British Columbia Geological Survey
Geological Fieldwork 1987

GEOLOGY OF THE NOAXE CREEK MAP AREA* (92O/02)

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KEYWORDS: Regional geology, Noaxe Creek, Warner Pass, Bridge River terrane, Cadwallader terrane, Tyaughton trough, Yalakom fault, Shulaps ultramafic complex, wrench faults.

INTRODUCTION

The Noaxe Creek map area lies 200 kilometres north of Vancouver on the eastern margin of the Coast Mountains, and covers an area of 1000 square kilometres within the Chilcotin Range. The topography and vegetation vary from alpine to subalpine in the west, southeast and northeast, where elevations range up to 2850 metres, to rolling tree-covered ridges with intervening broad river valleys in the central part of the area.

Approximately 70 per cent of the area, mostly north of Tyaughton and Noaxe creeks, was mapped at a scale of 1:20 000 by a four-person field crew during the 1987 season. This was augmented by results from independent detailed mapping in the western part of the area by Paul Umhoefer and in the western and southern parts of the area by John Garver during 1985, 1986 and 1987.

Approximately 50 rock samples were collected from zones of alteration and mineralization for trace element analysis.

This report covers the second year of a 4-year regional mapping project, begun in 1986, and funded by the Canada/British Columbia Mineral Development Agreement in order to provide 1:50 000-scale geology maps and mineral potential overlays of the Taseko–Bridge River area as an aid to exploration.

REGIONAL GEOLOGY

The study area is underlain by Mesozoic sedimentary and volcanic rocks that lie within a northwest-trending, structurally complex zone along the western margin of the Intermontane Belt, to the east of the Coast plutonic complex (Figure 1-9-1). This zone comprises several fault-bounded tectonostratigraphic units, some of which are coeval, as outlined below:

The Bridge River Terrane: Oceanic rocks of the lower Jurassic and older (?) Shulaps ultamafic complex and Middle Triassic to Lower Jurassic Bridge River complex (Potter, 1986).

The Cadwallader Terrane: Volcanic arc-related rocks of the Upper Triassic Cadwallader and Tyaughton groups (Rusmore, 1987), and lower to middle Jurassic sediments (H.W. Tipper, personal communication, 1987).

The Tyaughton Trough: Marine sedimentary strata of the Middle Jurassic to Lower Cretaceous Relay Mountain Group and the mid-Cretaceous Taylor Creek and Jackass Mountain groups (Jeletzky and Tipper, 1968).

An Upper Cretaceous succession, which comprises laterally discontinuous, nonmarine basinal deposits that grade up into continental volcanic arc-related rocks, overlies the older marine strata of the the Tyaughton trough with local pronounced angular unconformity (Glover and Schiarizza, 1987).

The Bridge River terrane and Tyaughton trough are thought to have been offset from their correlatives to the south, the Hozameen Group and Methow basin, by at least 70 kilometres of right-lateral strike-slip movement along the north-trending Fraser – Straight Creek fault system during Late Cretaceous (?) and Early Tertiary time (Monger, 1985). Earlier, post-Albian fragmentation of the Tyaughton-Methow basin occurred along the Yalakom-Hozameen fault system, along which 80 to 190 kilometres of right-lateral offset has been postulated (Tipper, 1969). The Yalakom fault crosses the map area from southeast to northwest, from where it has been traced, north of Taseko and Chilko lakes, to the Tatla Lake area in the Mount Waddington map area (Tipper, 1969, 1978; McLaren, 1986, 1987).

Mesozoic strata are intruded by mid-Cretaceous quartz diorite to quartz monzonite of the Coast plutonic complex in the southwest part of the belt (McMillan, 1976) and by widespread equigranular and porphyritic granitic stocks and dykes of probable late Cretaceous and Eocene age; they are unconformably overlain by Eocene volcanic and sedimentary rocks and by Pliocene and Miocene plateau basalts (Mathews and Rouse, 1984).

LOCAL GEOLOGY

Figure 1-9-2 outlines the general geology of the Noaxe Creek map area. Previous regional mapping by Tipper (1978) and detailed biostratigraphy (Tozer, 1967; Jeletzky and Tipper, 1968) form the basis of divisions within much of the Mesozoic strata; division of Cretaceous rocks into the Taylor Creek and Kingsvale groups, defined for the Taseko Lakes map area by Jeletzky and Tipper, has been modified based on field relationships recognized during the 1986 and 1987 seasons. Results from two independent structural and stratigraphic studies of the Tyaughton and Relay Mountain groups by P.J. Umhoefer, and of the Taylor Creek Group by J. I. Garver are incorporated in Figure 1-9-2 (Umhoefer, Garver and Tipper, in preparation), together with a limited amount of data from assessment reports. The geology along the southern margin of the map sheet has been compiled from

* This project is a contribution to the Canada/British Columbia Mineral Development Agreement.
British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1987, Paper 1988-1.

previous work (Cairnes, 1943; Leech, 1953; Tipper, 1978; Rusmore, 1985), with the addition of data supplied by B.N. Church (Church *et al.*, this volume).

LITHOLOGY

THE SHULAPS ULTRAMAFIC COMPLEX AND RELATED SERPENTINITE ZONES

The Shulaps ultramafic complex, which extends into the southeastern part of the map area, is located in the Shulaps Range, southwest of the Yalakom River and north of the Bridge River. The complex and its contact relationships were first studied in detail by Leech (1953), who concluded that it was an intrusive body, emplaced in Late Triassic or Early Jurassic time, and later redistributed, possibly by solid flow, along fault zones to the west and northwest. Later workers (Monger, 1977; Nagel, 1979; Wright *et al.*, 1982) suggested that the Shulaps ultramafic and Bridge River complexes together constitute a dismembered ophiolite. Potter (1983,

