British Columbia Geological Survey
Geological Fieldwork 1989

GEOLOGY AND MINERAL OCCURRENCES OF THE YALAKOM RIVER AREA* (92O/1, 2, 92J/15, 16)

By P. Schiarizza and R.G. Gaba,
M. Coleman, Carleton University
J.I. Garver, University of Washington
and J.K. Glover, Consulting Geologist

KEYWORDS: Regional mapping, Shulaps ophiolite, Bridge River complex, Cadwallader Group, Yalakom fault, Mission Ridge fault, Marshall Creek fault.

INTRODUCTION

The Yalakom River area covers about 700 square kilometres of mountainous terrain along the northeastern margin of the Coast Mountains. It is centred 200 kilometres north of Vancouver and 35 kilometres northwest of Lillooet. Our 1989 mapping provides more detailed coverage of the northern and western Shulaps Range, partly mapped in 1987 (Glover *et al.*, 1988a, 1988b) and 1988 (Schiarizza *et al.*, 1989a, 1989b), and extends the mapping eastward to include the eastern part of the Shulaps Range, the Yalakom and Bridge River valleys and the adjacent Camelsfoot Range. In addition, several weeks were spent re-examining critical areas in the Tyaughton Creek area and traversing the area south of Gun Creek in an effort to mesh our work with the maps produced by B.N. Church during his mineral deposit studies of the Bridge River mining camp (Church, 1987; Church and MacLean, 1987a; Church *et al.*, 1988a, 1988b; Church and Pettipas, 1989).

Mapping in the Yalakom River area was carried out in cooperation with Meg Coleman of Carleton University who extended her 1988 mapping of the Mission Ridge area (Coleman, 1989) northwestward to Shulaps Creek. It also incorporates detailed mapping of the Shulaps ultramafic complex in the Jim Creek–East Liza Creek area, begun in 1988 by Tom Calon and continued this field season by Calon, John Malpas and Rob Macdonald, all from the Memorial University of Newfoundland (Calon *et al.*, 1990, this volume). Geological mapping and sampling by D.A. Archibald of Queen's University extends a geochronology study begun in 1987 and continued in 1988 (Archibald *et al.*, 1989, 1990, this volume).

This is the final year of a 4-year regional mapping project, initiated east of Taseko Lakes in 1986 and funded by the Canada/British Columbia Mineral Development Agreement. Open File geology and mineral potential maps covering this season's study area will be released in February, 1990. A final report covering the entire 4-year program, including updated 1:50 000 maps, will be prepared during the 1990/91 fiscal year.

REGIONAL GEOLOGY

The regional geologic setting of the Taseko–Bridge River project area is described by Glover *et al.* (1988a) and Schiarizza *et al.* (1989a). The distribution and relationships of the major tectonostratigraphic assemblages are summarized in Figures 1-6-1 and 1-6-2.

The Yalakom River area, comprising the southwestern segment of the project area, encompasses the whole of the Shulaps ultramafic complex which is interpreted by Nagel (1979), Potter (1983, 1986) and Calon *et al.*(1990) as a dismembered ophiolite. The area south and west of the Shulaps complex is underlain mainly by oceanic rocks of the Permian(?) to Jurassic Bridge River complex, and arc-derived volcanic and sedimentary rocks of the Upper Triassic Cadwallader Group. These two assemblages are structurally interleaved over a broad area extending from west of Gold Bridge eastward to the slopes northeast of the Yalakom and Bridge rivers. In the Bralorne–Gold Bridge area they are imbricated with the Permian Bralorne diorite complex and associated ultramafic rocks.

Sedimentary rocks exposed north and west of the Bridge River–Cadwallader belt range from Late Triassic to mid-Cretaceous in age. The base of the section comprises Upper Triassic clastic rocks and limestone of the Tyaughton Group and overlying Lower to Middle Jurassic sandstone and shale of the Last Creek formation (Tipper, 1978; Umhoefer, 1989). These rocks are not seen in depositional contact with the slightly older Cadwallader Group, but are inferred to represent a continuation of the same arc-derived sedimentation, and are included within the Cadwallader Terrane of Rusmore *et al.* (1988).

Younger sedimentary rocks within the region are assigned to the Tyaughton basin (Jeletzky and Tipper, 1968; Kleinspehn, 1985). Southwest of the Yalakom fault these include shallow-marine clastic rocks of the Middle Jurassic to Lower Cretaceous Relay Mountain Group together with conglomerate and associated finer grained clastics and volcanic rocks of the Albian Taylor Creek Group. The Relay Mountain Group outcrops most extensively in the Warner Pass and Noaxe Creek map areas where it is locally in depositional contact with the underlying Last Creek formation (Umhoefer, 1989). To the south and southeast the Relay Mountain Group occurs as local fault-bounded slivers in contact with either the Cadwallader Group or the Bridge

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

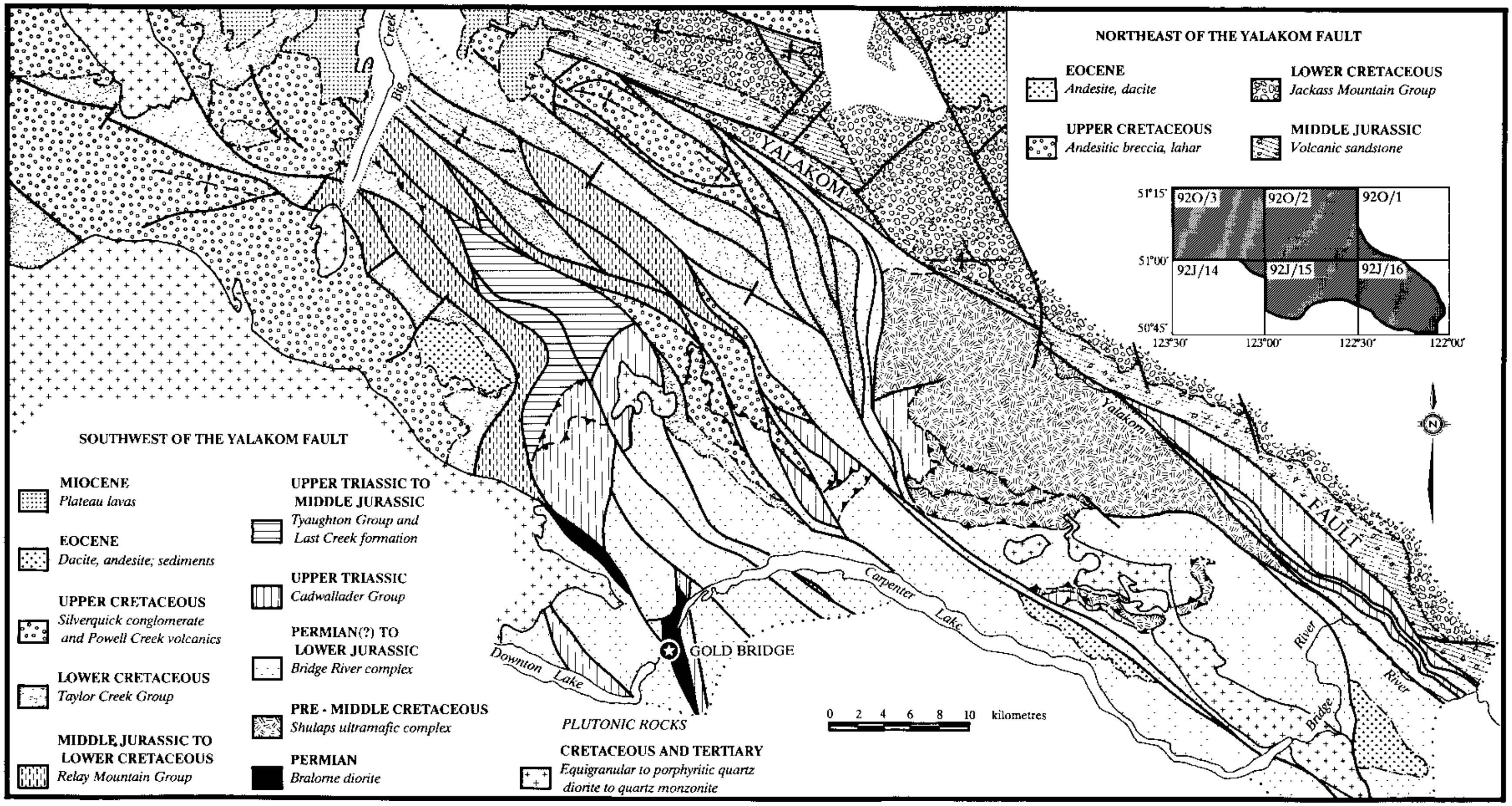

Figure 1-6-1. Generalized geology of the Taseko–Bridge River project area.

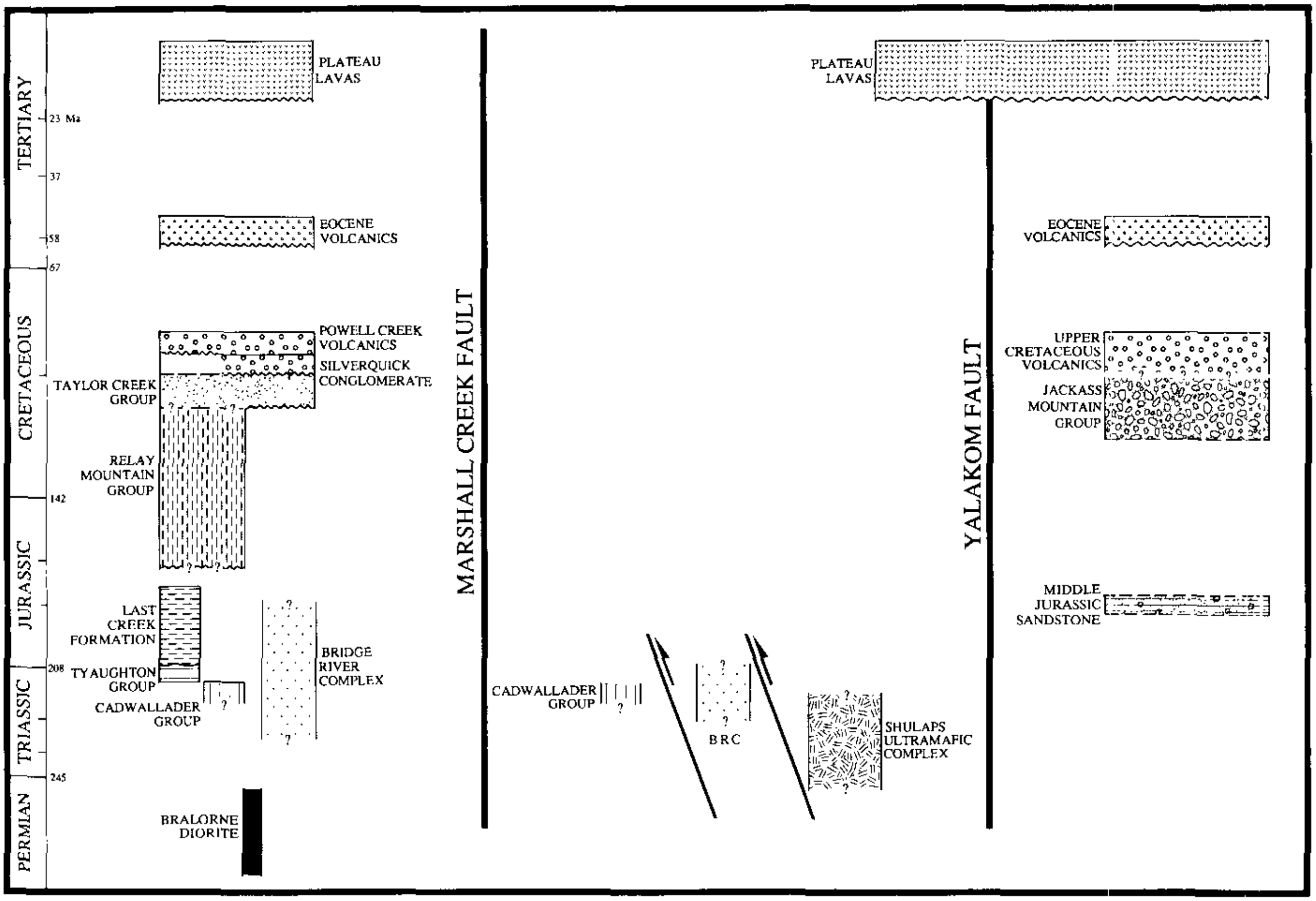

Figure 1-6-2. Tectonostratigraphic assemblages of the Taseko–Bridge River area.

River complex. Synorogenic deposits of the Taylor Creek Group sit stratigraphically above the Relay Mountain Group in the Relay Mountain area, and above deformed Bridge River rocks in the Taylor Creek area (Garver *et al.*, 1989a). Clasts within the Taylor Creek Group provide the first evidence of regional uplift and erosion of the Bridge River complex.

Upper Cretaceous andesitic breccias and flows of the Powell Creek volcanics are widespread in the northwestern part of the area, where they sit above the Taylor Creek Group and older rocks with pronounced angular unconformity. To the southeast Upper Cretaceous deposits of the nonmarine Silverquick conglomerate rest unconformably above the Taylor Creek Group and pass gradationally upward into andesitic volcanic breccia correlated to the Powell Creek volcanics (Garver *et al.*, 1989a).

