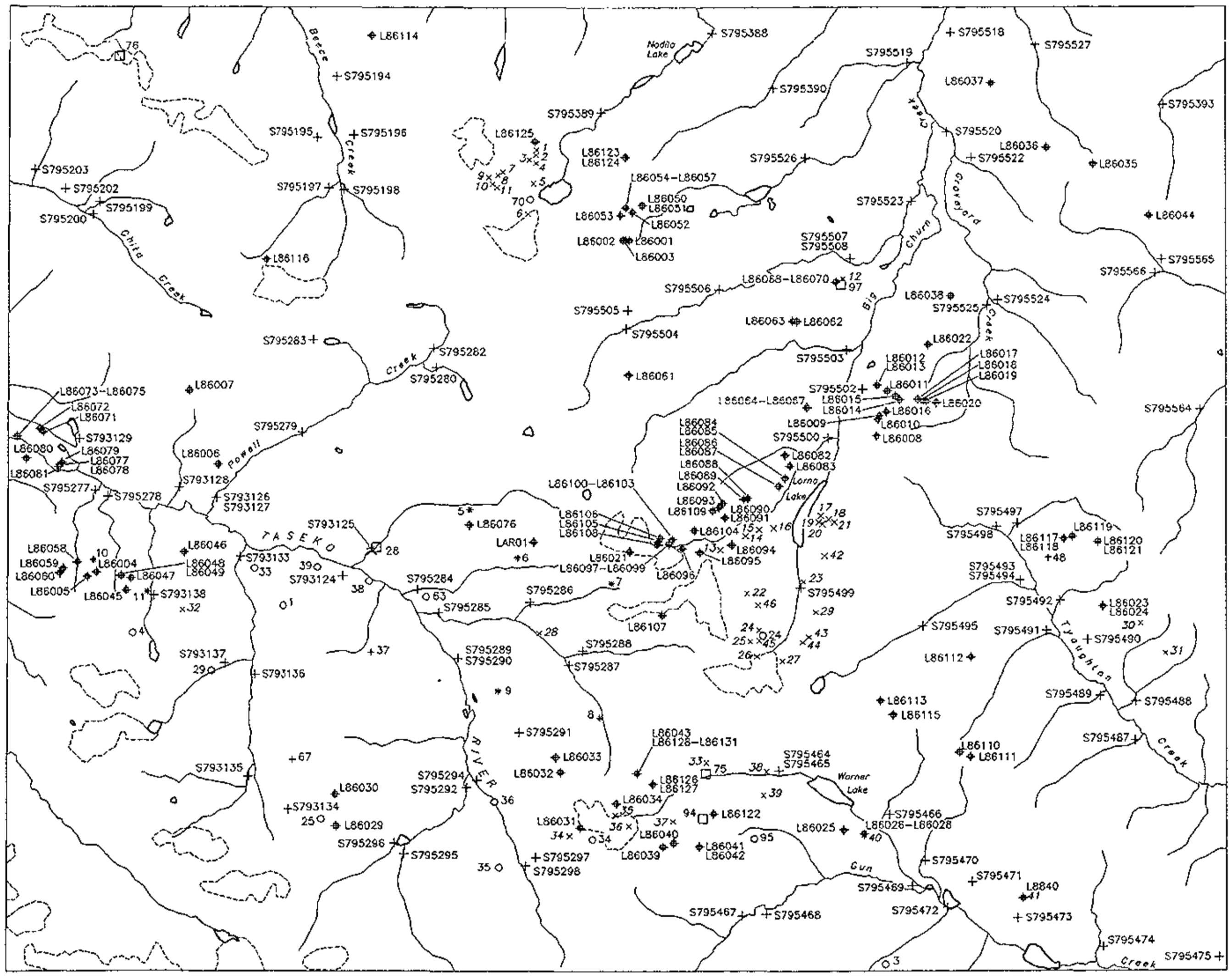


Figure 54. Mineral occurrences and geochemical sample sites in the Warner Pass map area. *See* Figure 52 for list of symbols.

TABLE 19
MINFILE OCCURRENCES, 92O/3

MINFILE NUMBER	NAME	DEPOSIT TYPE	DEPOSIT CHARACTER	COMMODITIES	DOMINANT MET. MINERALS	HOST ROCKS	STATUS	PRODUCTION (P) RESERVES (R)
920-001	Mohawk	Porphyry	stockwork, breccia	Cu, Au, Ag; Mo	ccp, py; mo	biotite granodiorite	Prospect	
920-003	Copper Mountain	Porphyry	stockwork, veins, breccia	Cu, Ag, Mo; Zn, Pb	ccp; py, bn, mo, sp, gn	hornblende biotite granodiorite	Prospect	
920-004	Spokane	Porphyry	veins, stockwork	Cu, Au, Ag; W	ccp, apy, py; sch	biotite hornblende granodiorite	Prospect	
920-005	Battlement Creek	Bog iron	surficial	Fe	lm	alluvium	Prospect	(R) 12 000 t: 49% Fe
920-006	Rae Creek	Bog iron	surficial	Fe	lm	alluvium	Prospect	(R) 9800 t: 49% Fe
920-007	Feo Creek	Bog iron	surficial	Fe	lm	alluvium	Prospect	(R) 15 900 t: 48% Fe
920-008	Denain Creek	Bog iron	surficial	Fe	lm	alluvium	Prospect	(R) 20 000t: 47% Fe
920-009	Forrest	Bog iron	surficial	Fe	lm	alluvium	Prospect	(R) 74 000 t: 45% Fe
920-010	Limonite	Bog iron	surficial	Fe	lm	alluvium	Prospect	(R) 348 000 t: 45% Fe
920-011	Chilcotin	Bog iron	surficial	Fe	lm	alluvium	Prospect	(R) 114 000 t: 49% Fe
920-024	BJB	Porphyry	stockwork, veins	Cu; Mo	ccp; mo [sp, gn]	andesite, volcanic breccia and tuff	Showing	
920-025	Rowbottom	Porphyry	disseminations, fracture fillings	Cu; Mo	ccp; mo	homeblende quartz diorite, quartz feldspar porphyry dikes	Prospect	
920-028	Taylor-Windfall	Polymetallic veins	tourmaline and sulphide-rich veins	Au, Ag	py, ten, ccp; sp, gn, tet, eng, native Au	dacitic and andesitic tuff	Past Producer	(P) 14525 g Au 156 g Ag
		Placer	eluvial	Au	detrital native Au	eluvium	Past Producer	(P) 3484 g placer gold (total metal)
920-029	Phair	Porphyry	veinlets in shear zone	Cu; Ag	py, ccp	hornblende biotite granodiorite	Showing	
920-033	Empress	Porphyry	disseminations, fracture coatings, veinlets	Cu; Au	py, ccp; mo, bn	andesitic flows, volcanic breccia and tuff	Showing	(R) 10 004 000 t: 0.61% Cu 0.789 g/t Au