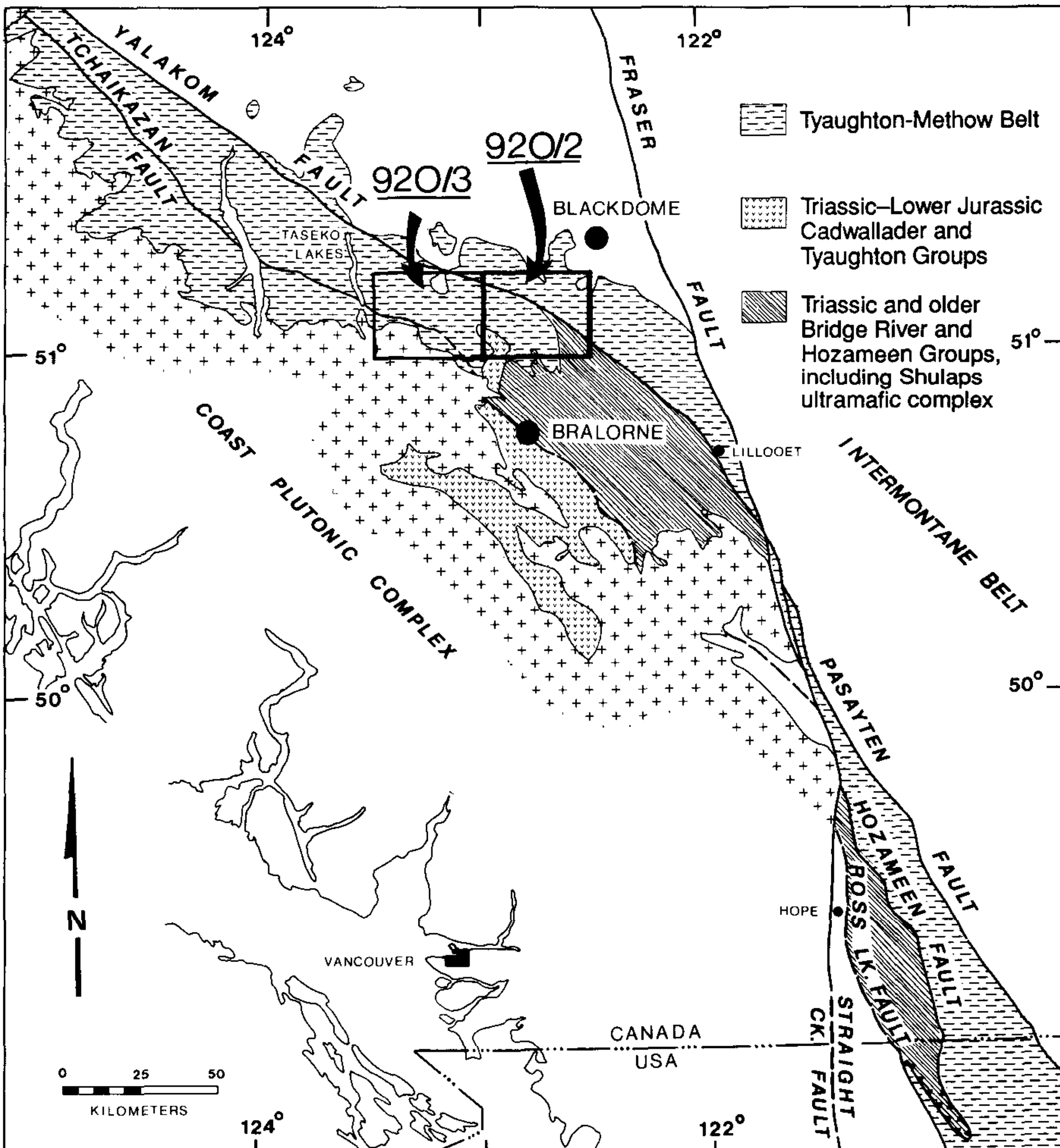
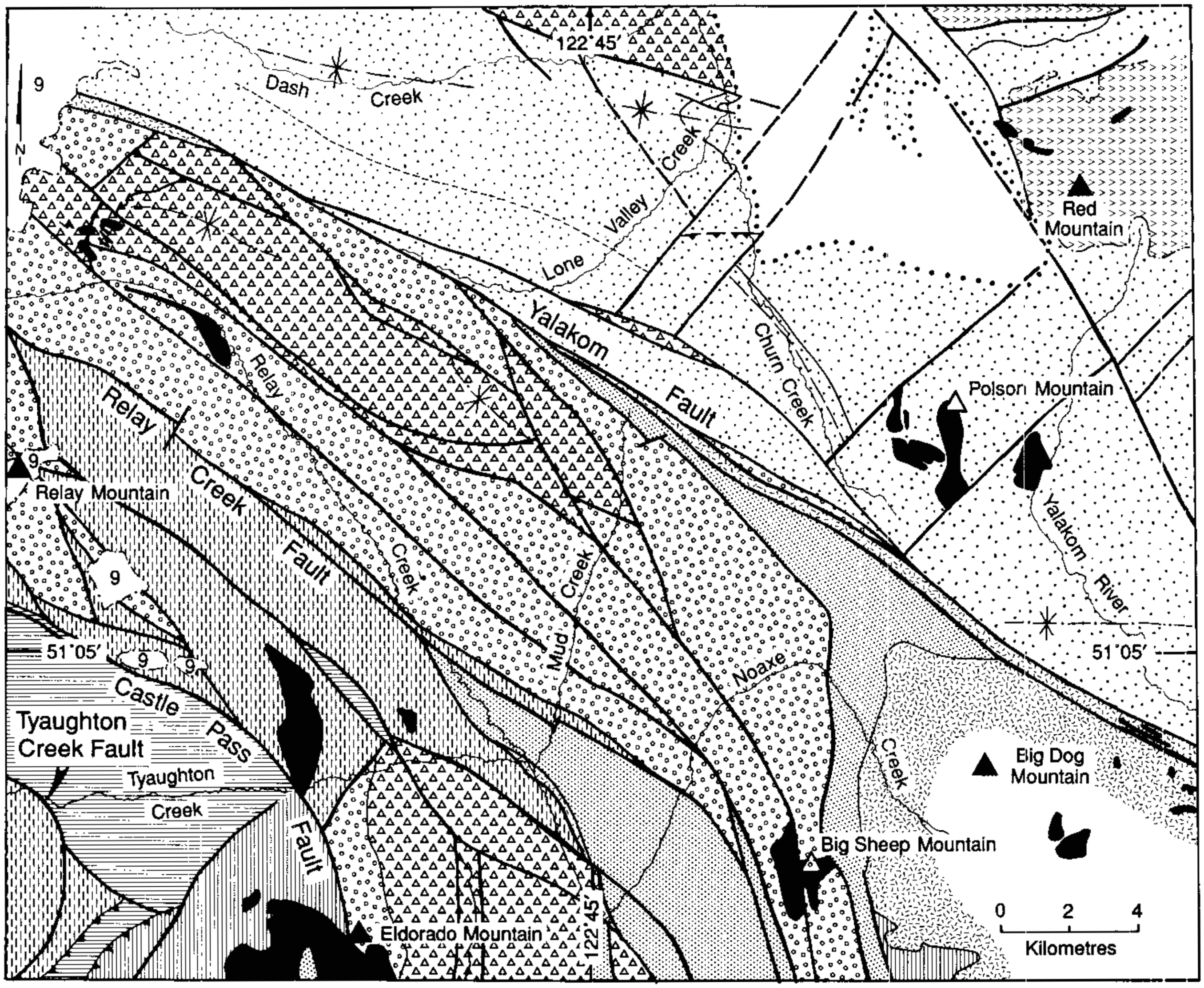


Figure 1-9-1. Location and geological setting, Noaxe Creek and Warner Pass map areas (92/02 and 92O/03).