Northeast of the Yalakom fault Mesozoic sedimentary rocks are distinctly different from those to the southwest. The base of the succession comprises Middle Jurassic volcanic-rich sandstones and associated shale and conglomerate. These are overlain by a thick succession of arkosic sandstone, conglomerate and shale of the Lower Cretaceous Jackass Mountain Group. Andesitic volcanic and volcaniclastic rocks, similar to the Powell Creek volcanics southwest of the Yalakom fault, occur locally as fault-bound slivers within this belt, but were not observed in stratigraphic contact with the Jackass Mountain Group.

Mesozoic strata throughout the region are intruded by felsic to intermediate stocks and dikes ranging from Late Cretaceous to Oligocene in age (Archibald *et al.*, 1989). Locally the strata are unconformably overlain by Eocene volcanic and sedimentary rocks and by Miocene to Pliocene plateau lavas of the Chilcotin Group (Mathews, 1989). Late Cretaceous granite to quartz diorite of the Coast plutonic complex intrudes the Mesozoic strata in the southwestern part of the Warner Pass map area and along the western edge of the Bralorne map area (Figure 1-6-1).

LITHOLOGY

SHULAPS ULTRAMAFIC COMPLEX

The Shulaps ultramafic complex covers most of the northern half of the study area (Figure 1-6-3). It is bounded by the Yalakom fault to the northeast, and is juxtaposed against Bridge River and Cadwallader Group rocks across thrust and high-angle faults on the north, west, south and southeast. 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 along fault

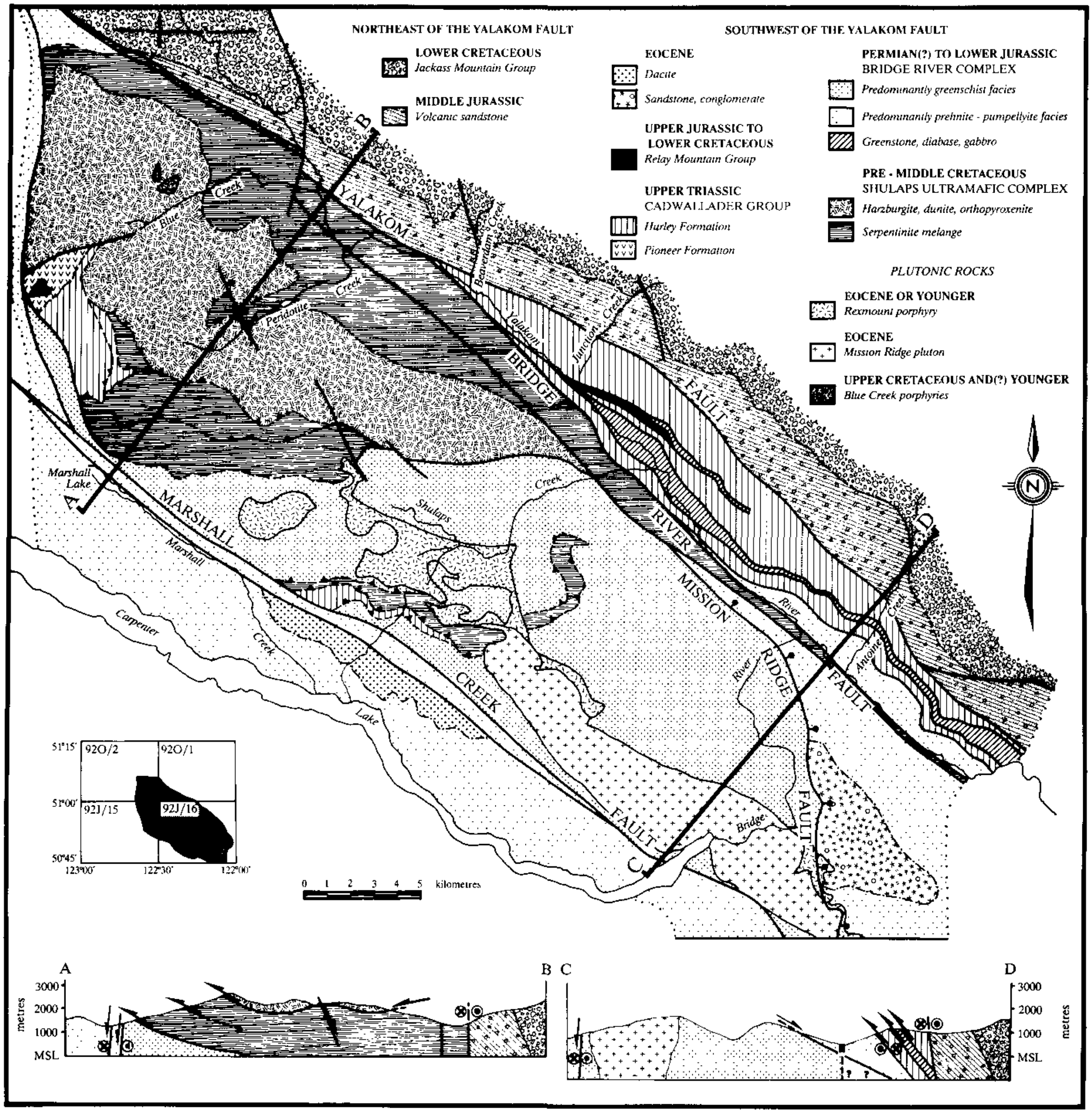

Figure 1-6-3. Generalized geology map and cross-sections, Yalakom River map area.

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 Tom Calon and coworkers along the southwestern margin of the complex (Calon *et al.*, 1990) has confirmed this interpretation.

The structurally and topographically highest portion of the Shulaps complex comprises variably serpentinized harzburgite with lesser dunite and orthopyroxenite. The harzburgite is locally layered, with layering defined by centimetre-wide bands of orthopyroxenite and rarely by wider bands of dunite, orthopyroxenite and harzburgite. A penetrative mineral foliation and lineation are locally evident; the foliation is typically parallel, or at a low angle to, compositional layering. This foliation is interpreted by Calon *et al.* to be a mantle tectonite fabric. A spectacular mylonitic foliation displayed by harzburgite 2 kilometres north-northeast of Serpentine Lake is also thought to be a mantle fabric. Dunite within the upper harzburgite unit locally defines layering, 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. Calon, personal communication, 1988). Where the harzburgite unit sits structurally above cumulate-derived serpentinite mélange, it does so across a sole of harzburgite-derived foliated serpentinite that can generally be distinguished from the underlying cumulate-derived serpentinite (Calon *et al.*, 1990). The thick harzburgite unit itself is apparently imbricated across thrust contacts defined by similar foliated serpentinite, but these have not been mapped in detail.

A well-exposed belt of cumulate-derived serpentinite mélange structurally underlies the mantle harzburgite unit along the southwestern margin of the Shulaps complex, between East Liza and Hog creeks. It is in turn structurally underlain by Bridge River schists and locally by Cadwallader Group metasediments. This belt was studied in detail by Calon *et al.* and the following summary is based largely on their work. The mélange comprises foliated serpentinite containing blocks of ultramafic, gabbroic, volcanic and sedimentary rock. The largest knockers, up to hundreds of metres in size, derive from an igneous complex which includes layered ultramafic cumulates, layered gabbro and varitextured gabbro, all cut by swarms of mafic to intermediate dikes. Gabbro at the base of the mélange in the western part of the belt grades into a dike complex which in turn grades into pillowed volcanic rocks. The mélange thus contains remnants of a plutonic-volcanic suite characteristic of the upper part of an ophiolite complex. Volcanic and sedimentary knockers occur throughout the mélange and presumably represent a sampling of the footwall succession across which the Shulaps complex was emplaced. Sedimentary knockers include bedded chert, limestone, sandstone and pebble conglomerate. These in part resemble rocks found in the Bridge River complex, but in part may have been derived from the Cadwallader Group or an unknown clastic sequence.

Serpentinite also dominates the poorly exposed northeastern part of the Shulaps complex. In exposures extending from the northern tip of the complex southeastward to Peridotite Creek this serpentinite contains small knockers and boudinaged dikes of diabase, amphibolite and gabbro. The serpentinite mélange exposed along upper Peridotite Creek clearly sits structurally beneath mantle harzburgite. The two serpentinite mélange belts are therefore inferred to be continuous beneath the intervening mantle harzburgite unit that comprises the backbone of the Shulaps Range, indicating that the Shulaps complex is broadly synformal in nature.

A separate belt of serpentinite mélange outcrops between 4 and 7 kilometres south of the main part of the Shulaps complex and has been traced for about 12 kilometres eastward from the Marshall Creek fault (Figure 1-6-3). Serpentinite within this belt encloses knockers of ultramafic, gabbroic and dioritic rocks similar to those within the cumulate-derived mélange exposed between East Liza and Hog creeks. The lower mélange belt is structurally overlain by penetratively deformed Bridge River rocks, and is underlain by Cadwallader Group conglomerates and sandstones in the west and Bridge River rocks in the east. The occurrence of ophiolitic serpentinite mélange at this lower structural level suggests that emplacement and imbrication of the Shulaps complex was a complex process involving some out-of-sequence thrusting or folding.

Bridge River Complex

The Permian(?) to Jurassic Bridge River complex includes variably metamorphosed and structurally imbricated chert, mafic extrusive and intrusive rocks, limestone, clastic rocks and serpentinite (Potter, 1983, 1986; Schiarizza *et al.*, 1989a, Garver *et al.*, 1989a). It underlies much of the area southwest of the Yalakom fault, where it is structurally interleaved with rocks of the Cadwallader Group and Shulaps ultramafic complex. A central block of penetratively deformed schists and phyllites exposed in the Shulaps Range is separated from lower grade rocks to the northeast and southwest by the Mission Ridge and Marshall Creek faults respectively (Figure 1-6-3).

Bridge River rocks southwest of the Marshall Creek fault are described by Potter (1983, 1986) and Schiarizza *et al.* (1989a). They consist mainly of prehnite-pumpellyite-grade chert and greenstone, together with lesser amounts of argillite, limestone, tuff, chert and volcanic-rich sandstone, pebble conglomerate, diabase and gabbro. Similar rocks characterize the belt east of the Mission Ridge fault although clastic rocks and limestone are uncommon in this area. Structural slivers of serpentinite and diabase-gabbro-bearing serpentinite mélange are common in the area southwest of the Bridge and Yalakom rivers. Bridge River rocks northeast of the Bridge River comprise chert and greenstone that are structurally overlain by the Hurley Formation across a moderately northeast-dipping fault. Similar northeast-dipping faults bound two persistent slivers of pillowed and brecciated greenstone with lesser diabase, gabbro and serpentinite that occur within the Hurley belt farther to the northeast. These are tentatively assigned to the Bridge River complex, but in part may be equivalent to the Pioneer Formation and/or Shulaps serpentinite mélange.

The Bridge River complex between the Marshall Creek and Mission Ridge faults is represented mainly by phyllites and schists that were penetratively deformed under predominantly greenschist-facies metamorphic conditions (Potter 1983, 1986). The most common rock types are medium to dark grey phyllite, quartz phyllite and biotite-bearing schist (locally garnet-bearing) derived from argillite and chert, and chloritic schist (locally biotite-bearing) derived from mafic volcanic rock. These are locally intercalated with crudely foliated phyllosilicate-bearing metasandstone, marble, and chlorite-actinolite-carbonate schists probably derived from impure calcareous sediments. Serpentinite is commonly interleaved with the schists for several kilometres south of the Shulaps complex. Non-penetratively deformed rocks similar to those which characterize the Bridge River complex elsewhere within the map area occur locally in the block, particularly along the upper reaches of Hell and LaRochelle creeks.

The Bridge River schists are bounded by the Shulaps ultramafic complex on the north; they sit structurally beneath serpentinite mélange on the west, but are juxtaposed directly against mantle harzburgite to the east (Figure 1-6-3). Farther south they enclose an imbricate belt of serpentinite mélange and Hurley Formation which was traced for more than 12 kilometres eastward from the Marshall Creek fault. The schists are intruded by foliated granodiorite of the Eocene Mission Ridge pluton, which crosscuts the imbricate belt, as well as by undeformed to foliated and folded dikes and sills of similar composition. They, together with the Mission Ridge pluton, are also intruded by the undeformed Rexmount porphyry and associated dikes.

CADWALLADER GROUP

The Upper Triassic Cadwallader Group, as redefined by Rusmore (1985, 1987), comprises mafic volcanic rocks of the Pioneer Formation and conformably overlying clastic sediments of the Hurley Formation. These rocks, inferred to be volcanic-arc related, are the same age as parts of the Bridge River complex with which they are structurally interleaved over a broad area extending from the Coast plutonic complex west of Gold Bridge to the Yalakom River valley (Figure 1-6-1). The Pioneer Formation consists of green to purplish weathering, commonly amygdaloidal, pillowed and massive greenstone and greenstone breccia. The overlying Hurley Formation consists mainly of thin-bedded sandstone and siltstone turbidites, but commonly includes distinctive pebble to cobble conglomerates containing limestone, mafic to felsic volcanic and granitoid clasts.