MINFILE NUMBER	NAME	DEPOSIT TYPE	DEPOSIT CHARACTER	COMMODITIES	DOMINANT MET. MINERALS	HOST ROCKS	STATUS	PRODUCTION (P) RESERVES (R)
920-034	Taylor Mountain	Porphyry	stockwork, disseminations	Cu, Mo	py, ccp, mo	quartz diorite	Showing	
920-035	Westside	Porphyry	stockwork, disseminations	Cu	ccp	hornblende biotite quartz diorite	Showing	
920-036	Canyon	Pophyry	stockwork, disseminations	Cu	ccp	hornblende biotite quartz diorite	Showing	
920-037	Top	Porphyry	disseminations	Mo, Cu, Au	mo, ccp	pegmatite dike in granodiorite	Showing	
920-038	Buzzer	Porphyry	stockwork	Cu, Mo; Au, Ag	py, ccp; mo	porphyritic quartz diorite	Showing	(R) 4 990 000 t: 0.35% Cu
920-039	Bur	Porphyry	stockwork	Cu; Mo	ccp; mo	granodiorite	Showing	
920-048	Brass Tags #3	Epithermal gold	breccia, fracture fillings, disseminations	Au	py; apy, sti, po	siltstone, biotite feldspar pophyry, quartz porphyry	Showing	
920-063	Teek	Porphyry	disseminations	Cu	ccp, py	granodiorite	Showing	
920-067	Massena	Vein	vein	Au	lm	porphyritic dike, quartz diorite	Showing	
920-070	Grab	Porphyry	disseminations, veinlets	Cu	ccp; po, gn, sp, mo	quartz eye rhyolite, andesite, diorite; argillite, sandstone, conglomerate	Showing	
920-075	Warner Creek	Polymetallic vein	vein, stockwork	Ag; Cu, Zn, Au	tet; sp, sti [cn]	andesite flows	Showing	
920-076	Taseko Mountain	Polymetallic veins	veins, stockwork	Au, Ag, Cu, Zn	apy, sp, ccp, py	andesitic breccia, lapilli tuff, andesite to basalt flows	Showing	
920-094	BK	Polymetallic veins	veins, disseminations	Ag, Zn, Pb	sp, gn, py, ccp	andesitic agglomerate	Showing	
920-095	Porphyry	Porphyry	veins, disseminations	Cu; Ag, Au	ccp	feldspar hornblende porphyry, agglomerate	Showing	
920-097	Big Creek	Polymetallic veins	veins, stockwork, disseminations	Au, Ag, Zn; Cu	sp, apy; ccp, py	andesitic tuff and breccia	Showing	

Abbreviations: apy = arsenopyrite, bn = bornite, ccp = chalcopyrite, cn = cinnabar, cv = covellite, eng = enargite, gn = galena, lm = limonite, mo = molybdenite, po = pyrrhotite, py = pyrite, sch = scheelite, sp = sphalerite, sti = stibnite, ten = tennantite, tet = tetrahedrite

TABLE 20
MINOR MINERAL OCCURRENCES, 92O/3

OCCURRENCE NO.	DESCRIPTION	REFERENCES
1	ccp	AR 5159
2	ccp, mal, cv, sp	AR 5159
3	ccp	AR 5159
4	ccp, gn, sp	AR 5159
5	ccp, gn, sp	AR 5159
6	ccp, gn, sp	AR 5159
7	sp	AR 5159
8	ccp	AR 5159
9	ccp, az, mo	AR 5159
10	ccp	AR 5159
11	ccp	AR 5159
12	gn, sp (410 ppb Au; 3000 ppm As; 10 ppm Sb)	AR 8890, 10089
13	ccp	AR 3850
14	mo	AR 3850
15	mo	AR 3850
16	ccp, mo	AR 3850
17	ccp, mo	AR 3850
18	ccp	AR 3850
19	ccp	AR 3850
20	ccp	AR 3850
21	ccp	AR 3850
22	ccp	AR 3850
23	ccp, mal	AR 3850
24	ccp	AR 3850
25	ccp, mal	AR 3850
26	ccp	AR 3850
27	ccp, mo	AR 3850
28	apy, sp, ccp (20 cm wide quartz vein: 180 ppb Au; 83.0 ppm Ag; 7.4 ppm Hg; 730 ppm As; 2600 ppm Cu;1200 ppm Zn)	AR 10191
29	mo	AR 3850
30	ccp, bn	AR 9753
31	gn, sp, apy	AR 9753
32	ccp	AR 19466
33	bog lm	BCMMAR (1920) p.186
34	ccp, mal	AR 9550
35	ccp	AR 17358
36	mal, az	AR 17358
37	sp, mal, tet (535 ppb Au; 15.8 ppm Ag; 1916 ppm Cu; 138 ppm Zn)	AR 13742
38	mal	AR 17358
39	mal (145 ppb Au; 1.7 ppm Ag; 2.5 ppm Hg; 281 ppm Cu; 359 ppm Pb; 1326 ppm Zn)	AR 13742
40	mal, sp, bn (see L86026, L86027, and L86028 for assays)	
41	ccp, mal, az (see L8840 for assay)	
42	ccp, mo	PF 920-024
43	mo	PF 920-024
44	mo	PF 920-024
45	mo	PF 920-024
46	ccp, mt	PF 920-024

Abbreviations: AR = BCMEMPR Assessment Report, BCMMAR = Annual Report of the Minister of Mines, PF = BCMEMPR Property File, apy = arsenopyrite, az = azurite, bn = bornite, ccp = chalcopyrite, cv = covellite, gn = galena, lm = limonite, mal = malachite, mt = magnetite, mo = molybdenite, sp = sphalerite, tet = tetrahedrite