LEGEND

MIOCENE/PLIOCENE

9 — *Plateau lava, basalt flows*

EOCENE (Unit 8)

>>> — *Aphyric to porphyritic andesitic to dacitic flows; rhyolite flows and flow breccias; minor volcanic sandstone and siltstone*

UPPER CRETACEOUS

BATTLEMENT RIDGE GROUP (Units 6 and 7)

Polymict conglomerate, sandstone; epiclastics; andesitic flows, volcanic breccia and lapilli tuff

LOWER CRETACEOUS

TAYLOR CREEK GROUP (Units 4 and 5)

Shale, siltstone and sandstone; volcanic conglomerate; chert-pebble conglomerate; micaceous sandstone

JACKASS MOUNTAIN GROUP (Unit 3)

Lithic sandstone and wacke; arkosic sandstone; polymict conglomerate and conglomeratic sandstone; siltstone and shale

MIDDLE JURASSIC TO LOWER CRETACEOUS

RELAY MOUNTAIN GROUP (Unit 2)

Interbedded dark grey shale, grey-brown siltstone, green-grey greywacke and lithic sandstone; grit and conglomerate

UPPER TRIASSIC TO LOWER JURASSIC

TYAUGHTON GROUP (Unit 1)

Massive limestone; red conglomerate; grit and conglomerate interbedded with green sandstone and shale; dark grey to black shale and argillite

UPPER TRIASSIC

CADWALLADER GROUP (Unit UTc)

Mafic volcanics and volcaniclastics; conglomerate; limestone and grey to black argillite

MIDDLE TRIASSIC TO LOWER JURASSIC (Unit BRc)

BRIDGE RIVER COMPLEX

Ribbon and massive cherts; greenstone; argillaceous mélange, argillite and limestone; minor altered gabbro to diorite

PLUTONIC ROCKS

EOCENE AND OLDER

Equigranular to porphyritic quartz diorite to quartz monzonite

Peridotite, harzburgite, dunite, serpentinized peridotite

Figure 1-9-2. Generalized geology map, Noaxe Creek map area.

1986), working along its southern margin, documented a thrust zone at the base of the complex which juxtaposes it against underlying rocks of the Bridge River complex that contain an inverted metamorphic gradient and a transposed foliation; he concluded that thrusting occurred during mid-Jurassic time while the ultramafic rocks were still hot.

Only the northeastern margin of the Shulaps ultramafic complex has been mapped during the present study; here, its contact with rocks of the Jackass Mountain Group to the northeast is defined by a broad, poorly exposed zone of serpentinization along the Yalakom fault. This zone continues to the northwest of the complex for a distance of 16 kilometres. Two other slivers of serpentinite occur elsewhere: along the Yalakom fault in the northwestern part of the map area, and along a fault zone on the west margin of a panel of Bridge River complex, in the vicinity of Tyaughton Creek.

Leech (1953) estimated the main body of the complex to comprise 85 per cent harzburgite, with dunite making up the remainder; variable serpentinization of these rocks is ubiquitous. Pods and lenses of relict harzburgite within foliated serpentinite were observed in the study area north of Quartz Mountain along the Yalakom fault zone, and at the confluence of Mud Creek with Relay Creek, along the fault zone west of the Bridge River complex.

Serpentinized ultramafic rocks associated with some of the major faults in the map area are extensively carbonatized and silicified. These rusty to orange-weathering rocks are composed of silica and magnesian carbonate with fuchsite. Quartz, some of which is chalcedonic, occurs in anastamosing veinlets and irregular masses in a carbonate matrix, with some late, crosscutting veinlets of euhedral magnesite. All stages of hydrothermal alteration of serpentinite can be found in these zones.

THE BRIDGE RIVER COMPLEX (UNIT BRC)

The Bridge River complex (Potter, 1983) includes all rock types previously assigned to the Bridge River Group by Roddick and Hutchison (1973) and to the Fergusson series by Cairnes (1937, 1943) and later, by Church (1987). In this report the term complex is preferred because internal structural complexities and small-scale variability of lithology prohibit measurement of a meaningful type section.

This unit outcrops in the southern and southeastern parts of the area where its thickness is unknown. It comprises, in order of decreasing abundance, intercalated and structurally juxtaposed ribbon chert, greenstone, melange, black argillite, limestone and minor altered gabbro or diorite. Ribbon chert is generally grey, with less common red, brown and green varieties. Individual beds vary from 1 to 10 centimetres thick and are separated by argillaceous partings, but massive chert occurs locally. Greenstone is grey-green to chocolate-brown weathering, generally massive, with rare pillows, and is fine grained, but locally contains amygdules and altered ferromagnesian phenocrysts; volcanic breccias occur in places. These rocks represent submarine volcanism of probable basaltic to andesitic composition. Scattered pods and lenses of light grey, massive crystalline limestone, generally less than 10 metres thick, occur within ribbon chert, argillite and melange. They are rarely traceable for more than 20 metres, but one, located north of the confluence of Relay Creek with Mud Creek, extends for a strike length of 3 kilometres. Melange comprises pods and lenses of all the above lithologies in a foliated argillaceous matrix; the fabric is generally coplanar with bedding in adjacent ribbon chert. These rocks, together with the Shulaps ultramafic complex, are interpreted as an accretionary prism of oceanic provenance (Price *et al.*, 1985; Potter, 1986). No fossils have been obtained from the complex in the study area, but to the south, on the north side of Carpenter Lake, conodonts from carbonates and radiolaria from cherts give a range in age from Middle Triassic to Early Jurassic (Cameron and Monger, 1971; Cordey, 1986).