Within the study area, the Cadwallader Group is exposed in two areas on the northeast side of the Marshall Creek fault, as well as within an extensive, but previously unrecognized belt along the northeastern slopes of the Yalakom and Bridge rivers (Figure 1-6-3). Cadwallader rocks northeast of the Marshall Creek fault are structurally imbricated with the Shulaps complex and Bridge River phyllites. They were penetratively deformed under lower greenschist(?) facies metamorphic conditions such that fine-grained sediments are typically cleaved and clasts in conglomerate are locally highly flattened. The most extensive exposures are in the East Liza Creek area, where the Hurley Formation is structurally overlain, across a gently dipping and locally folded thrust contact, by a pillowed volcanic-dike-gabbro complex at the base of the Shulaps serpentinite mélange. Pillowed greenstone that contacts the Hurley to the north is tentatively asigned to the Pioneer Formation, although the nature of the contact has not been established. The greenstones are juxtaposed against the Shulaps harzburgite by a steeply dipping east-northeast-trending fault that defines a prominent left-stepping jog in the western boundary of the Shulaps complex. The Hurley Formation also outcrops 12 kilometres southeast of the East Liza Creek exposures, where it occurs as a narrow lens structurally overlain by the lower serpentinite mélange and underlain by Bridge River schists (Figure 1-6-3). This thrust-imbricated package is truncated on the west by the Marshall Creek fault; the Hurley lens pinches out 7 kilometres southeast of the fault, whereas the overlying serpentinite mélange belt was traced an additional 7 kilometres eastward before apparently pinching out within Bridge River schists.

The extensive belt of Hurley Formation sedimentary rocks mapped along and northeast of the Yalakom and Bridge rivers (Figure 1-6-3) was largely unrecognized by previous workers, although Leech (1953) describes the rocks, including the distinctive conglomerate lenses, where they outcrop along the Yalakom River north of Shulaps Creek, and Roddick and Hutchison (1973) mapped a small patch of Hurley Formation at the mouth of Antoine Creek. Coleman (1989) noted the similarity between sedimentary rocks northwest of Applespring Creek and the Cadwallader Group described by Rusmore (1987), but tentatively included them in the Lillooet Group. We presently map the Hurley Formation within a belt up to 4 kilometres wide and more than 30 kilometres long that extends from Beaverdam Creek southeastward to at least Applespring Creek. This belt includes rocks assigned to an unnamed Lower Cretaceous unit by Leech (1953), to the the Relay Mountain and Jackass Mountain groups by Roddick and Hutchison (1973) and to the Lillooet Group by Coleman (1989). The Hurley Formation within this belt is strongly deformed by southwesterly overturned folds and northeast-dipping transpressional faults. It is imbricated with two mappable lenses of pillowed greenstone, volcanic breccia, diabase and gabbro tentatively assigned to the Bridge River complex and with one or more slivers of *Buchia*-bearing Relay Mountain Group (Figure 1-6-3).

The Hurley Formation within this belt consists largely of grey siltstone to fine-grained sandstone that occurs as thin, commonly graded and crosslaminated beds intercalated with dark grey mudstone. These are interbedded with thin to thick, locally graded beds of sandstone, calcareous sandstone and gritty sandstone, and rare thin to medium beds of laminated and crosslaminated limestone. Conglomerate occurs locally as lenticular beds several metres to more than 10 metres thick that commonly cut into underlying beds. It consists of angular to rounded pebbles, cobbles and blocks of light grey weathering limestone that occur with variable proportions of rounded felsic to intermediate volcanic and plutonic clasts within a limy matrix. These conglomerates, together with all of the other associated lithologies, are typical of the Hurley Formation elsewhere in the region, and form the basis for our correlation. Collections of limestone are presently being processed for conodonts in an attempt to confirm the inferred Late Triassic age of the rocks.

RELAY MOUNTAIN GROUP

Middle Jurassic to Lower Cretaceous shallow-marine sedimentary rocks of the Relay Mountain Group outcrop extensively in the Warner Pass and Noaxe Creek map areas (Figure 1-6-1). There, they are locally in depositional contact with the underlying Last Creek formation and are in turn overlain by the Taylor Creek Group (Figure 1-6-2). Within the Yalakom River area, Upper Jurassic and Lower Cretaceous *Buchia*-bearing rocks outcrop locally near Ore Creek (Leech, 1953; Jeletzky, 1967). These fossiliferous rocks apparently led Roddick and Hutchison (1973) to map most of the lower slopes northeast of the Yalakom and Bridge rivers between Applespring and Junction creeks as Relay Mountain Group. Most of these rocks are now interpreted as Hurley Formation on the basis of the lithologic correlation discussed in the previous section. The Relay Mountain Group is thought to be restricted to one or more narrow fault-bound slivers of mainly shale and siltstone structurally interleaved with the Hurley Formation northeast of the Yalakom River between Ore and Junction creeks (Figure 1-6-3).

Middle Jurassic Volcanic Sandstone Unit

Middle Jurassic rocks outcrop along the northeastern side of the Yalakom River area where they form a continuous belt bounded on the southwest by the Yalakom fault (Figure 1-6-3). They comprise a steep to moderately dipping (locally overturned along the Yalakom fault) east to northeast-facing succession of volcanic sandstones intercalated with lesser amounts of granule to pebble conglomerate, siltstone and shale. To the northeast, these rocks sit stratigraphically beneath the Jackass Mountain Group with no apparent angular discordance.

The Middle Jurassic section consists mainly of coarse to medium-grained, locally gritty, green to grey volcanic-lithic sandstone. The volcanic grains are commonly accompanied by lesser amounts of feldspar and fine-grained sedimentary rock fragments, and locally by several per cent glassy quartz grains. The sandstone commonly occurs as medium to thick, locally graded beds with relatively thin caps or interbeds of grey shale. Locally it is massive and apparently unbedded over intervals of several tens of metres. Thick beds of granule to small-pebble conglomerate are not uncommon and contain mainly volcanic and fine-grained sedimentary clasts, including lenticular clasts of grey argillite and siltstone that were probably local rip-ups. Thin-bedded, commonly laminated or crosslaminated siltstone and mudstone locally define intervals up to several tens of metres thick within the coarser rocks. These are commonly carbonaceous, as are some portions of the coarser grained intervals. Brown-weathering beds of calcareous sandstone, conglomerate or siltstone occur locally, and thin to medium beds of silty limestone were noted rarely.

The rocks described in the previous paragraph are in part Middle Jurassic in age on the basis of Aalenian and Bajocian ammonites collected from the lower part of the exposed interval near the mouth of Blue Creek (Leech, 1953; Frebold *et al.*, 1969; Tipper, 1978). The upper part of the succession has not been dated, but is lithologically similar to the underlying Middle Jurassic rocks and therefore may be separated from the overlying Lower Cretaceous Jackass Mountain Group by a significant disconformity. Correlative rocks in the Noaxe Creek map area were mapped as Unit 3v by Glover *et al.* (1988a, 1988b), and tentatively assigned to the lower part of the Jackass Mountain Group; ammonites collected from the unit along Dash Creek, however, were subsequently identified as Bajocian (T. Poulton, written communication, 1988) supporting the present correlation. The Middle Jurassic sandstones are lithologically similar to the Lillooet Group described by Duffell and McTaggart (1952) and Trettin (1961) along the Fraser River near Lillooet, and occupy the same stratigraphic position beneath the Jackass Mountain Group. The rocks near Lillooet were assigned a Lower Cretaceous age by Duffell and McTaggart (1952) but an ammonite recently discovered within them may be Middle Jurassic (J.W.H. Monger, personal communication, 1989), supporting their correlation, at least in part, with the Middle Jurassic sandstone unit described here.

Jackass Mountain Group

The Jackass Mountain Group (Selwyn, 1872; Duffell and McTaggart, 1952) comprises Lower Cretaceous clastic sedimentary rocks that sit stratigraphically above Middle Jurassic strata along the northeastern margin of the study area. This area is 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. Rocks within this belt have yielded sparse collections of Early Cretaceous fossils ranging from Barremian to Albian in age (Duffell and McTaggart, 1952; Trettin, 1961; Jeletzky and Tipper, 1968; Roddick and Hutchison, 1973).

Only the lower part of the Jackass Mountain Group was examined in the Yalakom River area (Figure 1-6-3). It consists mainly of olive-green to blue-green medium to coarse-grained feldspathic-lithic wackes, commonly with sparsely scattered granules to small pebbles of volcanic, sedimentary and plutonic rock fragments. The sandstones are typically massive, with bedding only locally defined by pebble concentrations or trains of siltstone intraclasts. Intervals of siltstone and shale, ranging from less than a metre to as much as 300 metres thick, occur locally and are characterized by distinct thin beds that may be graded or crosslaminated. Pebble to cobble conglomerates were observed only at or near the contact with the underlying Middle Jurassic section. These comprise predominantly rounded clasts of mainly volcanic and granitic to dioritic plutonic rocks, with relatively minor proportions of sedimentary and metamorphic clasts.

The basal contact of the Jackass Mountain Group was observed at one locality, 5 kilometres east of the mouth of Blue Creek, and was closely approached in several other places to the southeast. No angular discordance is apparent between Jackass Mountain Group and underlying rocks in any of these locations. The contact is typically marked, however, by a thin conglomerate unit at the base of the Jackass Mountain Group; the conglomerate, together with overlying sandstones, contains abundant plutonic detritus that is nowhere seen in the underlying section. This observation, in combination with the Middle Jurassic age of at least the lower part of the underlying unit as compared to the Barremian to Albian age of the Jackass Mountain Group suggests that the contact is a significant disconformity.

Eocene Volcanic and Sedimentary Rocks

Sedimentary and volcanic rocks of probable Eocene age outcrop in two areas within the map area. On Mission Ridge they comprise sedimentary rocks exposed in a northwest-plunging syncline that is truncated on the west by the Mission Ridge fault (Figure 1-6-3). They apparently lie unconformably upon low-grade Bridge River rocks in the hangingwall of the fault, although the contact is poorly exposed. Eocene(?) rocks exposed 15 kilometres to the west-northwest, on the slopes northeast of Carpenter Lake, apparently also lie unconformably above low-grade Bridge River rocks. These comprise gently northeast-dipping intermediate volcanic and volcaniclastic rocks with lesser sediments that are truncated to the northeast by the Marshall Creek fault.

The sedimentary rocks on Mission Ridge comprise several hundred metres of thick-bedded, moderately well sorted, volcanic and chert-rich conglomerates interbedded with siltstone and sandstone in a fining-upwards sequence. Low-angle cross-stratification and basal scour in some of the conglomerates, and the presence of wood fragments and *Metasequoia* leaf fossils in the fine-grained intervals, indicate that deposition probably occurred in a fluvial environment. The composition of the sandstone and conglomerate suggest that two different source terrains supplied detritus to this sequence; one rich in chert and another rich in felsic volcanics. Mixing of the two types of detritus is common, but the felsic volcaniclastic detritus also occurs undiluted. Thin sections reveal that these white-weathering sandstones are replete with felsic volcanic clasts, beta quartz, plagioclase and biotite. Minor amounts of strained quartz, feldspar, muscovite and sedimentary rock fragments are present and may represent partial input from a plutonic and sedimentary source. Chert-rich sandstones and conglomerates contain minor amounts of felsic volcanicastic material but are dominated by clasts of veined and unveined chert and metachert with lesser quantities of volcanic rock and sandstone.

The Eocene(?) rocks northeast of Carpenter Lake comprise 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 comprise conglomerate, sandstone and shale, locally with narrow seams of lignite. Clasts in the conglomerate include chert with lesser amounts of granitic and felsic volcanic rock.

The chert-rich detritus within both the Mission Ridge and Carpenter Lake sedimentary sections was probably derived from the Bridge River complex. The intimate mixing of chert and felsic volcanic detritus, together with the presence of exclusively volcanic-derived interbeds on Mission Ridge and the thick volcanic succession along Carpenter Lake, suggests that volcanism was contemporaneous with deposition and comprised periodic eruptions that punctuated the erosion of the Bridge River complex. Both the Mission Ridge and Carpenter Lake sections are cut by normal faults that record relative uplift of an intervening belt of relatively high-grade metamorphic rocks during a complex period of Tertiary strike-slip and extensional faulting. Bridge River detritus within the Eocene sediments is, however, derived almost exclusively from low-grade parts of the complex, although rare clasts of quartz-biotite schist in one thin section from Mission Ridge may have been derived from Bridge River schists. This suggests that the presently exposed Eocene sediments were deposited relatively early in the uplift history, prior to unroofing of the higher grade rocks.