TABLE 21
LITHOGEOCHEMICAL ANALYSES, 92O/3

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	DESCRIPTION
L86001	<20	<10	<20	<25	<5	34	10	54	10	<3	clay alt
L86002	<20	<10	30	<25	<5	3	15	33	<3	<3	QFP - ser alt
L86003	<20	<10	<20	<25	<5	31	15	36	8	<3	
L86004	<20	<10	44	<25	<5	81	62	20	28	<3	qtz alt
L86005	<20	<10	50	<25	<5	19	11	11	3	7	clay alt
L86006	<20	<0.3	20	<40	<5	<10	12	24	0	<5	qtz-lm alt
L86007	<20	<0.3	23	<40	<5	39	<10	<10	0	<5	qtz (cdy) alt
L86008	<16	19	44	<20	<10	38	10	72	0	4	HFP - chl-ep alt; py
L86009	<16	11	32	<20	<10	31	10	113	0	6	HFP - qtz alt; py
L86010	24	<10	75	<20	<10	83	42	293	0	8	qtz alt; py
L86011	<16	11	20	<20	<10	57	43	271	0	2	qtz alt; po
L86012	<16	<10	36	<20	<10	15	7	77	0	4	qtz alt; py
L86013	22	<10	22	<20	<10	16	7	75	0	8	diss py
L86014	46	<10	<20	<20	<10	52	11	149	0	5	chl alt; py
L86015	<16	14	<20	<20	<10	55	9	82	0	7	chl-qtz alt; py
L86016	<16	10	<20	<20	<10	58	150	170	0	4	qtz alt; py
L86017	22	<10	433	<20	<10	550	47	70	0	10	cdy vein
L86018	20	11	56	<20	<10	11	10	<3	0	3	FP - clay alt
L86019	25	10	270	<20	<10	20	15	30	0	<2	FP - clay alt
L86020	<16	24	667	<20	<10	15	111	33	0	3	chl alt; po
L86021	17	<10	29	<20	<10	20	<5	5	0	5	qtz alt
L86022	<20	<0.3	402	<40	<5	44	18	119	0	<5	FP - diss py
L86023	117	<0.3	<20	119	<5	188	<10	127	0	<5	
L86024	<20	<0.3	<20	67	8	186	<10	109	0	<5	
L86025	<20	<0.3	<20	<40	<5	59	<10	31	0	<5	ep-hem alt
L86026	58	377	358	<40	20	1.06%	96	2298	0	<5	ep alt; mal, py
L86027	26	340	762	<40	15	2.01%	96	6986	0	<5	ep alt; mal, py
L86028	60	331	1500	<40	18	1.92%	102	5283	0	20	ep alt; mal , py
L86029	<20	<0.3	43	<40	<5	400	10	37	0	19	ep-chl-qtz-ser-py alt
L86030	<20	<0.3	30	<40	6	37	<10	10	0	<5	lm alt
L86031	26	10	734	423	75	1.71%	<10	41	0	768	qtz-carb vein; mal
L86032	<20	<0.3	33	<40	5	35	<10	<10	0	27	qtz-lm alt
L86033	<20	<0.3	35	<40	<5	33	<10	78	0	<5	qtz-py alt
L86034	<20	<0.3	<20	<40	<5	22	<10	46	0	<5	qtz-py alt
L86035	<20	<0.3	99	<40	<5	32	19	43	0	<5	clay alt
L86036	100	<0.3	1400	<40	<5	28	<10	64	0	<5	clay alt
L86037	<20	<0.3	943	<40	7	75	<10	49	0	<5	qtz veins
L86038	26	<0.3	23	149	13	58	<10	93	0	<5	diss py
L86039	34	<0.3	<20	<40	<5	21	<10	15	0	<5	
L86040	31	<0.3	<20	<40	<5	40	<10	35	0	<5	ser-qtz-py alt
L86041	23	<0.3	<20	<40	<5	40	<10	35	0	<5	qtz-ser alt
L86042	32	0.4	<20	<40	<5	141	23	125	0	<5	qtz-ser alt
L86043	24	1.3	239	<40	<5	18	<10	10	0	34	ser-clay alt
L86044	<20	<0.3	2000	121	18	68	<10	75	0	<5	clay alt
L86045	<20	<10	<20	25	<5	30	9	35	28	<3	qtz-py alt
L86046	<20	<10	<20	<25	<5	74	13	23	16	<3	qtz-py alt
L86047	<20	<10	25	<25	<5	47	7	102	30	7	qtz-py alt

TABLE 21

LITHOGEOCHEMICAL ANALYSES, 92O/3

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	DESCRIPTION
L86048	<20	<10	69	<25	<5	87	25	22	40	<3	diss py
L86049	<20	<10	129	<25	<5	95	20	15	40	<3	diss py
L86050	<20	<10	526	<25	<5	46	7	108	110	5	chl-ep alt
L86051	<20	<10	3140	<25	<5	46	10	131	86	<3	chl-ep alt
L86052	<20	<10	41	<25	<5	35	16	70	12	<3	clay alt
L86053	<20	<10	29	<25	<5	36	7	67	10	<3	QFP - ser alt
L86054	<20	<10	2010	162	7	76	30	100	200	103	qtz-lm alt
L86055	<20	26	239	72	<5	34	27	72	189	210	qtz alt
L86056	<20	<10	24	<25	<5	23	2	22	49	<3	qtz alt
L86057	<20	<10	40	<25	<5	37	2	32	81	17	qtz alt
L86058	<20	<10	<20	28	<5	140	5	84	32	<3	qtz-py alt
L86059	<20	<10	63	34	<5	23	5	19	<3	<3	qtz-ser-tour alt
L86060	<20	<10	21	35	<5	6	14	8	8	3	qtz alt
L86061	<20	<10	43	<25	<5	31	18	61	7	<3	carb alt
L86062	<20	<10	184	<25	<5	180	12	100	14	4	clay alt
L86063	<20	<10	169	<25	<5	23	28	50	15	<3	clay alt
L86064	<20	<10	<20	<25	<5	6	17	37	11	10	qtz-py alt
L86065	<20	<10	<20	<25	<5	107	13	60	39	10	qtz alt
L86066	22	<10	56	<25	<5	13	51	23	<3	12	QFP - clay alt
L86067	27	<10	50	<25	<5	14	40	22	<3	9	QFP - clay alt
L86068	22	<10	163	135	<5	87	50	325	30	<3	QFP - lm alt
L86069	42	<10	83	0.12%	<5	43	40	550	32	5	lm alt
L86070	34	<10	193	72	<5	61	14	128	58	<3	py vein
L86071	<16	11	196	<20	<10	4	26	115	0	9	QP - ser alt
L86072	<16	130	1390	33	<10	132	10	11	0	8	qtz-py alt
L86073	<16	<10	262	33	<10	30	7	4	0	8	diss py
L86074	<16	<10	307	<20	<10	42	<5	123	0	4	diss py
L86075	<16	<10	385	<20	<10	14	<5	<3	0	2	qtz alt
L86076	<16	<10	176	<20	<10	60	<5	4	0	6	clay alt; py
L86077	41	<10	605	86	<10	380	42	21	0	<2	qtz-ser alt
L86078	<16	12	162	<20	<10	39	17	<3	0	7	qtz-ser alt
L86079	<16	<10	600	140	<10	27	12	17	0	15	clay alt
L86080	<16	<10	3780	<20	<10	36	<5	5	0	<2	qtz alt
L86081	<17	<10	1060	54	<10	78	59	301	0	7	qtz-py alt
L86082	17	<10	28	<20	<10	330	20	435	0	2	diss py
L86083	<16	<10	<20	600	<10	900	14	51	0	<2	qtz-tour-py veins
L86084	<16	17	<20	<20	<10	118	10	62	0	<2	chl-ep alt; py-tour veins
L86085	<16	137	30	<20	<10	68	27	45	0	10	chl-ep alt; py
L86086	<16	10	<20	<20	<10	49	18	35	0	<2	chl-ep-qtz alt; py
L86087	<16	<10	<20	<20	<10	33	10	38	0	10	qtz alt
L86088	<16	<10	23	<20	<10	290	20	107	0	<2	diss py
L86089	38	<10	21	<20	<10	20	8	6	0	<2	qtz-py alt
L86090	<16	<10	<20	<20	<10	54	11	25	0	<2	chl-ep alt; py
L86091	<16	<10	<20	<20	<10	54	9	26	0	<2	chl-ep alt; py
L86092	<16	<10	<20	<20	<10	114	9	95	0	<2	
L86093	<16	10	20	159	<10	33	10	39	0	<2	diss py
L86094	<16	16	<20	<20	<10	360	55	86	0	9	
L86095	<16	26	57	<20	<10	35	6	52	0	2	chl-ep alt
L86096	<16	<10	<20	<20	<10	23	9	70	0	3	chl-ep alt; py
L86097	<16	<10	51	<20	<10	18	5	76	0	105	ser alt; py
L86098	18	10	225	<20	<10	17	4	<3	0	37	
L86099	<16	10	71	<20	<10	26	10	5	0	27	clay alt; py