THE CADWALLADER GROUP (UNIT UTc)

Rocks of the Cadwallader Group are confined to two areas along the southern margin of the map sheet, neither of which was mapped during the present study; their distribution, outlined on Figure 1-9-2, is based on previous work.

The Cadwallader Group, as defined by Roddick and Hutchison (1973) for the Pemberton (east half) map area, to the south of the present study, comprises the Noel, Pioneer and Hurley formations of Cairnes (1937, 1943). Subsequent work by Rusmore (1985, 1987) indicates that the Noel Formation is not a coherent unit and should be abandoned. The revised stratigraphy of the group, based on sections south of Tyaughton Creek and west of Eldorado Mountain (map sheets 92O/02 and 92J/15), comprises a mafic volcanic unit, the Pioneer Formation, at the base, overlain by a lower volcaniclastic member and an upper turbidite member of the Hurley Formation; an estimated total thickness of at least 2000 metres (Rusmore, 1987). Conodonts from the Hurley Formation give a range in age from latest Carnian or earliest Norian to Middle Norian (Rusmore, 1987).

Rocks of the Cadwallader Group have been mapped along the southwest margin of the Shulaps Range by various workers (Leech, 1953; Roddick and Hutchison, 1973; Church *et al.*, this volume). However, contact relationships with adjacent rocks of the Bridge River and Shulaps ultramafic complexes are poorly defined.

THE TYAUGHTON GROUP (UNIT 1)

Cairnes (1943) originally confined the Tyaughton Group to rocks of Triassic age. We also include a distinct unit of overlying Lower to Middle Jurassic sediments, following Tipper (1978), pending its formal separation as a group (H.W. Tipper, personal communication, 1987). The Tyaughton Group is exposed in the southwest part of the map area where it occurs within a structurally complex panel on the north and south sides of Tyaughton Creek.

The lower part of the group is the most extensively exposed and has a minimum composite thickness of 500 metres, based on two measured sections north of Tyaughton Creek (P.J. Umhoefer, personal communication, 1987). It comprises red-weathering interbeds of conglomerate with limestone and volcanic clasts, conglomeratic sandstone and sandstone at the base, overlain by light grey to buff-weathering, massive to thinly bedded limestone with corals and megalodont bivalves. This is in turn overlain by limestone conglomerate with a sandy matrix. The upper part of this unit has a green-weathering sandstone with conglomeratic seams containing volcanic clasts, overlain by green sandstone intercalated with coquina beds of *Cassianella lingulata* (the "Cassianella beds" of Tozer, 1967). At the top, green sandstone and conglomeratic sandstone with pebbles of volcanic rock occur. The depositional environment of these rocks fluctuated between shallow marine and fluvial; provenance of the clastic rocks was probably a volcanic arc, perhaps related to the Cadwallader Group (Rusmore, 1987). The age of this lower unit is from mid to latest Norian (Late Triassic).

The upper part of the Tyaughton Group is exposed along the southwest and northeast margins of the belt and in a structural window along Tyaughton Creek. Its contact with the lower unit is either faulted or not exposed. It also outcrops within an apparently isolated fault sliver to the east of the main belt (H.W. Tipper, personal communication, 1986). The thickness of this unit is unknown due to poor exposures and small-scale folding. It comprises dark grey to black calcareous shale and argillite that contain ammonites of Sinemurian (Early Jurassic) to Early Bajocian (Middle Jurassic) age (Tipper, 1978).

THE RELAY MOUNTAIN GROUP (UNIT 2)

Marine strata of the Relay Mountain Group were first described in detail by Jeletzky and Tipper (1968); they estimated a total thickness of 1500 to 2700 metres in sections north of Relay Mountain. Lithological divisions are, on the whole, difficult to implement because of lateral facies changes and lack of distinctive marker units, with the exception of a lower shaley unit of Middle Jurassic age; division of the overlying strata is facilitated by a well-defined paleontological zonation that ranges from Late Oxfordian (Late Jurassic) to Barremian (Early Cretaceous), based on *Buchia*, ammonites and *Inoceramus* species (Jeletzky and Tipper, 1968). The Relay Mountain Group is undifferentiated in Figure 1-9-2, but the threefold division of Tipper (1978) into Middle Jurassic, Upper Jurassic and Lower Cretaceous strata is followed on the open file map of the Noaxe Creek map sheet (Glover *et al.*, in preparation).

The thickness of the mid-Jurassic part of the Relay Mountain Group is difficult to ascertain because of poor exposures and structural complications, but probably ranges from 300 to 600 metres (Tipper and Jeletzky, 1968). It is most extensively exposed to the west, on the Warner Pass map sheet (Glover and Schiarizza, 1987), but also occurs at the base of a section north of Relay Mountain and in narrow fault-bounded slivers to the south. Similar rocks of uncertain age occur along the Relay Creek road and have been tentatively assigned to this unit. Rocks of this unit comprise recessive, variably rusty weathering dark grey to black shales with minor thin beds of siltstone; sparse lenticular concretions of dark siliceous shale and siltstone occur as discontinuous beds or isolated pods. A mid-Callovian to early Oxfordian age is attributed to this unit, based on *Cardioceras* sp. in the uppermost beds in two sections studied by Jeletzky and Tipper (1968, page 16).

The most widespread exposures of Upper Jurassic and Lower Cretaceous strata of the Relay Mountain Group occur in the western part of the area within fault-bounded blocks that extend into the eastern part of the Warner Pass map area (Tipper, 1978; Glover and Schiarizza, 1987). A faunal assemblage of Tithonian (Latest Jurassic) age (T. Poulton, personal communication, 1987) was collected from strata of the Relay Mountain Group in a fault sliver that strikes northwest from Mud Creek. These rocks comprise intercalated greenish grey lithic wacke and lithic sandstone, rusty brown-weathering grey-brown siltstone, dark grey shale, grit and thin conglomerate interbeds with well-rounded volcanic, granitic and sedimentary clasts. Minor thin limy interbeds and concretions occur in places. They are characterized by abundant and well-preserved buchias, belemnites and to a lesser extent ammonites, which provide the basis for differentiation of Upper Jurassic from Lower Cretaceous strata, although, in general, Lower Cretaceous rocks appear to be more shaley in the study area.