INTRUSIVE ROCKS

BLUE CREEK PORPHYRIES

Hornblende feldspar porphyry, diorite and quartz diorite that occur in and adjacent to the Blue Creek drainage area were referred to as Blue Creek porphyries by Leech (1953). They occur as abundant dikes and small plugs that intrude both mantle harzburgite and serpentinite mélange in the northern part of the Shulaps complex. Two of the largest plugs cut the harzburgite unit 6 kilometres west of the mouth of Blue Creek and host the Elizabeth and Yalakom gold-quartz veins. One of these has recently been dated at 58.4 ± 2.0 Ma by the whole-rock K-Ar method (Church and Pettipas, 1989). Fresh hornblende separates from hornblende feldspar porphyry that intrudes serpentinite mélange along the Yalakom fault, 4 kilometres to the northwest, however, yielded ^{40}Ar-^{39}Ar total fusion and step-heating dates of 75.6 ± 2.8 and 77.0 ± 10.7 Ma respectively (Archibald *et al.*, 1989, 1990). These mineral-separate dates may be a more reliable estimate of the cooling age or, alternatively, rocks included within the Blue Creek porphyries may represent more than one intrusive suite.

Although they are most abundant within the northern part of the Shulaps complex, dikes of hornblende feldspar porphyry and porphyritic diorite to quartz diorite also occur within the southern Shulaps complex and structurally underlying Bridge River schists. These include a suite of hornblende ± feldspar porphyry dikes that intrudes the mélange belt and caused local synkinematic metamorphism (Archibald *et al.*, 1989, 1990; Calon *et al.*, 1990). These may be related to the Blue Creek porphyries since ^{40}Ar-^{39}Ar step-heating of an amphibolite knocker within the same mélange belt suggests cooling of the mélange at about 73 Ma (Archibald *et al.*, 1989).

MISSION RIDGE PLUTON

The Mission Ridge pluton (Potter, 1983) is a markedly elongate body of coarse-grained biotite granodiorite that extends from 5 kilometres south of the study area (Coleman, 1989) for about 30 kilometres northwestward to the head of Holbrook Creek (Figure 1-6-3). It intrudes Bridge River schists within the belt of metamorphic rocks that is bounded by the Marshall Creek and Mission Ridge faults. Uranium-lead dating of zircon and monazite fractions from the pluton indicates an age of 47.5 ± 0.2 Ma (Coleman, M.Sc. thesis in progress) which is slightly older than a previously reported K-Ar biotite date of 44 Ma (Woodsworth, 1977). The Mission Ridge pluton displays strongly foliated margins and is accompanied, within the Bridge River schist belt, by both deformed and undeformed dikes of similar composition. It is inferred to be synkinematic with respect to the latest stages of deformation within the belt.

REXMOUNT PORPHYRY

Rexmount porphyry (Drysdale, 1916; Leech, 1953) refers to a light grey weathering rock comprising phenocrysts of hornblende, biotite, quartz and feldspar in an aphanitic to fine-grained groundmass. It outcrops mainly in the Shulaps Range between LaRochelle and Hog creeks (Figure 1-6-3) and may be an intrusive equivalent of the dacitic volcanics that occur on the other side of the Marshall Creek fault, 3 kilometres to the southwest (Drysdale, 1916; Roddick and Hutchison, 1973). Although many earlier maps (Roddick and Hutchison, 1973; Potter, 1983; Schiarizza *et al.*, 1989b) do not differentiate between the Rexmount porphyry and coarse-grained granodiorite of the Mission Ridge pluton, our 1989 mapping indicates that the porphyry is a discrete, later intrusive phase, as indicated by Woodsworth (1977). In the southwestern part of the belt it occurs mainly as dikes and sills cutting Mission Ridge granodorite 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, from south to north, the southern serpentinite mélange belt, Bridge River schists and part of the main Shulaps serpentinite mélange belt. Separate bodies of porphyry make up the Hog Creek stock to the west (Figure 1-6-3) as well as a series of small plugs extending several kilometres to the east (Leech, 1953). Hornblende-phyric felsite that intrudes both hangingwall and footwall rocks along the Mission Ridge fault south of the Bridge River (Coleman, 1989) may also be correlative.

STRUCTURE

OVERVIEW

The regional structure is dominated by a system of northwest to north-trending faults that reflect a complex history of mid-Cretaceous to Tertiary compressional, strike-slip and extensional deformation (Figure 1-6-1). Our earlier interpretations attributed most of the through-going faults to dextral strike-slip in Late Cretaceous time (Glover *et al.*, 1988a; Schiarizza *et al.*, 1989a). Systems of folds and thrust faults which are preserved locally were attributed mainly to an earlier compressional event of mid-Cretaceous age, reflected in a pronounced angular unconformity in the northwestern part of the project area (Glover and Schiarizza, 1987). Our 1989 mapping suggests, however, that many of the important faults in the region, including the Tyaughton Creek and Castle Pass systems, have a history of sinistral transpressional deformation. This deformation probably occurred in early Late Cretaceous time and produced both sinistral strike-slip faults and compressional structures.

Dextral strike-slip is recorded along the Marshall Creek–Relay Creek and Yalakom fault systems and is, at least in part, Tertiary in age. Southwesterly directed thrust emplacement of the Shulaps ophiolite complex occurred prior to and/or during the Late Cretaceous, and apparently predated most or all of the dextral strike-slip faulting. Northerly trending oblique normal faults within the western Shulaps complex are related to a transfer zone linking the Marshall Creek and Yalakom fault systems along the southeastern margin of an extensional strike-slip duplex. Farther to the southeast, extensional faulting is reflected by the gently northeast-dipping Mission Ridge normal fault (Coleman, 1989) and by later vertical displacement on the Marshall Creek fault. These normal faults truncate Tertiary rocks and structures, including fabrics related to dextral strike-slip faulting.

The mid-Cretaceous to Tertiary structures which dominate the map pattern of the region are superimposed on older structures which are not well understood. Triassic subduction-related deformation and metamorphism is reflected in penetratively deformed blueschist-facies Bridge River rocks which occur locally (Garver *et al.*, 1989a, 1989b; Archibald *et al.*, 1990). Imbrication of the blueschist-facies rocks with greenschist and prehnite-pumpellyite grade rocks occurred sometime after Late Triassic metamorphism and prior to (or during) mid-Cretaceous uplift and erosion when the metamorphic rocks were incorporated as clasts in Albian Taylor Creek conglomerate. The brittle faulting and lenticularity of lithologic units that characterizes the Bridge River complex elsewhere may also be attributed to an earlier deformational history, perhaps in a subduction zone or accretionary prism setting. A Middle Jurassic deformational event has also been postulated (Potter, 1986; Rusmore *et al.*, 1988) and is inferred to mark the juxtaposition of Cadwallader Terrane with the Bridge River and Shulaps complexes. Structures that can be unequivocally assigned a Middle Jurassic age have not been found, however, and it is possible that amalgamation of these tectonostratigraphic elements was a mid-Cretaceous event (Schiarizza *et al.*, 1989; Garver, 1989).

TYAUGHTON CREEK – CASTLE PASS FAULT SYSTEMS

Mapping in the Gold Bridge area was aimed at establishing the southern extensions of the Tyaughton Creek and Castle Pass fault systems. These are important through-going structures that had previously been traced from the Warner Pass map area through the southwestern corner of the Noaxe Creek area and into the Bralorne map area as far south as Gun Creek (Glover *et al.*, 1988a, 1988b; Garver *et al.*, 1989a; Schiarizza *et al.*, 1989a, 1989b). Within this area the two faults enclose a lens of Cadwallader and Tyaughton Group rocks and juxtapose them against younger Jura-Cretaceous strata (Figure 1-6-4). Our 1989 mapping suggests that these fault systems were the locus of early Late Cretaceous sinistral transpressional deformation, and that the uplifted block of older rocks they enclose is separated from adjacent younger rocks by predominantly inward-dipping reverse-sinistral faults.

The structure near Gold Bridge (Figure 1-6-4) is dominated by a complex system of mainly northwest to north-trending faults (Cairnes, 1937, 1943; Church *et al.*, 1988b) informally referred to as the Bralorne fault zone (Rusmore, 1985; Leitch, 1989). Previous detailed work has concentrated along a northwest to north-trending belt of structurally interleaved Bralorne diorite, Cadwallader Group and Bridge River complex that hosts the Bralorne, Pioneer, and numerous smaller gold-quartz vein systems. These studies have established a complex history of faulting that included west-directed thrusting of the Bridge River complex over the Cadwallader Group along the Ferguson thrust fault; oblique thrusting along the north to north-northeast-dipping ribboned gold-quartz veins; and later dextral and vertical offset along steeply dipping north-trending faults (Cairnes, 1937; Joubin, 1948; Leitch, 1989). Observations made along the northern part of this system, near Gold Bridge (Figure 1-6-4), support the proposed west-directed thrusting of Bridge River complex over Cadwallader Group; these include westerly overturned folds in footwall Cadwallader Group, asymmetric west-verging mesoscopic folds in hangingwall Bridge River complex, and shear bands in foliated rocks along the fault itself. Kinematic indicators were also observed along two northwesterly trending faults, one that apparently marks the northern termination of the Cadwallader Group and Bralorne diorite panels, and one that separates the Bralorne diorite from adjacent Bridge River rocks near Gold Bridge. These are northeast-dipping structures along which the hangingwall has moved to the west; this sinistral transpression is the same as the documented movements along the Bralorne and Pioneer vein systems farther south.

The northeast-dipping transpressional fault that crosses the Bridge River at Gold Bridge apparently extends northwest-

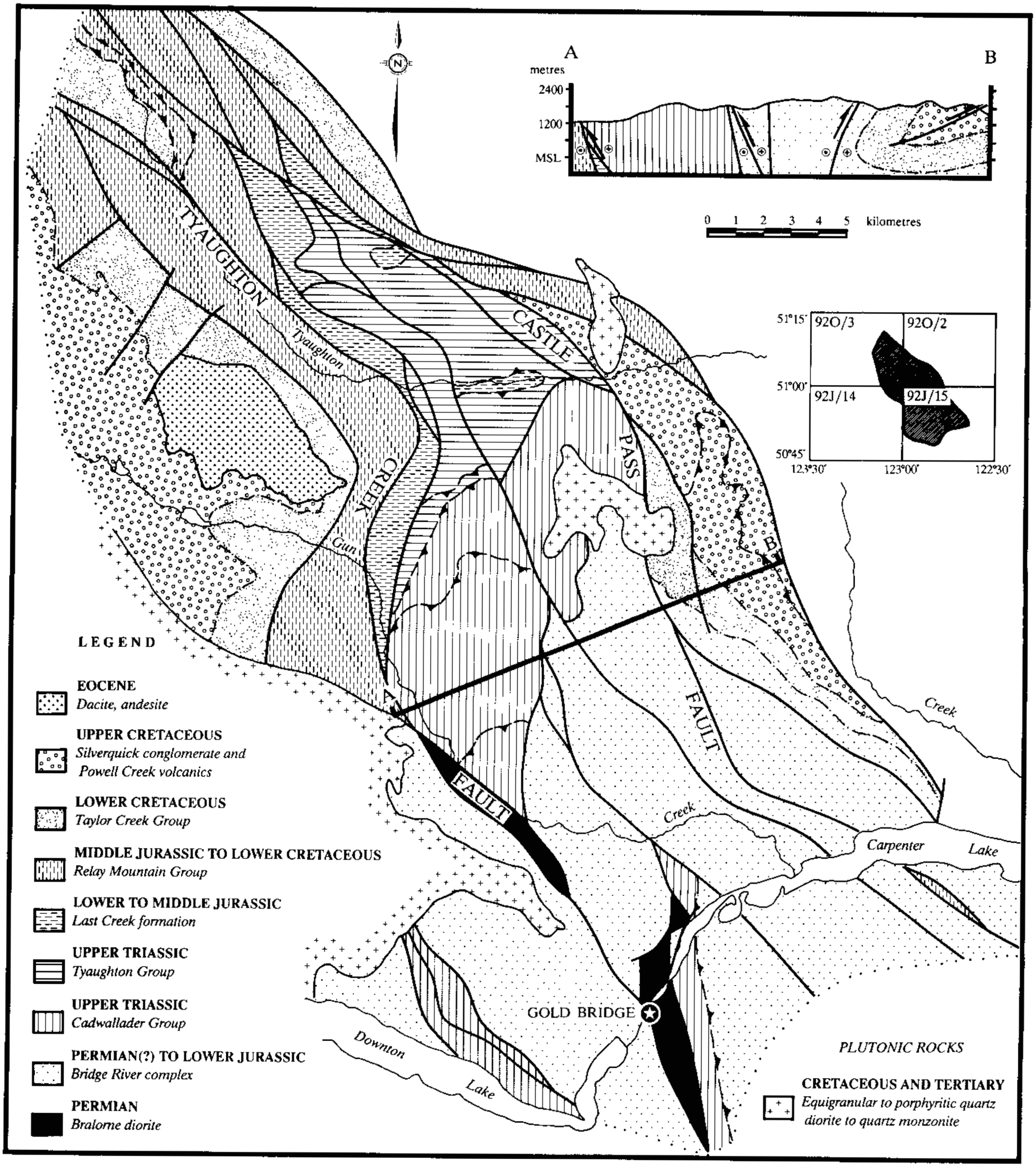

Figure 1-6-4. Generalized geology of the Tyaughton Creek and Castle Pass fault systems.

ward to Gun Creek (Figure 1-6-4). From there it is continuous with the north-trending segment of the Tyaughton Creek fault, although an important splay continues northwestward to separate the Bridge River complex from younger strata to the north. This splay is truncated by the Coast plutonic complex but may have been continuous with the Tchaikazan fault which abuts the granitic rocks along strike to the northwest (Figure 1-6-1).