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	DESCRIPTION
L86100	20	<10	700	<20	<10	4	4	<3	0	5	qtz alt; py
L86101	21	<10	2120	<20	13	4	3	<3	0	6	qtz-clay alt
L86102	<16	<10	26	<20	<10	18	17	80	0	7	clay alt: py
L86103	<16	<10	<20	<20	<10	15	10	39	0	2	clay alt
L86104	17	10	800	<20	20	82	21	429	0	2	ser alt; py
L86105	<16	<10	790	<20	13	9	3	<3	0	4	clay alt
L86106	306	<10	551	<20	<10	52	3	55	0	84	clay-qtz-py alt
L86107	<16	<10	77	167	<10	83	14	229	0	6	qtz alt; py
L86108	<16	<10	35	60	<10	43	4	3	0	11	clay alt; py
L86109	<20	<0.3	39	<40	<5	35	12	72	0	<5	qtz alt
L86110	<20	<0.3	297	<40	<5	45	<10	57	0	<5	qtz-carb vein
L86111	<20	<0.3	672	45	<5	<10	<10	20	0	<5	qtz-carb vein
L86112	21	<0.3	129	<40	<5	14	<10	44	0	<5	QFP - carb alt
L86113	<20	<0.3	30	167	<5	90	<10	125	0	<5	
L86114	<20	<0.3	26	68	<5	95	<10	61	0	7	ser alt
L86115	<20	<0.3	135	66	14	15	<10	18	0	<5	ser alt
L86116	<20	<0.3	28	<40	<5	148	<10	70	0	<5	diss py
L86117	<20	<0.3	<20	<40	<5	112	<10	30	0	<5	ser alt
L86118	<20	<0.3	<20	<40	<5	191	<10	27	0	<5	ser alt; py
L86119	79	<0.3	235	<40	<5	774	<10	9264	0	<5	diss py
L86120	<20	<0.3	<20	<40	<5	32	<10	64	0	<5	ser alt; py
L86121	<20	<0.3	<20	<40	<5	24	<10	35	0	10	ser alt; py
L86122	<20	<0.3	98	<40	<5	<10	<10	<10	0	<5	qtz alt; py
L86123	<20	<0.3	32	<40	<5	22	<10	63	0	24	
L86124	<20	<0.3	25	<40	<5	<10	<10	43	0	27	
L86125	<20	<0.3	<20	<40	<5	35	29	54	0	<5	qtz alt; py
L86126	<20	<0.3	<20	<40	<5	37	<10	69	0	<5	qtz alt
L86127	<20	0.6	<20	<40	<5	53	<10	128	0	<5	qtz alt; py
L86128	28	29	2100	<40	41	38	140	25	0	11	clay alt; qtz-py veins
L86129	92	13	3200	<40	13	38	35	17	0	15	clay alt; qtz-py veins
L86130	<20	18	81	<40	14	<10	51	13	0	21	clay alt; qtz-py veins
L86131	<20	29	169	<40	14	10	90	12	0	<5	clay alt; qtz-py veins
L8840	16	204	8	0.13%	120	0.39%	1.18%	270	13	635	qtz vein; ccp, mal, az, py
LAR 01	<10	0.1	3000	420		39		10		13	chl-ser alt; py (AR 10191)

Abbreviations: alt = alteration, AR = BCMEMPR Assessment Report, az = azurite, carb = carbonate, ccp = chalcopyrite, cdy = chalcedony, chl = chlorite, diss = disseminated, ep = epidote, FP = feldspar porphyry, hem = hematite, HFP = hornblende felspar porphyry, lm = limonite, mal = malachite, py = pyrite, po = pyrrhotite, QFP = quartz feldspar porphyry, QP = quartz porphyry, qtz = quartz, ser = sericit tour = tourmaline.

L86 and L88 samples were collected by staff of the B.C.Geological Survey Branch, and analyses performed by the Analytical Sciences Section.

Analytical Techniques: Au by fire assay and atomic absorption spectroscopy; Ag by standard fire assay; As, Sb, Cu, Pb, Zn, Ni and Mo by atomic absorption spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy.

LAR data is from B.C. Ministry of Energy, Mines and Petroleum Resources assessment report.