JACKASS MOUNTAIN GROUP (UNIT 3)

The Jackass Mountain Group (Selwyn, 1872; Duffell and McTaggart, 1952) comprises clastic sedimentary rocks, which outcrop over most of the map area lying northeast of the Yalakom fault. These rocks range in age from Barremian to Albian (Early Cretaceous); they are therefore coeval with rocks of the Taylor Creek Group and (?) the uppermost part of the Relay Mountain Group, which outcrop southwest of the fault (Duffell and McTaggart, 1952; Jeletzky and Tipper, 1968). Rocks of Unit 3 are unconformably overlain by Eocene volcanics at Red Mountain and by Miocene plateau lavas near the headwaters of Dash Creek. They are locally in fault contact with upper Cretaceous volcanic rocks of Unit 7, but are separated from other Mesozoic units by the Yalakom fault.

Continuous sections of strata assigned to the Jackass Mountain Group are not present in the map area; moreover, fossils collected from this group are as yet unidentified. Consequently, the proposed stratigraphic relationships between lithologic units described below are preliminary: **Unit 3v**, believed to be at the base of the succession, comprises predominantly massive, marine, volcanic-rich sandstone; this is locally overlain by fluvial to shallow-marine, organic-rich sandstones of **Unit 3f**; in some places these are overlain by marine boulder-cobble conglomerates of **Unit 3cg**; dominantly arkosic turbidites of **Unit 3ak** locally appear to sit stratigraphically above Unit 3v, and may, in part, be equivalent to or younger than Unit 3cg. The distribution of these units is shown in Figure 1-9-3.

UNIT 3V

Rocks of Unit 3v outcrop in a northwesterly trending belt, bounded by the Yalakom fault and related splays to the southwest, and extending from Poison Mountain to the northwest boundary of the map area. This unit consists predominantly of massive, green volcanic-lithic sandstones. Bedding is rarely evident, but locally may be defined by subtle variations in grain size or by trains of siltstone intraclasts. Locally the sandstone occurs as thick graded beds with flutes and

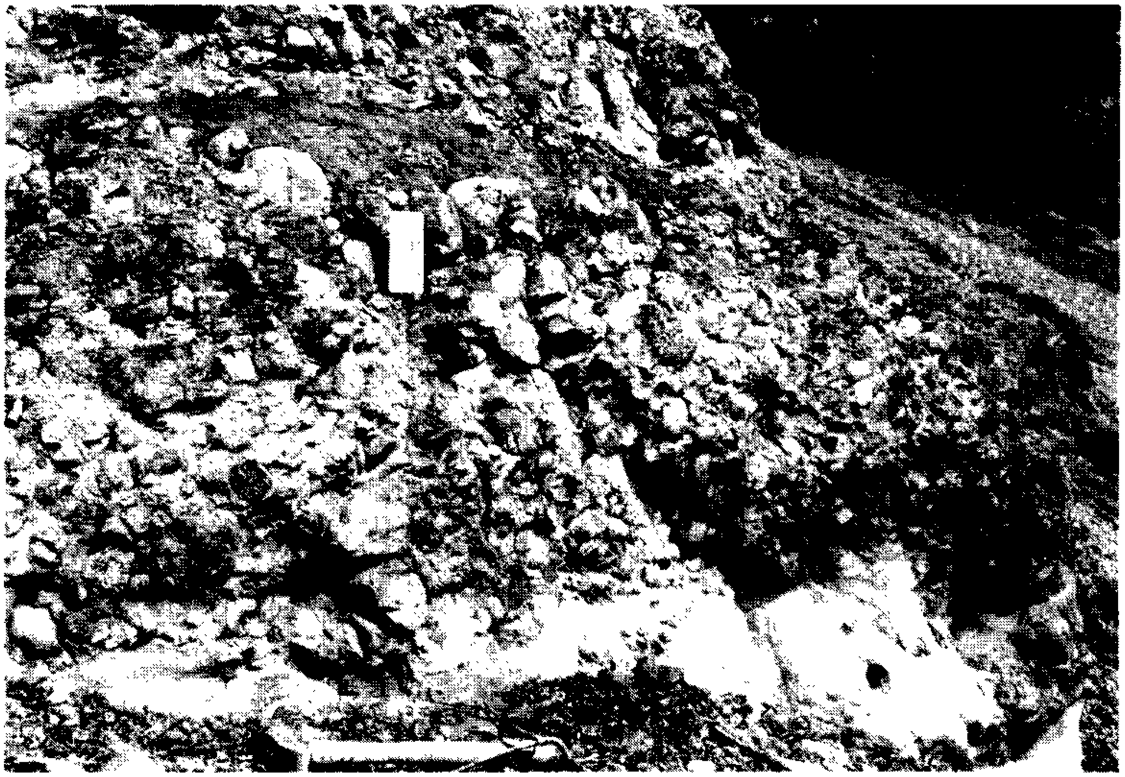


Plate 1-9-1. Interbedded polymict conglomerate and sandstone of the Jackass Mountain Group (Unit 3cg); north of Red Mountain, Noaxe Creek map area.