The southern extension of the Castle Pass fault is inferred to be a southwest-dipping fault identified on the south side of Carpenter Lake 10 kilometres northeast of Gold Bridge (Figure 1-6-4). It separates contrasting Bridge River packages, comprising mainly greenstone and chert on the west, and variably foliated and sheared sandstone, chert, argillite and serpentinite on the east. It encloses a lens of conglomerate and sandstone identified as Relay Mountain Group by Church and MacLean (1987b) on the basis of fossil *Buchia* collected from a thin interbed of laminated siltstone and argillite. Foliation and mesoscopic shear zones within the Bridge River rocks on the northeast side of the fault dip moderately southwest to west. Shear bands and outcrop-scale transpressional duplex structures indicate a top-to-the-east sense of shear. This segment of Castle Pass fault is therefore inferred to have been the locus of oblique sinistral shear; the east-west movement direction is the same as that demonstrated for the Cadwallader–Tyaughton Creek system to the west, but it has the opposite sense of vergence because the fault and associated shears dip in the opposite direction.

The observations summarized here are consistent with the map-scale geometry of the Tyaughton Creek and Castle Pass fault systems from Carpenter Lake to the head of Tyaughton Creek, as they enclose a composite lens of relatively old, presumably uplifted rocks and separate it from younger rocks to both the northeast and southwest (Figure 1-6-4). Furthermore, east-verging folds and thrust faults are documented directly east of the Castle Pass fault while northwest to west-verging thrust faults occur within the Cadwallader and Tyaughton groups along the Tyaughton Creek fault. These are consistent with the outward-directed vergence of structures related to this uplifted block implied by fault dips and kinematics observed in the Gold Bridge area. The uplifted lens enclosed by the Tyaughton Creek and Castle Pass faults resembles the "positive flower" or "palm tree" structures documented along numerous strike-slip fault systems (Sylvester, 1988). The uplift may have been localized by the change from northwest to northerly trends of the faults between Tyaughton and Gun creeks since this corresponds to a restraining bend in a sinistral fault system (Woodcock and Fisher, 1986; Sylvester, 1988).

The Castle Pass fault cuts the Albian Taylor Creek Group and the overlying (Albian or Cenomanian ?) Silverquick conglomerate, and is itself cut by the 64 Ma Eldorado pluton (Garver *et al.*, 1989a). The Tyaughton Creek fault also cuts the Taylor Creek Group, and is apparently continuous with the Bralorne fault zone, within which reverse-sinistral mineralized shear veins probably formed between 86 and 91 Ma (Leitch, 1989). Farther south within the Bralorne fault zone penetrative deformation and metamorphism of the Chism Creek schists occurred between 85 and 100 Ma (Rusmore, 1985). Important strands of the Bralorne–Tyaughton Creek fault system are truncated by the Coast plutonic complex, but may in part continue as the Tchaikazan fault farther to the northwest (Figure 1-6-1); a lower limit of about 87 Ma for major movement along the Tchaikazan fault is provided by radiometric dating of the adjacent Coast plutonic rocks (McMillan, 1976; Archiabald *et al.*, 1989). The timing constraints outlined above indicate that sinistral transpressional deformation occurred in early Late Cretaceous time and produced steep regionally persistent faults as well as folds and thrust faults. This requires a re-evaluation of the complex network of anastomosing northwest-trending faults that pervades the area within and adjacent to the Tyaughton Creek–Castle Pass systems as most of these were previously attributed to a wide band of dextral faulting related to the Yalakom system. Although dextral offsets are locally apparent in this area, they may be of relatively minor importance compared to early Late Cretaceous transpressional structures. The dextral faults are presumably related to younger dextral faulting that was concentrated along the Relay Creek–Marshall Creek and Yalakom systems farther to the northeast.

THRUST FAULTS WITHIN THE SHULAPS ULTRAMAFIC COMPLEX

Detailed mapping along the southwestern margin of the Shulaps ultramafic complex by Tom Calon and coworkers indicates that the Shulaps harzburgite and underlying serpentinite mélange together define a major southwest-verging linked thrust system comprising a number of hinterland-dipping duplexes (Calon *et al.*, 1990). The large-scale twofold division of the Shulaps complex, comprising mantle harzburgite sitting structurally above serpentinite mélange derived from ultramafic-mafic cumulates, reflects structural stacking of lower over higher stratigraphic elements of an original ophiolite suite. A similar stacking order occurs within the serpentinite mélange itself, as upper structural levels contain knockers of ultramafic-mafic cumulates whereas a large block of gabbro and pillowed volcanics linked by an intervening dike swarm occurs along the structural base of the mélange. Serpentinite forming the matrix of the mélange commonly displays a penetrative, steeply northeast-dipping S_1 foliation cut by discrete, more gently northeast-dipping S_2 slip surfaces spaced several millimetres to several centimetres apart; sigmoidal deflection of S_1 at S_2 boundaries typically suggest a top-to-the-southwest sense of shear. Mylonite, possibly synchronous with the S_1 serpentinite foliation, commonly occurs within gabbro and serpentinite along the margins of large knockers. These mylonites display a variety of kinematic indicators, including S-C foliations, shear bands and rotated mineral grains, that indicate a top-to-the-southwest sense of shear. Serpentinite mélange along the northeastern margin of the Shulaps complex is not as well exposed as the belt to the southwest, but is inferred to comprise part of the same imbricate zone and to be continuous with the southwestern mélange beneath the intervening mantle harzburgite. S-C foliations within moderately northwest-dipping serpentinite mylonite along the contact between serpentinite mélange and overlying mantle harzburgite near upper Peridotite Creek support this interpretation as they also indicate a top-to-the-west sense of shear.

Deformation within the Shulaps serpentinite mélange was in part synchronous with intrusion of a suite of dioritic hornblende porphyry dikes. These dikes caused prograde metamorphism of serpentinite to talc-serpentine-magnesite schist, locally with regenerated olivine porphyroblasts. The dikes are locally boudinaged within the serpentinite mélange matrix and locally occur in knockers where they are truncated at the contact with the enclosing serpentinite. They therefore predate some movement within the mélange but because they caused prograde metamorphism of previously serpentinized ultramafic rock, and at one locality cut the foliation in a penetratively deformed metasedimentary knocker, are interpreted to have been intruded during the late stages of deformation (Archibald *et al.*, 1989; Calon *et al.*, 1990). These dikes in part resemble the Blue Creek porphyries; one which occurs as aligned pods within serpentinite mélange along the northeast margin of the Shulaps complex has yielded a ^{40}Ar-^{39}Ar plateau age of 77 Ma (Archibald *et al.*, 1990). Heating of the mélange at this time is also suggested by a 73 Ma ^{40}Ar-^{39}Ar date obtained from an amphibolite knocker within the southwestern mélange belt which may date cooling following intrusion-related heating (Archibald *et al.*, 1989).

The Shulaps serpentinite mélange, comprising the structural base of the imbricated Shulaps ophiolite complex, sits structurally above Bridge River schists in the area of Jim and Hog creeks. The contact was not observed, but is apparently concordant to the moderately to steeply dipping foliation within both the mélange and underlying schists, and is inferred to be a thrust contact, as suggested by Potter (1983). To the east, along East Liza Creek, the serpentinite mélange was apparently thrust over the Cadwallader Group. In this area, a greenstone-gabbro complex at the base of the mélange sits structurally above the Hurley Formation across a narrow mylonitic zone which is deformed by east-verging folds and associated slaty cleavage (Calon *et al.*, 1990). A thrust contact also defines the northern margin of the Shulaps complex (Figure 1-6-3) where southerly dipping serpentinite mélange at the base of the complex overlies subgreenschist grade Bridge River rocks. The contact 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 thrusting of the Shulaps complex over the Bridge River complex.

INTERNAL STRUCTURE OF THE BRIDGE RIVER SCHISTS

The Bridge River schists comprise several kilometres of structural thickness of foliated and lineated schist and phyllite intruded by abundant syntectonic to post-tectonic granitic to felsic porphyry intrusions. The schists are truncated by the Mission Ridge fault on the northeast and by the Marshall Creek fault on the southwest. They are structurally overlain by the Shulaps complex to the north, and several kilometres south of the Shulaps enclose an imbricate lens of Shulaps serpentinite mélange and penetratively deformed metasedimentary rocks of the Hurley Formation.

Foliation in the northern part of the Bridge River schist belt dips to the north, beneath the structurally overlying Shulaps complex. It is axial planar to gently east or west-plunging mesoscopic folds and is locally crenulated and folded about later open to tight folds that are approximately coaxial with the earlier ones. The foliation within the schists is concordant to foliation and thrust contacts within the overlying Shulaps serpentinite mélange as well as to those within the southern imbricate zone of serpentinite mélange and Hurley metasediments. Where observed southwest of Rex Peak, the contact between Bridge River schists and underlying mélange is marked by a mylonitic fabric which appears to grade upward into the schistosity in the overlying schists, and is folded about later upright, gently east-plunging, south-verging asymmetric folds (Schiarizza *et al.*, 1989). These relationships suggest that foliation and later deformation fabrics displayed by the Bridge River schists in the northern part of the belt relate primarily to a complex history of thrust imbrication and folding during south to southwest-directed emplacement of the Shulaps complex. The timing of this event is not well constrained but, as discussed in the previous section, the latest stages of deformation may have occurred in the Late Cretaceous. It predated intrusion of the Eocene Mission Ridge pluton, which crosscuts the southern imbricate zone (Figure 1-6-3).

Farther south, foliation within the Bridge River schists has a consistent northwest strike with shallow to moderate northeast dips. Stretching and intersection lineations are subhorizontal and consistently trend northwest, as do the fold hinges of both early and late folds. Kinematic indicators, including shearbands, S-C planes and rotated porphyroblasts, give a consistent upper-member-to-the-southeast sense of shear (Coleman, 1989). Two late-syntectonic granitic dikes which crosscut foliation in the enclosing schists but have the same S-C mylonitic fabrics have yielded 47 ± 1 Ma U-Pb zircon ages (Coleman, M.Sc. thesis in progress). This suggests that the top-to-the-southeast kinematic indicators formed in the Eocene, probably during dextral strike-slip faulting, and are relatively late products of a protracted history of ductile deformation within the Bridge River schists.

YALAKOM FAULT

The Yalakom fault is the most prominent structural feature of the region as it separates areas of sharply contrasting stratigraphy and structural style (Figure 1-6-1). A major steeply dipping fault zone bounding the Shulaps complex along the Yalakom River was first described and named the Yalakom fault by Leech (1953). It was traced northwestward through the Taseko Lakes and Mount Waddington map areas by Tipper (1969, 1978) who postulated that it was the locus of major right-lateral displacement. It extends southeastward to Lillooet, where it is truncated by the more northerly trending Fraser fault system (Monger and McMillan, 1984), along which it is separated by about 90 kilometres from its probable offset equivalent, the Hozameen fault, to the south (Monger, 1985). Dextral offset of more than 100 kilometres has been postulated along the Yalakom fault based on a number of different piercing point correlations. These include: 130 to 190 kilometres offset of Middle Jurassic volcanic rocks that outcrop within the Mount Waddington, Anahim Lake and Bella Coola map areas (Tipper, 1969); 125 to 175 kilometres offset of similar submarine-fan facies within the Albian Jackass Mountain Group between the Camelsfoot Range and

Chilco Lake (Kleinspehn, 1985); and about 100 kilometres separation between the Shulaps ultramafic complex and the Petch Creek serpentinite along the Hozameen fault, after first accounting for 85 kilometres of dextral offset along the Fraser fault (Umhoefer, 1989). While none of these reconstructions is unequivocal, they are consistent with the dextral sense inferred within the Taseko–Bridge River project area, and with the large offset implied by the juxtaposition of contrasting Albian lithologies of the Jackass Mountain and Taylor Creek groups.

During the present study the Yalakom fault has been traced southeastward across the Noaxe Creek map area (Glover *et al.*, 1988a, 1988b), through the southwest corner of the Big Bar Creek sheet to the southeast corner of the Bridge River map sheet (this report). Northwest of Blue Creek the fault is a steeply dipping structure commonly marked by a zone of serpentinized to listwanite-altered ultramafic rocks up to several hundred metres wide. It juxtaposes broadly folded and faulted Middle Jurassic and Jackass Mountain Group rocks on the northeast against more complexly deformed Powell Creek, Taylor Creek, Bridge River and Shulaps rocks to the southwest (Figure 1-6-1). Dextral strike-slip movement is suggested by fibrous minerals and slickensides along fault surfaces within and near the fault zone and by east-trending folds within the Middle Jurassic sandstone–Jackass Mountain Group succession that are truncated by the fault (Glover *et al.*, 1988a). Shear bands cutting foliated serpentinite along the fault zone near the mouth of Blue Creek also indicate dextral movement, as does the orientation of extensional veins and slickensided surfaces in listwanite-altered ultramafite along the fault in the same area.