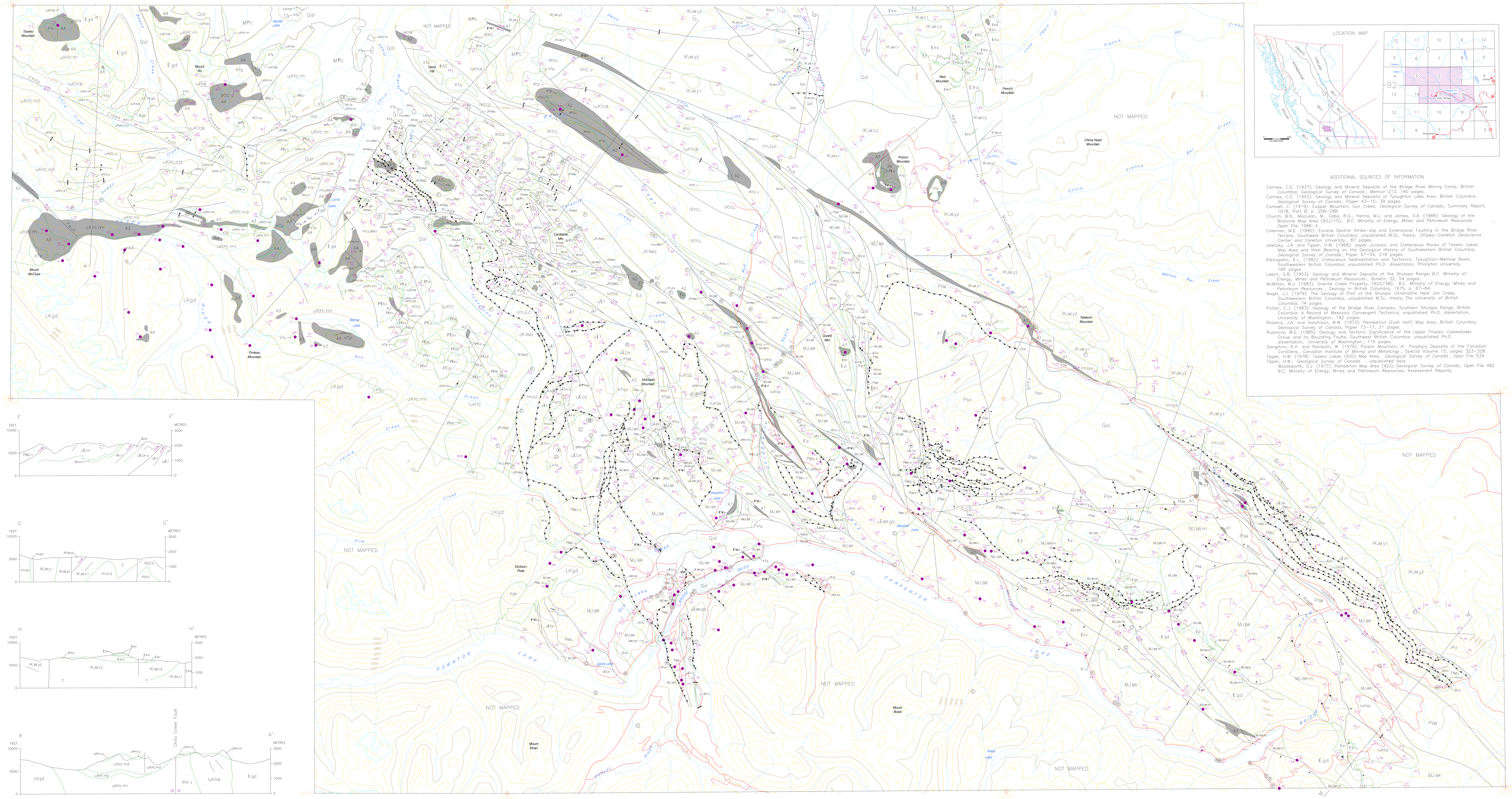
TABLE 22
STREAM SEDIMENT GEOCHEMICAL ANALYSES, 92O/3

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Co (ppm)	Ba (ppm)
S793124	26	0.1	330	8	2.3	188	4	36	16	4	2	14	650
S793125	31	0.1	270	20	5.2	67	3	53	12	3	2	15	770
S793126	5	0.1	220	10	2.3	22	4	60	17	1	1	13	510
S793127	2	0.1	210	11	2.4	22	5	62	17	1	1	13	520
S793128	2	0.1	150	8	1.6	23	2	46	15	1	1	11	420
S793129	2	0.1	90	2	1.4	9	1	30	11	1	1	8	420
S793133	7	0.2	160	26	3	76	50	78	8	2	4	7	680
S793134	13	1	190	2.5	1.2	1100	3	68	9	80	45	7	810
S793135	39	1	130	65	2.9	19	85	91	8	1	1	9	770
S793136	8	0.6	90	28	2.8	91	62	102	9	3	2	9	650
S793137	70	1.2	100	47	2.3	89	44	80	10	4	9	9	720
S793138	3	0.1	270	12	3.1	84	3	33	12	3	2	16	660
S795194		0.1	60	18		136	34	124	16	1	1	6	
S795195	16	0.1	60	10	10.6	32	11	51	4	1	1	4	950
S795196	14	0.6	120	30	3	142	23	108	14	1	1	7	600
S795197	2	0.1	90	12	4.4	36	6	77	30	1	1	12	810
S795198	2	0.1	60	17	7.7	39	9	73	27	1	1	11	750
S795199	2	0.1	80	18	2	53	7	86	34	1	1	15	520
S795200	2	0.1	50	3.5	1	19	1	49	21	1	1	11	450
S795202		0.2	110	60		124	7	66	22	1	4	13	
S795203	2	0.1	60	15	1.7	47	1	72	23	1	2	13	400
S795277	25	0.1	40	13	8.2	65	4	24	15	2	1	9	550
S795278	4	0.1	70	14	3.7	31	2	20	7	4	1	3	480
S795279	2	0.1	70	7.5	1.9	16	4	59	15	1	1	9	480
S795280	3	0.1	80	12	1.2	25	9	70	21	1	1	13	450
S795282	4	0.1	60	25	4.7	42	26	119	24	1	9	13	590
S795283	2	0.1	70	4.5	1.5	25	6	64	24	1	1	13	450
S795284	6	0.1	160	17	4.5	91	11	69	13	1	1	17	410
S795285	3	0.1	80	5	3.7	240	2	18	8	6	13	7	880
S795286	7	0.1	90	9.5	5.2	79	17	78	23	4	1	18	720
S795287	2	0.1	80	5	3.2	310	2	10	6	5	14	5	830
S795288	30	0.4	90	13	6.3	136	26	92	21	6	5	19	670
S795289	2	0.1	60	12	1.6	46	9	40	12	3	6	8	530
S795290	2	0.1	60	11	1.8	44	8	39	10	4	5	8	650
S795291	3	0.2	110	17	2.5	125	14	69	18	6	3	15	720
S795292	2	0.1	60	3	1.6	36	6	34	14	2	1	8	630
S795294	2	0.1	70	1.5	1.9	34	1	22	8	2	1	5	730
S795295	2	0.1	60	3	1.5	36	3	34	15	1	5	9	620
S795296	2	0.1	70	1.5	2.7	28	7	24	8	1	1	5	410
S795297	4	0.2	90	18	2.6	675	6	48	22	27	60	14	620
S795298	2	0.1	60	1.5	2	23	2	16	7	1	1	5	690
S795388	2	0.1	70	41	1.9	65	28	147	50	2	1	25	450
S795389	2	0.1	80	25	2.4	50	15	122	36	1	1	16	570
S795390	2	0.1	70	5	2	27	8	66	35	1	1	12	430
S795393	2	0.1	1150	8	1.4	39	5	96	71	1	1	18	520
S795464	22	0.1	70	3	1.2	240	1	12	6	4	4	8	820
S795465	20	0.1	70	3	1.2	230	1	12	6	3	4	7	620
S795466	2	0.1	380	18	8.5	55	3	57	24	1	3	17	740