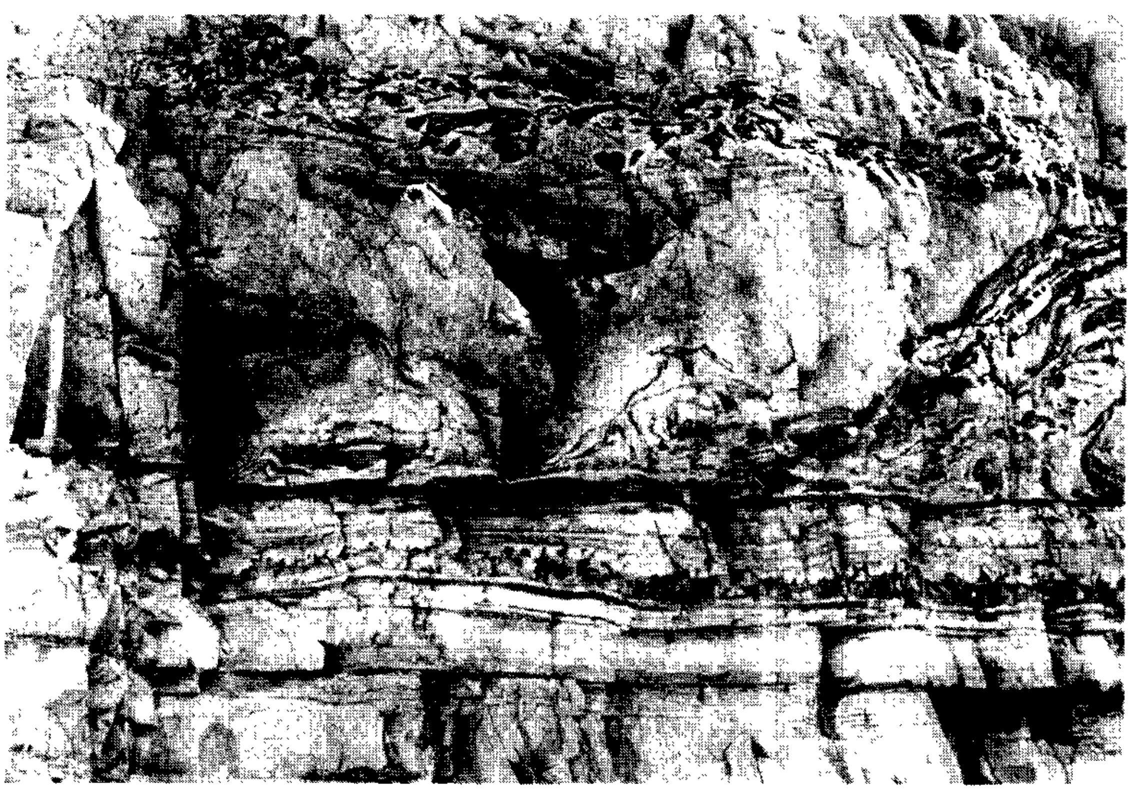


Plate 1-9-2. Arkosic sandstone turbidites of the Jackass Mountain Group (Unit 3ak); Dash Creek, Noaxe Creek map area.

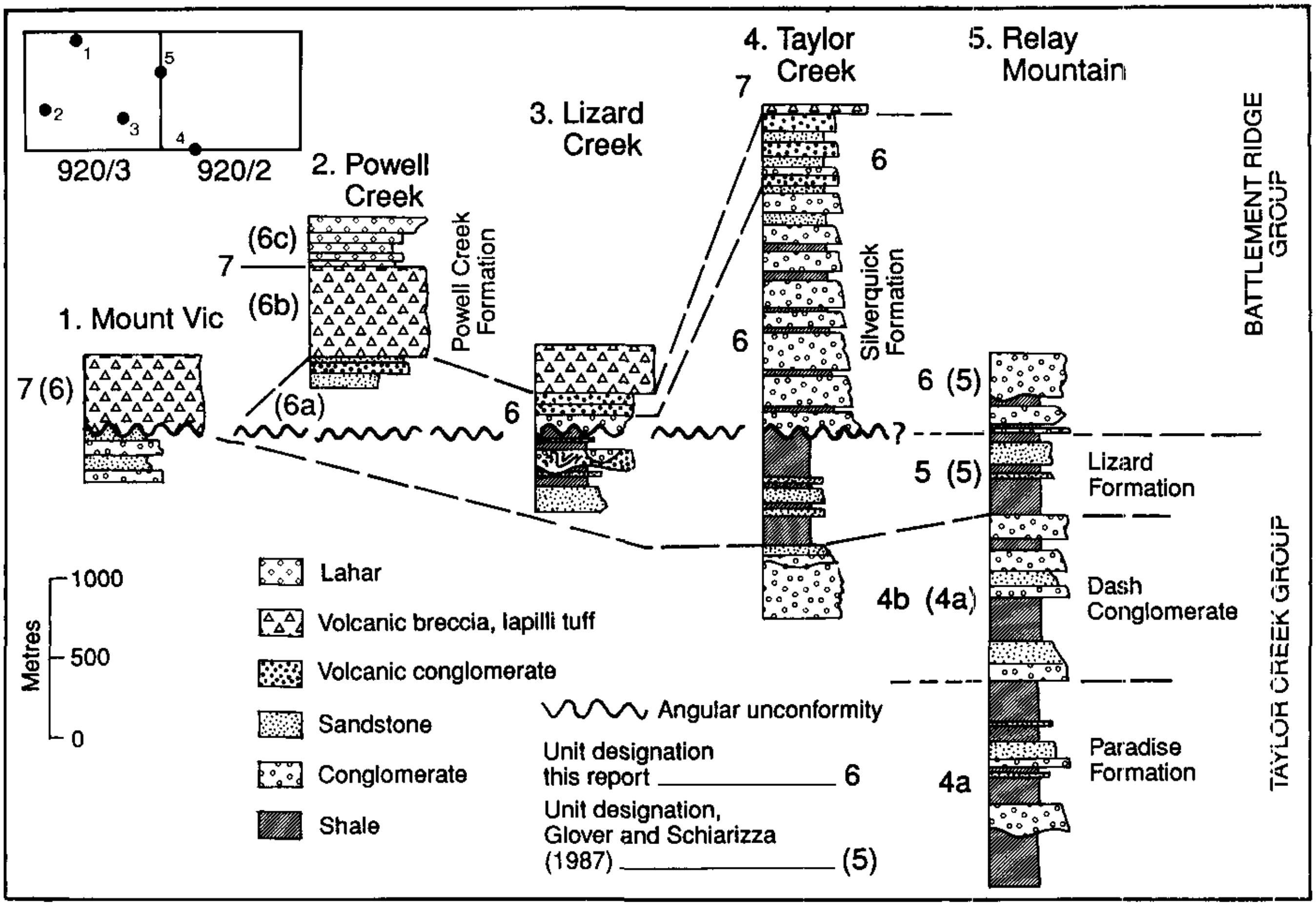


Figure 1-9-3. Stratigraphic sections and correlations within the Cretaceous succession, Noaxe Creek and Warner Pass map areas.

grooves that suggest a turbiditic origin. Dark grey, fine-grained sandstone and siltstone are common in the upper part of the unit where it underlies Unit 3f along the lower reaches of Lone Valley Creek. Several fossil collections, comprising ammonites, pelecypods and gastropods, were made from this area.