Southeast of Blue Creek, the Yalakom fault apparently splays into two sub-parallel strands that enclose a wedge of imbricated Hurley Formation and Bridge River complex. The northeastern strand separates the Middle Jurassic sandstone–Jackass Mountain Group belt on the northeast from the imbricated Hurley–Bridge River wedge and is here considered the extension of the Yalakom fault. The southeastern strand separates the latter package from the Shulaps and Bridge River complexes to the southeast and is referred to as the Bridge River fault (Figure 1-6-3).

The northeastern strand is most readily related to the Yalakom fault since it bounds the same package of structurally simple Middle Jurassic and Jackass Mountain Group rocks that occur along the fault to the northwest, and juxtaposes it against Bridge River and Hurley rocks which elsewhere in the region occur only on the southwest side of the Yalakom fault. This fault is not exposed and was not recognized by previous workers; its trace crosses the wooded ridges northeast of the Yalakom and Bridge River valleys. Its presence is corroborated by contrasting structural styles since the Middle Jurassic sandstone and Jackass Mountain Group comprise a structurally simple, steeply dipping east-northeast facing belt, while the Hurley–Bridge River belt is 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 Middle Jurassic rocks and Hurley Formation where only the 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.

Bridge River Fault

The Bridge River fault apparently diverges from the Yalakom fault between the mouths of Blue and Beaverdam creeks, from where it extends southeastward along the slopes southwest of the Yalakom River to follow the lower course of the river and the adjoining Bridge River to the vicinity of Camoo Creek. It bounds the imbricated Hurley–Bridge River wedge to the northeast and separates it from rocks of the Shulaps and Bridge River complexes to the southwest. The fault zone is locally marked by conspicuous exposures of serpentinite mélange along the Bridge River; this mélange includes knockers of peridotite, gabbro and diabase similar to those seen within the mélange zone at the structural base of the Shulaps complex. This suggests that the Shulaps may have been translated in a dextral sense along the fault zone, although the dip, timing and nature of movement have not been established. The relationship of this fault (typically identified as the Yalakom fault by earlier workers) to the major fault bounding the Middle Jurassic sandstone–Jackass Mountain Group succession farther northeast (and here considered the main strand of the Yalakom fault) is also uncertain, but will be discussed further in the section dealing with the Mission Ridge fault.

Northeast-Dipping Faults Along the Yalakom and Bridge Rivers

The 4-kilometre-wide lens enclosed by the Yalakom and Bridge River faults southeast of Beaverdam Creek includes Hurley Formation, Bridge River complex and Relay Mountain Group rocks deformed by southwesterly overturned folds and northeast-dipping faults. The contacts that bound the major lithologic packages were identified as moderately northeast-dipping faults by Coleman (1989) who suggested that they might be oblique thrusts. The orientation of the faults was confirmed by our 1989 fieldwork, and sparse but consistent kinematic evidence suggests that they record sinistral transpressional deformation. The kinematic indicators include: sinistral shear bands cutting foliated serpentinite along a northeast-dipping Hurley–Bridge River fault contact 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 the northeast-dipping faults.

The relationship of the northeast-dipping transpressional faults within this wedge to adjacent structures is not certain. Coleman (1989) correlated the easternmost of these faults, which separates pillowed greenstone, gabbro and diabase of the Bridge River complex from overlying Hurley Formation (her Lillooet Group) with the Yalakom fault. Our 1989 fieldwork has established, however, that the Yalakom fault is farther to the northeast, where it separates the Hurley Formation from a structurally simpler Middle Jurassic sandstone–Jackass Mountain Group panel. Although neither the dip nor kinematics along this section of the Yalakom fault have been established it is readily correlated with the Yalakom fault farther northwest, which is a steeply dipping dextral strike-slip fault. Since the panel of imbricated Hurley and Bridge River rocks containing these northeast-dipping transpressional faults apparently pinches out between the Yalakom and Bridge River faults near Beaverdam Creek, they may be pre-Yalakom structures isolated within this fault-bound wedge. It is noteworthy that the sinistral transpressional movement along these faults is similar to that documented along early Late Cretaceous structures in the Gold Bridge area, and also that the imbricated Hurley–Bridge River–greenstone-diabase-gabbro panels within the wedge bear a strong resemblance to imbricate slices associated with the lower serpentinite mélange south of the Shulaps complex and its possible offset equivalent west of the Marshall Creek fault.

MISSION RIDGE FAULT

The Mission Ridge fault extends from 4 kilometres southeast of Lillooet, where it is truncated by the Fraser fault, northwest at least 40 kilometres to Shulaps Creek. It was first recognized and named by Coleman (1989) who established the geometry, kinematics and relative timing of movement on the segment of the fault between Lillooet and the Bridge River canyon.

The Mission Ridge fault strikes northwest and has a dip of 25° to 30° northeast. South of the Bridge River it juxtaposes low-grade, non-penetratively deformed Bridge River complex and Eocene nonmarine sedimentary rocks in the hangingwall against lower to upper greenschist-grade Bridge River schist and phyllite. Assuming a normal geothermal gradient, an estimated 12 kilometres of down-dip displacement is required to account for the contrasting metamorphic grade of hangingwall and footwall rocks (Coleman, 1989). The fault trace crosses the Bridge River about 1 kilometre west of the Yalakom River confluence and continues northwestward, parallel to the Yalakom, to at least Shulaps Creek. Between the Bridge River and LaRochelle Creek the fault trace follows the base of a distinctive planar slope. The slope has the same orientation as the Mission Ridge fault, consists of footwall schists and phyllites, and is interpreted to be the exhumed fault surface. The contrast in metamorphic grade across the fault diminishes to the northwest and is evidence for a decrease in the amount of normal displacement at this end of the fault. Its continuation beyond Shulaps Creek is uncertain, but it may swing westward and mark the boundary between Bridge River schists and Shulaps harzburgite, perhaps accounting for the pinching out of the intervening serpentinite mélange (Figure 1-6-3). Alternatively, or in addition, it may splay into a series of imbricate faults extending north and northwestward from Shulaps Creek as outcrop-scale, predominantly east-side-down, low and high-angle normal faults were observed at several localities in this area.

The Mission Ridge fault truncates Eocene(?) nonmarine sedimentary rocks in its hangingwall and the 47.5 Ma Mission Ridge pluton in its footwall (Coleman, 1989). Where the fault zone is exposed on the southeast side of the Bridge River canyon, an anastomosing fracture cleavage parallel to the fault is superimposed on foliation of the Bridge River schists in a zone 5 metres wide. This confirms that brittle normal movement on the Mission Ridge fault postdates penetrative strain in the Bridge River schists, part of which may be related to dextral strike-slip faulting. The Mission Ridge fault is in turn cut by the Fraser fault system, and was therefore probably active in the Middle to Late Eocene.

The major displacement suggested by the contrast in metamorphic grade across the low-angle Mission Ridge fault indicates that lithologic units and structures in its hangingwall have been displaced a considerable distance northeastward relative to adjacent footwall rocks. If pre-normal-faulting dextral shear recorded in footwall fabrics is related to movement on the Yalakom fault, then the Yalakom is an earlier structure that may have been cut by the Mission Ridge fault. This suggests that the southeastern segment of the Yalakom fault identified to the northeast of the Yalakom and Bridge rivers represents only a relatively high-level expression of an original Yalakom fault that was detached from its roots and translated eastward along the Mission Ridge fault. Perhaps continued or later strike-slip(?) movement along the root fault broke through the overlying cover (hangingwall of the Mission Ridge fault) at the position of the Bridge River fault and generated the present fault configuration.

MARSHALL CREEK FAULT

The Marshall Creek fault is a prominent northwest-trending structure that separates Bridge River schists on the northeast from lower grade Bridge River rocks on the southwest (Potter, 1983, 1986). It is a regionally persistent fault that extends from the Fraser fault system, 35 kilometres south of Lillooet (Monger and McMillan, 1984), for 90 kilometres northwestward to Marshall Lake. From there it extends an additional 45 kilometres northwest as the Relay Creek fault system (Glover *et al.*, 1988a, 1988b) before apparently merging with the Yalakom fault near Big Creek (Tipper, 1978).

Within the study area the Marshall Creek fault zone comprises two steeply dipping strands. The northeastern strand separates penetratively deformed greenschist-facies Bridge Riger complex and locally imbricated Cadwallader Group and serpentinite mélange on the northeast from prehnite-pumpellyite-grade Bridge River rocks on the southwest. A parallel strand to the southwest juxtaposes the low-grade Bridge River rocks against a similar Bridge River package and unconformably overlying Eocene(?) volcanics, indicating a component of Eocene or later southwest-side-down displacement. The two strands apparently merge to the southeast where, south of Carpenter Lake, the fault also cuts the Eocene Mission Ridge pluton which intrudes Bridge River schists on its northeast side. Farther to the southeast, beyond the limits of the present map area, the Marshall Creek fault truncates a low-angle fault on its southwest side which juxtaposes footwall Bridge River schist against hangingwall low-grade Bridge River rocks (Coleman, 1989). The low-angle fault is interpreted by Coleman to be part of the Mission Ridge fault; its restoration gives approximately 3.5 kilometres of southwest-side-down vertical displacement on the Marshall Creek fault (*see* Coleman, 1989, Figure 1-12-3).

The Marshall Creek fault is also inferred to have been the locus of significant dextral strike-slip movement. This inference is based partly on the prominent system of northerly trending faults that forms a transfer zone linking the Marshall Creek with the Yalakom strike-slip fault west of the

Shulaps complex (Figure 1-6-1). The regional fault pattern and distribution of lithologic units suggest that these northerly trending faults form the southeastern margin of an extensional duplex within a dextral strike-slip system (Schiarizza *et al.*, 1989a). Detailed mapping along the southwestern margin of the Shulaps complex supports this inference since northerly trending faults in this area are typically transtensional (Calon *et al.*, 1990). Dextral offset is further supported by tentative correlation of the thrust-imbricated package of Hurley Formation, serpentinite mélange and Bridge River schists that is truncated by the Marshall Creek fault 10 kilometres southeast of Marshall Lake with a similar (but lower metamorphic grade) package truncated on the other side of the fault 15 kilometres to the northwest at Liza Lake (Schiarizza *et al.*, 1989b). If strike-slip was synchronous with dextral shear along horizontal stretching lineations within the Bridge River schists, it predates the southwest-side-down normal faulting documented along the southeastern segment of the Marshall Creek fault

MINERAL OCCURRENCES

Metallic mineral prospects within the Yalakom River area occur mainly between the Marshall Creek and Yalakom–Bridge River faults. These include mesothermal gold-quartz veins within stocks of Blue Creek porphyry, as well as veins, disseminations and stockwork containing molybdenum, copper and gold along the northeastern margin of the Mission Ridge pluton. In addition, ultramafic rocks of the Shulaps complex contain small chromite concentrations and have been prospected for nephrite jade, magnesite and chrysotile (Figure 1-6-5). Cinnabar occurs locally as disseminations and veinlets near the Bridge River fault.

Gold-bearing quartz veins at the Yalakom and Elizabeth prospects occur within stocks of porphyritic quartz diorite (Blue Creek porphyry) that cut Shulaps harzburgite north of Blue Creek (Figure 1-6-5). The veins are typically ribboned and occupy steeply dipping, northerly trending shears (Gaba *et al.*, 1988). They contain visible gold and rarely more than a few per cent sulphide minerals, mainly arsenopyrite, pyrite and chalcopyrite. These veins are similar to the mesothermal veins at the Bralorne and Pioneer mines, which have yielded most of the gold produced from the Bridge River mining camp.

Most other metallic mineral occurrences are associated with granodiorite of the Mission Ridge pluton. These include high-sulphide auriferous veins at the Spokane and Broken Hill prospects as well as stockwork molybdenite at the Cub showing, which was discovered during the course of our mapping. These showings are described in a separate report by Gaba (1990, this volume).

Cinnabar veinlets and disseminations at the Eagle and Red Eagle prospects are within greenstone and greenstone breccia of the Bridge River complex. The cinnabar is associated with widely spaced carbonate veins that occupy shears parallel to the adjacent Bridge River fault. Similar mercury mineralization occurs along the Yalakom fault 30 kilometres to the northwest (Glover *et al.*, 1988a, 1988b), and along the Relay Creek fault system north of Tyaughton Lake (Schiarizza *et al.*, 1988a. 1988b).

SUMMARY

The Taseko–Bridge River project area was the locus of a complex history of mid-Cretaceous to mid-Tertiary deformation and intrusion that was superimposed on an earlier deformational history that in part included subduction-related deformation and metamorphism of the Bridge River complex. The main conclusions drawn from our 1989 field work are summarized as follows:

- The northwest to north-trending Tyaughton Creek and Castle Pass fault systems were the locus of sinistral transpressional deformation. They were previously attributed to Late Cretaceous dextral strike-slip related to the Yalakom system, and inferred to be distinctly later than mid-Cretaceous thrust faults they locally truncate. Our revised interpretation suggests that steep faults and compressional structures formed together during early Late Cretaceous sinistral transpression. This provides a better explanation for several map-scale features within the Taseko–Bridge River project area including: the localization of compressional structures along the north-trending fault segments associated with the Tyaughton Creek–Castle Pass systems in the Spruce Lake–Eldorado Mountain area, since these reflect restraining bends in a sinistral fault system; and the abrupt change in structural style west of Big Creek where relatively undeformed Upper Cretaceous Powell Creek volcanics apparently rest unconformably above both low and high-angle faults (Glover *et al.*, 1987) that may be related to transpressional deformation. The Tyaughton Creek fault is apparently continuous with the Bralorne fault zone farther southeast, which was the locus of mesothermal gold-quartz veining during this deformation.