TABLE 22
STREAM SEDIMENT GEOCHEMICAL ANALYSES, 920/3

SAMPLE NO.	Au (ppb)	Ag (ppm)	Hg (ppb)	As (ppm)	Sb (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Ni (ppm)	Mo (ppm)	W (ppm)	Co (ppm)	Ba (ppm)
S795467	2	0.1	60	0.5	1	17	1	16	5	1	1	6	780
S795468	2	0.1	70	1	0.9	23	1	22	13	1	1	7	850
S795469	2	0.1	60	1	0.9	20	1	23	8	1	1	7	760
S795470	8	0.1	360	17	4.7	48	6	65	27	1	1	17	580
S795471	2	0.2	190	28	8.7	52	15	80	31	2	1	23	610
S795472	230	0.1	120	11	5.3	100	48	280	22	4	1	16	540
S795473	2	0.1	110	3	1	54	13	88	34	1	1	16	640
S795474	2	0.1	370	4.5	1.2	42	5	68	38	1	1	16	840
S795475	2	0.1	120	6	1.1	40	4	70	26	1	1	13	670
S795487	2	0.1	480	14	1.8	38	6	90	26	1	1	15	540
S795488	4	0.1	110	32	3.3	41	2	106	17	3	1	14	340
S795489	2	0.1	270	8.5	1.2	59	7	109	53	1	1	21	690
S795490	9	0.1	70	39	3.1	61	10	174	26	5	1	20	480
S795491	3	0.1	160	13	1.4	59	7	98	44	1	1	21	540
S795492	25	0.1	100	22	3	66	8	255	30	6	1	17	560
S795493	2	0.1	300	80	10.2	60	11	112	46	3	1	22	590
S795494	2	0.1	310	85	11.1	57	9	112	47	2	1	22	610
S795495	4	0.1	100	70	3.8	60	11	94	29	1	1	20	650
S795497	5	0.1	100	15	4.9	59	6	270	25	5	1	15	1200
S795498	7	0.1	130	95	10.6	46	19	133	24	1	1	17	640
S795499	58	0.1	50	49	13.2	112	36	92	18	1	5	15	610
S795500	3	0.1	100	18	10	62	8	54	16	3	1	11	630
S795502	41	0.1	110	25	17.2	78	17	164	36	3	1	35	370
S795503	17	0.1	90	13	6.4	45	13	34	9	5	1	10	560
S795504	2	0.1	80	8.5	1.5	31	6	83	34	1	1	16	570
S795505	2	0.1	50	22	3.1	29	7	61	38	1	1	16	490
S795506	2	0.1	70	11	2	25	6	69	34	1	1	14	460
S795507	12	0.1	70	11	2	23	6	73	35	1	1	15	440
S795508	8	0.1	80	17	1.9	23	6	72	33	1	1	15	450
S795518	2	0.1	150	12	2.1	35	5	80	34	1	1	15	610
S795519	2	0.1	100	8	3	25	4	76	66	1	1	19	380
S795520	5	0.1	120	19	2.5	48	9	118	19	1	1	14	470
S795522	3	0.1	160	11	2.3	26	5	75	24	1	1	11	440
S795523	2	0.1	80	15	2.5	26	7	83	32	1	1	14	570
S795524	2	0.1	150	17	1.5	53	8	105	16	1	1	16	470
S795525	10	0.1	100	31	4.5	62	8	118	16	1	1	16	490
S795526	2	0.1	90	3	1.6	23	6	54	30	1	1	11	450
S795527	2	0.1	170	8	1.5	36	4	87	61	1	1	18	520
S795564	3	0.1	90	6	0.8	42	3	93	35	1	1	17	690
S795565	2	0.1	270	9	1.5	37	2	113	32	1	1	12	770
S795566	3	0.1	110	12	1.2	42	7	92	50	1	1	20	570

Data for most elements are from Regional Geochemical Survey BC RGS-3, 1979: Ag, Cu, Pb, Zn, Ni, Mo and Co by atomic absorption spectroscopy; Hg by flameless cold vapour atomic absorption spectroscopy; As by hydride generation atomic absorption spectroscopy; W by colourimetric determination after pyrosulfate fusion and a dithiolcarbonate complexing.
Au, Sb and Ba data extracted from Regional Geochemical Survey BC RGS-35, 1993, which re-analysed sediment pulps saved from the 1979 program using instrumental neutron activation.



ADDITIONAL SOURCES OF INFORMATION

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BC Ministry of Energy, Mines and Petroleum Resources

Geological Survey Branch

FIGURE 3
GEOLOGY OF THE TASEKO–BRIDGE RIVER AREA

NTS 92J/14, 15, 16; 92O/1, 2, 3

Geology compiled by P. Schiarizza and R.G. Gaba

Based on geological mapping by P. Schiarizza, J.K. Glover, R.G. Gaba, J.I. Garver, P.J. Umhoefer, R.W.J. Macdonald, P.P. Sajgalik, T. Lynch, J.M. Riddell, K.E. Safton, D.A. Archibald, M.E. Coleman, D.F. Payne, T. Calon, D. Handel, P. Rapp, J. Malpas, and J.K. Russell (1986–1989)

Macrofossils identified by T.P. Poulton, J.A. Jeletzky and J.W. Haggart; conodonts identified by M.J. Orchard; radiolarians identified by F. Cordey; plant fossils identified by J.F. Basinger; palynomorphs identified by A.R. Sweet

Scale 1:100 000

0 2 4 6 8 10 KILOMETRES

LEGEND

QUATERNARY

Qal — Unconsolidated glacial, fluvial and alluvial deposits; volcanic ash; locally may include small bedrock exposures not examined during the present study

TERTIARY
Miocene and(?) Pliocene
CHILCOTIN GROUP

MPc — Olivine basalt flows

Eocene(?)

EBv — BIG SHEEP MOUNTAIN VOLCANICS: quartz-phyric rhyolite

EJv — JONES CREEK VOLCANICS: light grey porphyritic dacite and volcanic breccia; minor amounts of conglomerate, sandstone, shale and lignite

RED MOUNTAIN VOLCANICS (ERr to ERs)

ERr — Rhyolite; lesser amounts of siltstone and sandstone

ERa — Andesite; in part pyroxene-feldspar-phyric

ERs — Sandstone, siltstone and conglomerate

Paleocene and/or Eocene(?)
MOUNT SHEBA VOLCANICS (PEsb and PEsv)

PEsb — Basalt flows and flow breccia

PEsv — Intermediate to felsic volcanic flows and breccias; minor amounts of conglomerate, sandstone and siltstone

PEcv — CLUCKATA RIDGE SUCCESSION: intermediate to felsic volcanic flows, tuffs and breccias; sandstone, conglomerate, tuffaceous shale and mudstone

UPPER TYAUGHTON BASIN
(Relay Mountain – Bridge River overlap)

UPPER CRETACEOUS
POWELL CREEK FORMATION (uKPCu to uKPCbs)

uKPCu — Well stratified lapilli tuff, volcanic breccia, lahar, volcanic conglomerate and sandstone

uKPCm — Andesitic volcanic breccia, lapilli tuff and ash tuff; mafic to intermediate volcanic flows; volcanic sandstone and conglomerate; uKPCm1 – mainly lapilli and ash tuffs, mafic and intermediate flows; uKPCm2 – well bedded volcanic sandstone, conglomerate and tuff; silicified lapilli tuff; rare andesite flows; uKPCm3 – massive volcanic breccia; lesser volcanic sandstone, conglomerate, lahar, andesitic flows

uKPCbs — Polymict and volcanic-clast conglomerate; sandstone, siltstone and shale; rare occurrences of welded tuff