Unit 3f

Unit 3f comprises grey to mottled greenish white-weathering, locally crossbedded, volcanic-lithic sandstone which contains abundant tree branches, coal seams, full length fern fossils and other fossil plants. These sediments are typically arranged in fining-upward sequences with basal crossbedded sandstones. Sedimentary structures, facies and fossils suggest fluvial deposition. Unit 3f outcrops north and northwest of Red Mountain, along Lone Valley and Churn creeks south of their confluence, and as a narrow northwest-trending belt west of Poison Mountain. It underlies conglomerates of Unit 3cg in all of these areas and sits above sandstones of Unit 3v in the northern localities; underlying rocks are not exposed in the Red Mountain area.

Unit 3cg

Boulder to cobble conglomerate of Unit 3cg is the most distinctive lithology within the Jackass Mountain Group. It was correlated with similar conglomerates east of the Fraser fault system by Jeletzky and Tipper (1968). The conglomerates contain poorly sorted, predominantly well-rounded clasts of mainly granitic and intermediate volcanic rocks, together with metamorphic and foliated plutonic rocks, chert and clastic sedimentary rocks. In the vicinity of Red Mountain, the conglomerate occurs as beds up to several metres thick which are commonly inverse to normally graded and pass upward into sandstone and siltstone (Plate 1-9-1). These conglomerates probably represent channel deposits within a proximal submarine fan environment. The contact with underlying nonmarine to shallow-marine sandstones of Unit 3f is abrupt and may be an erosional unconformity. This may represent an important time of uplift and subsidence associated with tectonism.

Unit 3ak

Unit 3ak consists mainly of buff-weathering grey arkosic sandstones and gritty to pebbly sandstones, together with minor amounts of pebble conglomerate, siltstone and shale. In most places, its contacts with adjacent units of the Jackass Mountain Group are faulted. However, in the Dash Creek area, where the base of the unit is marked by granitic pebble conglomerates, Unit 3ak apparently sits stratigraphically above massive volcanic-lithic sandstones of Unit 3v.

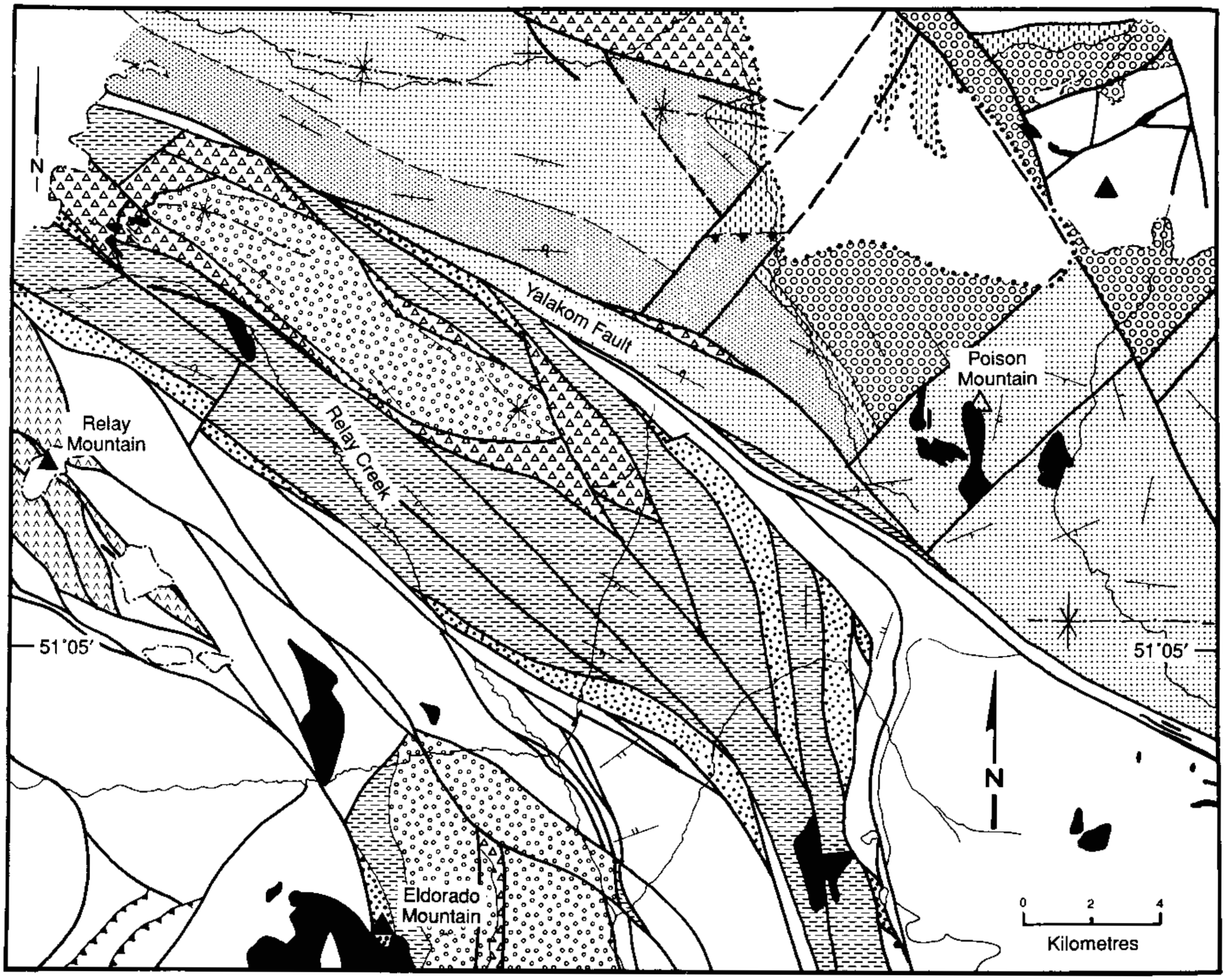


Figure 1-9-4. Distribution of Cretaceous rocks and late Cretaceous and Eocene structural features, Noaxe Creek map area.

The sandstones of Unit 3ak are predominantly coarse-grained arkoses with subordinate volcanic-lithic wackes, commonly containing hornblende, mica (biotite and minor muscovite) and magnetite. Gritty and pebbly sandstones, together with rare beds of pebble conglomerate, contain clasts of feldspar, quartz, granitic rocks, aphyric and feldspar-phyric intermediate volcanics, chert and siltstone. In exposures along the Yalakom River and Dash Creek, the sandstones comprise thick to medium-bedded turbidites with partial and complete Bouma sequences well displayed (Plate 1-9-2); a limited number of measurements suggests that transport was to the west and southwest. Northeast of the Yalakom River these turbidites coarsen upward into thick-bedded sandstone with pebbly seams. Elsewhere they occur mostly as thick, massive or graded sandstone beds with minor shale. Precise stratigraphic relationships cannot be defined between structural panels, but the entire unit belongs to an extensive submarine fan depositional system and may be in part a facies equivalent of Unit 3cg.