Imbrication and thrust emplacement of the Shulaps ophiolite complex over the Bridge River complex and Cadwallader Group occurred along southwesterly directed thrust faults. ^{40}Ar-^{39}Ar cooling dates from dikes and knockers within the Shulaps serpentinite mélange suggest a Late Cretaceous age for the latest pulse of deformation (Archibald *et al.*, 1990). Thrust faults that may be related to the Shulaps imbricate zone are also identified west of the Marshall Creek fault where they separate slices of serpentinite mélange, Cadwallader Group and Bridge River complex (Schiarizza *et al.*, 1989a, 1989b). West to southwest-verging overturned folds and transpressional faults also occur east of the Shulaps complex where they imbricate lenses of Cadwallader Group, Bridge River complex, serpentinite-diabase-greenstone and Relay Mountain Group between the Bridge River and Yalakom faults.

The structures described in the previous two paragraphs may have all formed during a protracted period of late Early Cretaceous to early Late Cretaceous compressive to transpressive deformation. The earliest manifestation of this event is the implied deformation and uplift related to deposition of the synorogenic Taylor Creek Group (Garver, 1989). Although middle to early Late Cretaceous contractional deformation is recognized throughout the region (*e.g.* Rusmore and Woodsworth, 1989; Journeay and Csontos, 1989), the

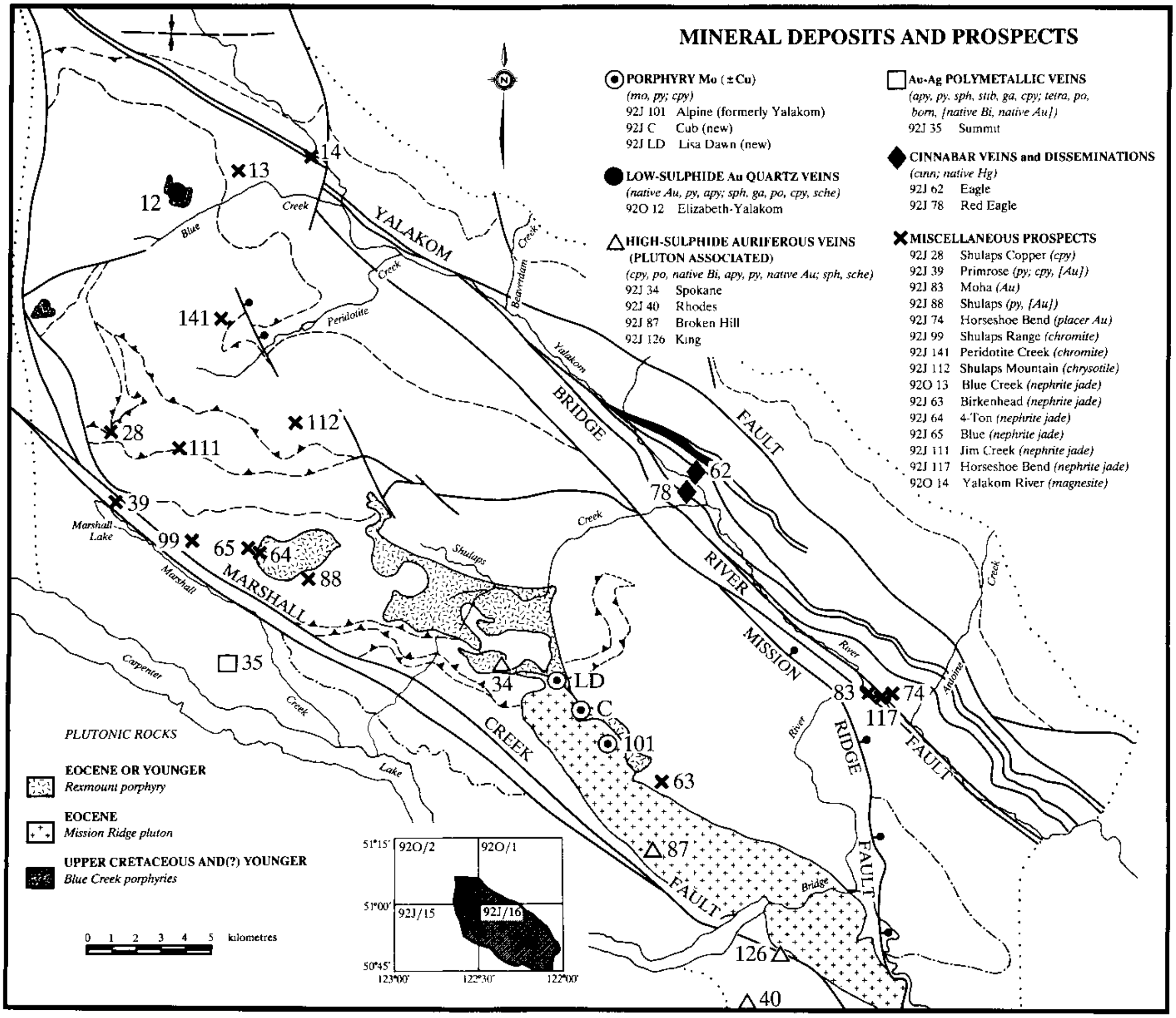

Figure 1-6-5. Mineral occurrences, Yalakom River map area. MINFILE number precedes deposit or prospect name. Mineral abbreviations: apy = arsenopyrite, born = bornite, cinn = cinnabar, cpy = chalcopyrite, ga = galena, mo = molybdenite, py = pyrite, po = pyrrhotite, sche = scheelite, sph = sphalerite, stib = stibnite, tetra = tetrahedrite.

regional extent or significance of the sinistral component is at present uncertain. It is of interest, however, that Greig (1989) has recently documented mid-Cretaceous sinistral transpression along the Pasayten fault to the southeast.

- Dextral strike-slip faulting along the Yalakom and Relay Creek–Marshall Creek fault systems postdates the compressional to transpressional deformation described above. Dextral movement along this system is suggested by east-trending folds within the Middle Jurassic sandstone and Jackass Mountain Group northeast of the Yalakom fault (Glover *et al.*, 1988a), and by a transfer zone of northerly-trending faults that links the Relay Creek–Marshall Creek and Yalakom fault systems northwest of the Shulaps ultramafic complex to define an extensional dextral-strike-slip duplex (Schiarizza *et al.*, 1989a). Shear bands in foliated serpentinite along the Yalakom fault near Blue Creek corroborate the dextral shear implied by these map-scale features. Top-to-the-southeast kinematic indicators associated with subhorizontal stretching lineations within northeast-dipping Bridge River schists also indicate dextral shear that may be related to movement along the bounding Yalakom and/or Marshall Creek faults. The same kinematic indicators are found in late synkinematic Eocene dikes, suggesting that dextral faulting was, at least in part, Eocene in age. The upper limit of dextral movement is not well constrained, however, and it is possible that the early stages of strike-slip faulting along the Yalakom and/or Marshall Creek systems coincided with the final pulse of (Late Cretaceous) deformation documented within the Shulaps serpentinite mélange.

- Miller (1987) conducted a detailed structural analysis of Lillooet and Jackass Mountain Group rocks exposed between the Yalakom and Fraser faults directly north of Lillooet. He concluded that structures within these rocks suggested a history of left-lateral followed by high-angle reverse movement along the Yalakom fault. The panel of oblique-sinistral faults and related folds documented here between the Yalakom and Bridge River faults is more or less along strike from Miller's study area, but contains distinctly different stratigraphic elements. Furthermore, these structures are inferred to be mid-Cretaceous in age and unrelated to the Yalakom fault which is here interpreted as a younger dextral strike-slip fault. Their relationship to the structures studied by Miller is therefore not readily apparent. However, Greig (1989) has also documented mid-Cretaceous sinistral transpression along the Pasayten fault, which marks the northeastern boundary of a panel of Jackass Mountain Group and related rocks that is probably the offset equivalent of the one studied by Miller. It is therefore suggested that the structures described by Miller may reflect mid-Cretaceous sinistral transpression, and be unrelated to (younger) movement along the Yalakom fault.
- The Bridge River schists and phyllites between the Marshall Creek and Mission Ridge faults were penetratively deformed under lower to upper greenschist-facies metamorphic conditions, in contrast to the predominantly prehnite-pumpellyite-facies that characterizes rocks to the northeast and southwest. Elevated metamorphic conditions along the north end of the belt apparently prevailed during imbrication and southwesterly directed thrusting of the Shulaps ophiolite complex over the Bridge river complex and Cadwallader Group. Metamorphism was in part synchronous with intrusion of a suite of late-kinematic hornblende feldspar porphyry dikes of Late Cretaceous age, but earlier deformation was also in part ductile and generated mylonites and greenschist-facies metamorphic mineral assemblages prior to intrusion of the dikes (Archibald *et al.*, 1989, 1990; Calon *et al.*, 1990). Potter (1983, 1986) suggested that the heat source for this metamorphism was hot upper mantle of the obducted Shulaps complex. The present study has not documented an inverted metamorphic gradient beneath the Shulaps complex where locally, as along the northern margin of the complex, Shulaps rocks are in thrust contact with subgreenschist facies rocks. However, a thick slice of serpentinite mélange occurs along the contact in areas where a thrust relationship between the Shulaps and underlying Bridge River complex is inferred or documented. Structures within and adjacent to the mélange record a complex deformational history that includes mixing of ophiolitic and lower to upper greenschist-facies supracrustal elements within the mélange as well as later imbrication and/or infolding of the mélange and underlying Bridge River and Cadwallader rocks. This deformation and attendant late metamorphism have clearly shuffled and overprinted the early metamorphic pattern such that its spatial relationship to the Shulaps ophiolite is unclear.

  Bridge River schists throughout most of the high grade belt, which extends from the Shulaps complex more than 40 kilometres southwestward to the Fraser River (Monger and McMillan, 1984; Coleman, 1989) are intruded by abundant synkinematic to postkinematic Middle Eocene granitic rocks, and record Middle Eocene ductile deformation (Price *et al.*, 1985; Potter, 1986; Coleman, 1989). Most of the belt was therefore at elevated temperatures during the Middle Eocene, perhaps directly or indirectly related to the granitic intrusions localized along the belt at that time. Later uplift of the belt was in part accommodated by extensional faulting along the gently northeast-dipping Mission Ridge fault (Coleman, 1989). Displacement along this fault seems to diminish to the north, suggesting that uplift may have been greatest in the south and imparted a northward tilt to the block. This is consistent with preservation of the structurally higher Shulaps ophiolite complex at the north end, and of structures related to its emplacement within Bridge River and Cadwallader Group rocks directly beneath it.
- Metallic mineral occurrences within the Yalakom River area are concentrated within the belt of relatively higher grade metamorphic rocks between the Marshall Creek and Yalakom faults. These include the Elizabeth-Yalakom mesothermal gold-quartz veins within stocks of Blue Creek porphyry, as well as base and precious metal bearing veins and disseminations within and adjacent to the Mission Ridge pluton. The metal prospects are therefore broadly related to the intrusive activity that characterized the belt in Late Cretaceous to Eocene time. Mineralization associated with the Mission Ridge pluton includes stockwork molybdenite that was discovered during the course of this summer's work; this type of mineralization was previously unrecognized and represents a new exploration target in the Bridge River mining camp (Gaba, 1990).
- The stratigraphic succession northeast of the Yalakom fault is represented by Middle Jurassic volcanic sandstone, granule to pebble conglomerate and less common siltstone and shale, together with disconformably overlying upper Lower Cretaceous arkosic sandstone, volcanic and plutonic-clast conglomerate, siltstone and shale of the Jackass Mountain Group. These units are lithologically distinct from age-equivalent strata on the southwest side of the Yalakom fault, where the Middle Jurassic is represented by mainly shales and siltstones of the Last Creek formation (Frebold *et al.*, 1969; Umhoefer, 1989) and the upper Lower Cretaceous is represented by mainly volcanic and chert-rich clastics of the Taylor Creek Group (Garver, 1989). The stratigraphic succession on the northeast side of the Yalakom fault compares more closely to the stratigraphy 100 to 200 kilometres to the south, where the Jackass Mountain Group is in part directly underlain by the Lower to Middle Jurassic Ladner Group, including lower Middle Jurassic volcanic sandstones and conglomerates, volcanic tuff, breccia and local flows of the Dewdney

Creek Formation (O'Brien, 1986). These rocks occur on the northeast side of the Hozameen fault, the probable southern extension of the Yalakom fault.