LOWER AND/OR UPPER CRETACEOUS
Albian and/or Cenomanian

lKSJ — SILVERQUICK FORMATION: medium to thick-bedded pebble to cobble conglomerate containing clasts of chert, volcanic rock and sandstone; lesser amounts of sandstone, siltstone and shale; upper part of unit includes intercalations of volcanic breccia and volcanic conglomerate

LOWER AND(?) UPPER CRETACEOUS
TAYLOR CREEK GROUP (lKTC to lKTC)
Albian and/or Cenomanian

lKTC — BEECE CREEK SUCCESSION: sandstone, siltstone and shale; pebble conglomerate containing clasts of chert, volcanic rock and clastic sedimentary rock; calcareous sandstone and shale; ash and crystal tuff; may in large part be equivalent to unit lKTC

Albian

lKTCv — Intermediate, felsic and mafic volcanic flows, tuffs and breccias; volcanic conglomerate, sandstone and shale

lKTCl — LIZARD FORMATION: thin to medium-bedded, light brown to grey-weathering micaceous quartzofeldspathic sandstone, and dark grey laminated shale; polymict conglomerate intercalated with micaceous quartzofeldspathic sandstone; green lithic sandstone, conglomeratic sandstone and polymict conglomerate

lKTCd — DASH FORMATION: orange-weathering, medium to thick-bedded, locally massive chert-pebble conglomerate; thin to medium-bedded chert-rich sandstone, and dark grey shale and siltstone

Albian and(?) older

lKTCp — PARADISE FORMATION: thin-bedded medium to dark grey shale and green-grey sandstone; lesser amounts of thick-bedded pebble to cobble conglomerate containing volcanic clasts and less abundant sedimentary and plutonic clasts

lKTCe — ELBOW PASS FORMATION: medium to thick-bedded green-grey sandstone, dark grey shale, and pebble conglomerate containing intermediate and mafic volcanic clasts

Albian and(?) older and(?) younger

lKTC — Undivided lKTCl, lKTCd, lKTCp and lKTCe

BRIDGE RIVER TERRANE

CAYOOSH ASSEMBLAGE (JKt and JKs)
JURASSIC AND/OR CRETACEOUS

JKt — TRULL CREEK CONGLOMERATE: polymict conglomerate; minor amounts of sandstone and shale

JKs — GUN LAKE CLASTIC UNIT: sandstone, siltstone and shale; minor amounts of pebble conglomerate

BRIDGE RIVER COMPLEX (JBRs to MJBRm)
JURASSIC AND(?) OLDER

JBRs — Argillite, sandstone and chert; minor amounts of pebble conglomerate, greenstone, limestone and serpentinite

UPPER TRIASSIC

uTrBR — Mainly pillowed to massive greenstone and lower Norian limestone; lesser amounts of chert, argillite, diabase, sandstone and pebbly mudstone

TRIASSIC AND(?) OLDER

TrBRS — Blueschist, glaucophane-lawsonite schist, glaucophane-epidote-garnet-white mica schist, glaucophane-stilpnomelane-epidote-calcite-quartz schist; also includes non-schistose pillowed and massive greenstone containing minor amounts of blue amphibole

MISSISSIPPIAN TO MIDDLE JURASSIC

MJBR — Undivided ribbon chert, argillite, phyllite, quartz phyllite and pillowed to massive greenstone, with lesser amounts of limestone, gabbro, diabase, sandstone, pebble conglomerate and serpentinite

MJBRm — Serpentinite with knockers and fault slivers of other Bridge River rock types

MJBRs — Biotite-quartz schist, biotite-chlorite-actinolite schist, calcareous actinolite schist, talc schist, metachert and marble, commonly includes small bodies of variably deformed granodiorite and orthogneiss

LOWER TYAUGHTON BASIN
(overlies Cadwallader Terrane, at least in part)

LOWER CRETACEOUS
Hauterivian and/or younger

lKTH — TOSH CREEK UNIT: volcanic conglomerate and breccia, dark grey shale with intercalations of siltstone and sandstone; mafic to intermediate volcanic rocks

MIDDLE JURASSIC TO LOWER CRETACEOUS
RELAY MOUNTAIN GROUP (lKRM to muJRM)
Hauterivian and(?) Barremian

lKRM2 — Dark grey shale and siltstone; lesser amounts of sandstone and calcareous sandstone

Upper Oxfordian to Valanginian

JKRM1 — Grey, brown and green sandstone and siltstone, locally calcareous, commonly massive, locally medium to thick-bedded; *Buchia*, pelecypods and belemnites common, coquina beds locally abundant; lesser amounts of conglomerate and conglomeratic sandstone containing mainly volcanic and plutonic clasts

Callovian to lower Oxfordian

muJRM — Dark grey siliceous shale intercalated with thin beds of green to brown siltstone and fine grained sandstone; commonly rusty-weathering; lesser amounts of thin to medium-bedded, medium to coarse grained sandstone, conglomerate, and calcareous siltstone; locally includes pebble conglomerate containing mainly felsic to intermediate volcanic clasts

UPPER JURASSIC TO LOWER CRETACEOUS

JKG — GROUSE CREEK UNIT: grey siltstone and shale; local *Buchia* coquina

CADWALLADER TERRANE – TYAUGHTON CREEK FACIES

JURASSIC(?)

JDL — DOWNTON LAKE UNIT: siliceous argillite and siltstone; lesser amounts of sandstone, conglomerate, silty limestone and carbonaceous limestone

LOWER TO MIDDLE JURASSIC
Hettangian to Bajocian

lmJLC — LAST CREEK FORMATION: brown calcareous sandstone, siltstone and conglomerate; overlain by dark grey to black calcareous shale

UPPER TRIASSIC
Middle(?) and upper Norian
TYAUGHTON GROUP

uTrT — Massive to thick bedded conglomerate and conglomeratic sandstone intercalated with medium to thin-bedded red to brown sandstone; thick to thin-bedded grey limestone and limestone conglomerate; thin to medium-bedded green to brown sandstone intercalated with granule to pebble conglomerate; conglomerates contain clasts of intermediate to felsic volcanic rocks, limestone and locally plutonic rocks

CADWALLADER TERRANE – CAMELSFOOT FACIES

LOWER TO MIDDLE JURASSIC

lmJJc — JUNCTION CREEK UNIT: dark grey to black shale, siltstone and siliceous argillite; lesser amounts of calcareous siltstone, sandstone and silty limestone

UPPER TRIASSIC
CADWALLADER GROUP (uTrCH to uTrCv)
Lower to upper Norian

uTrCH — HURLEY FORMATION (uTrCH and uTrCHv): Thin to thick-bedded sandstone, calcarenite and siltstone; lesser amounts of polymict conglomerate with clasts of limestone, mafic to felsic volcanic rocks and granitoid rocks; locally includes pebbly mudstone, limestone-greenstone breccia and micritic limestone

CADWALLADER GROUP *(continued)*

uTrCHv — Greenstone, mafic volcanic breccia and tuff intercalated with sandstone, micritic limestone and polymict conglomerate containing clasts of limestone, mafic to felsic volcanic rocks and granitoid rocks

Lower Norian and/or older

uTrCv — VOLCANIC UNIT: pillowed to massive greenstone, mafic volcanic breccia and mafic tuff

OPHIOLITIC ASSEMBLAGES

PERMIAN

PBL — BRALORNE–EAST LIZA COMPLEX: pillowed and massive greenstone, greenstone breccia, diabase, gabbro, diorite, quartz diorite, soda granite and serpentinite; minor amounts of limestone and chert. PBLg – mainly gabbro, diorite, quartz diorite and soda granite; PBLu – mainly serpentinite and serpentinized ultramafic rocks

PERMIAN (AND YOUNGER AND? OLDER)
SHULAPS ULTRAMAFIC COMPLEX (Psw and Psh)

Psw — SERPENTINITE MELANGE UNIT: serpentinite derived from olivine-clinopyroxene ultramafite (locally metamorphosed to olivine-talc-serpentine and olivine-talc-magnesite schists, or altered to listwanite), with knockers of ultramafic rock, gabbro, diorite, diabase, amphibolite, greenstone, rodingite, chert, phyllite, sandstone, conglomerate and limestone; Pswu – wehrlite, websterite, dunite and clinopyroxenite; Pswg – gabbro, in part with minor pyroxenite; Psws – conglomerate, sandstone, phyllite and chert

Psh — HARZBURGITE UNIT: harzburgite, with lesser amounts of dunite and orthopyroxenite (variably serpentinized); locally with a penetrative foliation and lineation inferred to be a mantle tectonite fabric

PALEOZOIC AND/OR MESOZOIC

PMst — Serpentinite, serpentinized ultramafite and quartz-carbonate-mariposite altered rocks (listwanite); PMst – undivided serpentinite, listwanite, and fault slivers of mainly MJBR and uTrBR

METHOW TERRANE – YALAKOM MOUNTAIN FACIES

LOWER CRETACEOUS
JACKASS MOUNTAIN GROUP (lKJMy2 and lKJMy1)
Albian

lKJMy2 — Arkosic sandstone, conglomeratic sandstone, siltstone, shale and conglomerate

Barremian–Aptian

lKJMy1 — Green to grey lithic sandstone, granule conglomerate and conglomeratic sandstone; lesser amounts of siltstone and shale; very minor amounts of laminated silty limestone

MIDDLE JURASSIC(?)

mJyv — Medium to dark grey-green volcanic breccia; andesitic flows; volcanic conglomerate

LOWER(?) TO MIDDLE JURASSIC
Toarcian(?) to Bajocian

lmJys — Lithic-arkosic sandstone intercalated with lesser amounts of granule to small pebble conglomerate, siltstone and shale; thin-bedded siltstone and laminated shale

JURASSIC AND/OR LOWER CRETACEOUS

JKy — Undivided lKJMy and lmJys lithic arkosic sandstone, granule to small pebble conglomerate, siltstone and shale

METHOW TERRANE – CHURN CREEK FACIES

LOWER CRETACEOUS
JACKASS MOUNTAIN GROUP (lKJMc2 and lKJMc1)
Albian?

lKJMc2 — Polymict pebble to boulder conglomerate containing mainly granitoid and volcanic clasts; lesser amounts of sandstone, conglomeratic sandstone, siltstone and shale

Aptian and(?) older

lKJMc1 — Lithic sandstone, conglomeratic sandstone and pebble conglomerate containing mainly volcanic clasts; lesser amounts of siltstone and shale; abundant fossil plant remains

MIDDLE JURASSIC
Bajocian

mJcs — Grey siltstone and fine-grained sandstone

INTERMONTANE BELT

CRETACEOUS(?)
DASH–CHURN SUCCESSION (KDC3 to KDC1)

KDC3 — Well stratified volcanic conglomerate and breccia; lesser amounts of thin to medium bedded volcanic sandstone and siltstone

KDC2 — Andesitic volcanic breccia and lapilli tuff; lesser amounts of volcanic sandstone, conglomerate and andesitic flows

KDC1 — Granule to boulder volcanic conglomerate; lesser amounts of volcanic sandstone

INTRUSIVE ROCKS

TERTIARY
Miocene or Pliocene(?)

MPmp — Mafic plugs

Oligocene

Op — Hornblende porphyry

Eocene

Ep — Hornblende–biotite–quartz–feldspar porphyry

Egd — Granodiorite and quartz monzonite

Paleocene and/or Eocene

PEp — Hornblende–biotite–quartz–feldspar porphyry, quartz diorite, granodiorite

LATE CRETACEOUS AND/OR EARLY TERTIARY

KTg — Granite

KTqd — Equigranular quartz diorite to granodiorite

KTp — Hornblende–feldspar porphyry, hornblende–biotite–feldspar porphyry; locally grading to diorite and quartz diorite

KTd — Diorite, gabbro

LATE CRETACEOUS

LKgd — Granodiorite

CETACEOUS (?)

Kgb — Gabbro

SYMBOLS

Geological contact (defined, approximate, assumed)
Bedding, tops observed (horizontal, inclined, vertical, overturned)
Bedding, tops not observed (inclined, vertical)
Bedding estimated from pillows (inclined, overturned)
Phase layering in ultramafic and mafic rocks
Cleavage, schistosity (inclined, vertical)
Mineral or stretch lineation
Crenulation lineation
Mesoscopic fold axis
Anticline (upright, overturned)
Syncline (upright, overturned)
Thrust or reverse fault; teeth on upthrust block (defined, approximate, assumed)
Fault; solid dot indicates downthrown block, arrows indicate relative sense of strike–slip movement (defined, approximate, assumed)
Alteration zone (A1 – quartz–carbonate–mariposite; carbonate; A2 – carbonate; carbonate–quartz ± serecite ± pyrite; A3 – quartz–pyrite ± sericite ± clay ± carbonate; A4 – chlorite–epidote ± carbonate ± clay ± pyrite; A5 – biotite) A1
Mineral occurrence (number refers to 92O or 92J/NE MINFILE number; W26 is 92J/W MINFILE number) 31
Macrofossil locality
Macrofossil from clast in conglomerate
Plant or palynomorph fossil locality
Conodont fossil locality
Conodont from clast in conglomerate
Radiolarian fossil locality
Limit of quaternary cover
Limit of geological mapping
Topographic contour (200 meter interval) 1800
Icefield or glacier
Road