ACKNOWLEDGMENTS

The authors would like to thank R. Macdonald, M. O'Dea, D.A. Archibald, T. Calon, J. Malpas, F. Cordey, P.J. Umhoefer and A. Till for their mapping contributions, geological insights and good company during the course of this season's fieldwork. We also benefited from field trips and discussions with W.R. Smyth, R. Meyers, W.J. McMillan and D. MacIntyre of this ministry, R. Parrish of the GSC, Ottawa, and R.L. Brown of Carleton University. Field and laboratory work by M. Coleman was funded by project 850001 of the Geological Survey of Canada (R. Parrish) and Natural Sciences and Engineering Research Council Supporting Geoscience Grant No. 86 awarded to R. Parrish. Bob Thurston and Bob Holt of Cariboo-Chilcotin Helicopters Ltd. are thanked for safe and punctual helicopter service.

REFERENCES

Archibald, D.A., Glover, J.K. and Schiarizza, P. (1989): Preliminary Report on $^{40}Ar/^{39}Ar$ Geochronology of the Warner Pass, Noaxe Creek and Bridge River Map Areas (92O/3, 2; 92J/16); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1988, Paper 1989-1, pages 145-151.

Archibald, D.A., Schiarizza, P. and Garver, J.I. (1990): ^{40}Ar-^{39}Ar Dating and the Timing of Deformation and Metamorphism in the Bridge River Terrane, Southwestern British Columbia (92O/2; 92J/15); *B.C. Ministry of Energy, Mines and Petroleum Resouces*, Geological Fieldwork 1989, Paper 1990-1, this volume.

Cairnes, C.E. (1937): Geology and Mineral Deposits of the Bridge River Mining Camp, British Columbia; *Geological Survey of Canada*, Memoir 213, 140 pages.

——— (1943): Geology and Mineral Deposits of Tyaughton Lake Area, British Columbia; *Geological Survey of Canada*, Paper 43-15, 39 pages.

Calon, T.J., Malpas, J.G. and Macdonald, R. (1990): The Anatomy of the Shulaps Ophiolite; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1989, Paper 1990-1, this volume.

Church, B.N. (1987): Geology and Mineralization of the Bridge River Mining Camp (92J/15, 92O/2, 92J/10); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1986, Paper 1987-1, pages 23-29.

Church, B.N. and MacLean, M.E. (1987a): Geology of the Gold Bridge Area (92J/15W); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1987-11.

Church, B.N. and MacLean, M.E. (1987b): Geology and Mineralization in the vicinity of the Mary Mac Mine; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Exploration in British Columbia 1986, pages B33-B37.

Church, B.N., Gaba, R.G., Hanna, M.J. and James, D.A.R. (1988a): Geological Reconnaissance in the Bridge River Mining Camp (92J/15, 16, 10; 92O/02); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1987, Paper 1988-1, pages 93-100.

Church, B.N., MacLean, M., Gaba, R.G., Hanna, M.J. and James, D.A. (1988b): Geology of the Bralorne Map Area (92J/15); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1988-3.

Church, B.N. and Pettipas, A.R. (1989): Research and Exploration in the Bridge River Mining Camp (92J/15, 16); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1988, Paper 1989-1, pages 105-114.

Coleman, M. (1989): Geology of Mission Ridge, near Lillooet, British Columbia (92I, J); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1988, Paper 1989-1, pages 99-104.

Drysdale, C.W. (1916): Bridge River Map-area, Lillooet Mining Division; *Geological Survey of Canada*, Summary report for 1915, pages 75-85.

Duffell, S. and McTaggart, K.C. (1952): Ashcroft Map Area, British Columbia; *Geological Survey of Canada*, Memoir 262, 122 pages.

Frebold, H., Tipper, H.W. and Coates, J.A. (1969): Toarcian and Bajocian rocks and Guide Ammonites from Southwestern British Columbia; *Geological Survey of Canada*, Paper 67-10, 55 pages.

Gaba, R.G. (1990): Stockwork Molybdenite in the Mission Ridge Pluton: A New Exploration Target in the Bridge River Mining Camp (92J/16); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1989, Paper 1990-1, this volume.

Gaba, R.G., Hanna, M.J. and Church, B.N. (1988): The Elizabeth-Yalakom Prospect, Bridge River Mining Camp (92O/2); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1987, Paper 1988-1, pages 329-333.

Garver, J.I. (1989): Basin Evolution and Source Terranes of Albian-Cenomanian Rocks in the Tyaughton Basin, Southern British Columbia: Implications for Mid-Cretaceous Tectonics in the Canadian Cordillera; unpublished Ph.D. thesis, *University of Washington*, 227 pages.

Garver, J.I., Schiarizza, P. and Gaba, R.G. (1989a): Stratigraphy and Structure of the Eldorado Mountain Area, Chilcotin Ranges, Southwestern British Columbia (92O/2 and 92J/15); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1988, Paper 1989-1, pages 131-143.

Garver, J.I., Till, A.B., Armstrong, R.L. and Schiarizza, P. (1989b): Permo-Triassic Blueschist in the Bridge River Complex, Southern British Columbia; *Geological Society of America*, Cordilleran/Rocky Mountain Sections Annual Meeting, Spokane, Washington, Abstracts with Programs, page 82.

Glover J.K. and Schiarizza, P. (1987): Geology and Mineral Potential of the Warner Pass Map Area (92O/3); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1986, Paper 1987-1, pages 157-169.

Glover, J.K., Schiarizza, P., Umhoefer, P.J. and Garver, J.I. (1987): Geology of the Warner Pass Map Area (92O/3); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1987-3.

Glover, J.K., Schiarizza, P. and Garver, J.I. (1988a): Geology of the Noaxe Creek Map Area (92O/2); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1987, Paper 1988-1, pages 105-123.

Glover, J.K., Schiarizza, P., Garver, J.I., Umhoefer, P.J. and Tipper, H.W. (1988b): Geology and Mineral Potential of the Noaxe Creek Map Area (92O/2); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1988-9.

Greig, C.J. (1989): Geology and Geochronometry of the Eagle Plutonic Complex, Coquihalla Area, Southwestern British Columbia; unpublished M.Sc. thesis, *The University of British Columbia*, 423 pages.

Jeletzky, J.A. (1967): Stratigraphy and Paleontology of Lower Cretaceous and Upper Jurassic Rocks of Taseko Lakes (92-O) and Pemberton (92-J) Map Areas; *in* Report of Activities, Part A, *Geological Survey of Canada*, Paper 67-1A, pages 65-68.

Jeletzky, J.A. and Tipper, H.W. (1968): Upper Jurassic and Cretaceous Rocks of Taseko Lakes Map Area and their Bearing on the Geological History of Southwestern British Columbia; *Geological Survey of Canada*, Paper 67-54, 218 pages.

Journeay, J.M. and Csontos, L. (1989): Preliminary Report on the Structural Setting along the Southeast Flank of the Coast Belt, British Columbia; *in* Current Research, Part E, *Geological Survey of Canada*, Paper 89-1E, pages 177-187.

Joubin, F.R. (1948): Structural Geology of the Bralorne and Pioneer Mines, Bridge River District, British Columbia; *Western Miner*, July 1948, pages 39-50.

Kleinspehn, K.L. (1985): Cretaceous Sedimentation and Tectonics, Tyaughton-Methow Basin, Southwestern British Columbia; *Canadian Journal of Earth Sciences*, Volume 22, pages 154-174.

Leech, G.B. (1953): Geology and Mineral Deposits of the Shulaps Range; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 32, 54 pages.

Leitch, C.H.B. (1989): Geology, Wallrock Alteration, and Characteristics of the Ore Fluid at the Bralorne Mesothermal Gold Vein Deposit, Southwestern British Columbia; unpublished Ph.D. thesis, *University of British Columbia*, 483 pages.

Mathews, W.H. (1989): Neogene Chilcotin basalts in South-central British Columbia: Geology, Ages, and Geomorphic History; *Canadian Journal of Earth Sciences*, Volume 26, pages 969-982.

McMillan, W.J. (1976): Granite Creek Property, (92O/3W); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geology in British Columbia, 1975, pages 67-84.

Miller, M. (1987): Deformation near Lillooet, British Columbia: Its Bearing on the Slip History of the Yalakom fault; unpublished M.Sc. thesis, *University of Washington*, 102 pages.

Monger, J.W.H. (1977): Upper Paleozoic Rocks of the Western Canadian Cordillera and their Bearing on Cordilleran Evolution; *Canadian Journal of Earth Sciences*, Volume 14, pages 1832-1859.

——— (1985): Structural Evolution of the Southwestern Intermontane Belt, Ashcroft and Hope Map Areas, British Columbia; *in* Current Research, Part A, *Geological Survey of Canada*, Paper 1985-1A, pages 349-358.

Monger, J.W.H. and McMillan, W.J. (1984): Bedrock Geology of Ashcroft (92I) Map Area; *Geological Survey of Canada*, Open File 980.

Nagel, J.J. (1979): The Geology of part of the Shulaps Ultramafite near Jim Creek, Southwestern British Columbia; unpublished M.Sc. thesis, *The University of British Columbia*, 74 pages.

O'Brien, J. (1986): Jurassic Stratigraphy of the Methow Trough, Southwestern British Columbia; *in* Current Research, Part B, *Geological Survey of Canada*, Paper 86-1B, pages 749-756.

Price, R.A., Monger, J.W.H. and Roddick, J.A. (1985): Cordilleran Cross-section, Calgary to Vancouver; *in Field Guides to Geology and Mineral Deposits in the* Southern Canadian Cordillera, D. Tempelman-Kluit, Editor, *Geological Society of America*, Cordilleran Section Annual Meeting, Vancouver, B.C., pages 3.1-3.85.

Potter, C.J. (1983): Geology of the Bridge River Complex, Southern Shulaps Range, British Columbia: A Record of Mesozoic Convergent Tectonics; unpublished Ph.D. thesis, *University of Washington*, 192 pages.

——— (1986): Origin, Accretion and Post-accretionary Evolution of the Bridge River Terrane, Southwest British Columbia; *Tectonics*, Volume 5, Pages 1027-1041.

Roddick, J.A. and Hutchison, W.W. (1973): Pemberton (East Half) Map Area, British Columbia; *Geological Survey of Canada*, Paper 73-17, 21 pages.

Rusmore, M.E. (1985): Geology and Tectonic Significance of the Upper Triassic Cadwallader Group and its Bounding Faults, Southwest British Columbia; unpublished Ph.D. thesis, *University of Washington*, 174 pages.

——— (1987): Geology of the Cadwallader Group and the Intermontane-Insular Superterrane Boundary, Southwestern British Columbia; *Canadian Journal of Earth Sciences*, Volume 24, pages 2279-2291.

Rusmore, M.E., Potter, C.J. and Umhoefer, P.J. (1988): Middle Jurassic Terrane Accretion along the Western Edge of the Intermontane Superterrane, Southwestern British Columbia. *Geology*, Volume 16, pages 891-894.

Rusmore, M.E. and Woodsworth, G.J. (1989): A Note on the Coast-Intermontane Belt Transition, Mount Waddington Map Area, British Columbia; *in* Current Research, Part E, *Geological Survey of Canada*, Paper 89-1E, pages 163-167.

Schiarizza, P., Gaba, R.G., Glover, J.K. and Garver, J.I. (1989a): Geology and Mineral Occurrences of the Tyaughton Creek area (92O/2, 92J/15,16); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1988, Paper 1989-1, pages 115-130.

Schiarizza, P., Gaba, R.G., Garver, J.I., Glover, J.K., Church, B.N., Umhoefer, P.J., Lynch, T., Sajgalik, P.P., Safton, K.E., Archibald, D.A., Calon, T., MacLean, M., Hanna, M.J., Riddell, J.L. and James, D.A.R. (1989b): Geology and Mineral Potential of the Tyaughton Creek area (92J/15, 16; 92O/2); *B.C. Ministry of Energy, Mines and Petroleum Resources*, Open File 1989-4.

Selwyn, A.R.C. (1872): Journal and Report of Preliminary Explorations in British Columbia; *Geological Survey of Canada*, Report of Progress 1871 to 1872, pages 16-72.

Sylvester, A.G. (1988): Strike-slip Faults; *Geological Society of America Bulletin*, Volume 100, pages 1666-1703.

Tipper, H.W. (1969): Mesozoic and Cenozoic Geology of the Northeastern Part of Mount Waddington Map Area (92N), Coast District, British Columbia; *Geological Survey of Canada*, Paper 68-33.

——— (1978): Taseko Lakes (92O) Map Area; *Geological Survey of Canada*, Open File 534.

Trettin, H.P. (1961): Geology of the Fraser River Valley between Lillooet and Big Bar Creek; *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 44, 109 pages.

Umhoefer, P.J. (1989): Stratigraphy and Tectonic Setting of the Upper Cadwallader Terrane and overlying Relay Mountain Group, and the Cretaceous to Eocene Structural Evolution of the Eastern Tyaughton Basin, British Columbia; unpublished Ph.D. thesis, *University of Washington*, 186 pages.

Woodcock, N.H. and Fischer, M. (1986): Strike-slip Duplexes; *Journal of Structural Geology*, Volume 8, pages 725-735.

Woodsworth, G.J. (1977): Pemberton Map Area (92J); *Geological Survey of Canada*, Open File 482.

Wright, R.L., Nagel, J.J. and McTaggart, K.C. (1982): Alpine Ultramafic Rocks of Southwestern British Columbia; *Canadian Journal of Earth Sciences*, Volume 19, pages 1156-1173.