THE TAYLOR CREEK GROUP (UNITS 4 AND 5)

The Taylor Creek Group (Cairnes, 1943; Jeletzky and Tipper, 1968) comprises about 2800 metres of lower to upper Albian (mid-Cretaceous) clastic rocks which outcrop southwest of the Yalakom fault. Unbroken stratigraphic sections are not present anywhere in the study area; the stratigraphy has been erected using numerous local sections, facies and provenance analyses and faunal control. The most complete sections are shown in Figure 1-9-4. In this study, the Taylor Creek Group is subdivided into three informal formations defined principally by the composition of clastic material: the Paradise formation (Unit 4a), at the base, overlain by the Dash conglomerate (Unit 4b), which is in turn overlain by the Lizard formation (Unit 5). The dominantly marine strata of the Taylor Creek Group are overlain by a thick section of nonmarine conglomerates at the base of the Upper Cretaceous sequence.

LEGEND

SOUTHWEST OF THE YALAKOM FAULT | **NORTHEAST OF THE YALAKOM FAULT**

UPPER CRETACEOUS

BATTLEMENT RIDGE GROUP

POWELL CREEK FORMATION
(Unit 7)
Andesitic volcanic breccia and lapilli tuff; fine-grained tuff, basaltic to andesitic flows; epiclastic sediments

Unit 7
Andesitic volcanic breccia, lapilli tuff, fine-grained tuff and epiclastic sediments

SILVERQUICK FORMATION
(Unit 6)
Pebble to cobble polymict conglomerates and minor sandstone; cobble to boulder volcanic conglomerates and volcanic sandstone

LOWER CRETACEOUS

TAYLOR CREEK GROUP

LIZARD FORMATION
(Unit 5)
Interbedded shale and muscovite-rich arkosic sandstone

DASH CONGLOMERATE
(Unit 4b)
Chert-pebble conglomerate, cherty sandstone, siltstone shale and minor tuff

PARADISE FORMATION
(Unit 4a)
Siltstone, shale, sandstone and polymict conglomerate

*JACKASS MOUNTAIN GROUP

Unit 3ak:
Arkosic sandstone, conglomeratic sandstone, siltstone and shale

Unit 3cg:
Polymict boulder to cobble conglomerate, conglomeratic sandstone and sandstone

Unit 3f:
Volcanic-lithic sandstone, siltstone and shale with abundant fossil plant remains

Unit 3v:
Massive, green volcanic-lithic sandstone, minor siltstone and shale

*These units are predominantly lithologic and may not be in stratigraphic order

THE PARADISE FORMATION (UNIT 4A)

The Paradise formation is at least 950 metres thick, comprising a sequence of siltstone, shale, thin-bedded sandstone and conglomerate, all of which were deposited in a submarine fan environment. The conglomerates are dominated by intermediate volcanic clasts but also contain minor metavolcanic, plutonic and chert detritus. Sparse paleocurrent data suggest transport was to the south and southeast. The base of this section is marked by at least 100 metres of concretionary shales which appear to pass transitionally from the underlying Hauterivian shales of the Relay Mountain Group, but this contact is not exposed. Northwest of Relay Mountain thin-bedded turbidites of the upper portion of the Paradise formation pass transitionally into the overlying Dash conglomerate. Similarity in composition and a north-to-south transport direction suggest that this unit may be the lateral equivalent of the volcanic-rich sediments of the Jackass Mountain Group (Unit 3v), northeast of the Yalakom fault.

THE DASH CONGLOMERATE (UNIT 4B)

The Dash conglomerate comprises at least 900 metres of chert-pebble conglomerate, cherty sandstone, siltstone, shale and minor interbedded tuff. Northwest of Relay Mountain, on the eastern margin of the Warner Pass map area, the Dash conglomerate passes upward from turbiditic sands and conglomerates to fossiliferous shallow-marine to nonmarine fan-deltaic deposits. The conglomerates contain 70 per cent chert and metachert, 25 per cent felsic volcanics, and 5 per cent greenstone. Sandstones are dominated by chert, with minor sedimentary and felsic to mafic volcanic grains, and quartz-mica tectonites. Chromite, iron oxides, garnet and aluminosilicates dominate the heavy mineral fraction. Typical of fan-deltaic deposits, the paleocurrents are scattered, but suggest a general westward transport direction. The abundance of chert, metachert, sedimentary rock fragments and common detrital chromite suggests that the source area was the locally uplifted Bridge River and Shulaps ultramafic complexes.

LIZARD FORMATION (UNIT 5)

The Lizard formation, at the top of the sequence, sharply overlies the Dash conglomerate. The basal deposits are characterized by at least 100 metres of shale; the unit passes upward into thin to medium-bedded muscovite-rich quartzofeldspathic sandstones and shales which were deposited in an extensive submarine fan system. In the Taylor Creek drainage the Lizard formation is 850 metres thick (Section 4, Figure 1-9-4); further to the west, near Relay Mountain, it is about 500 metres thick. The sandstones are rich in quartz (28 to 41 per cent), plagioclase (23 to 35 per cent), intermediate to felsic volcanic clasts (14 to 31 per cent) and minor metamorphic clasts; detrital chert is almost absent. Metamorphic clasts, 2.5 per cent muscovite and minor garnet, indicate a partial source of schistose metasedimentary rocks. Paleocurrents are to the northeast everywhere in the basin; measurements were taken from both overturned and upright panels. These shales and turbidites represent a rapid and widespread deepening of the basin that was probably tectonically controlled. The Lizard formation is sharply overlain by predominantly nonmarine conglomerates of the Silverquick formation.

THE BATTLEMENT RIDGE GROUP (UNITS 6 AND 7)

The Battlement Ridge group is proposed as an informal name for sedimentary, volcaniclastic and volcanic rocks of latest Albian (?) (mid-Cretaceous) to late Cenomanian (Late Cretaceous) age, previously assigned to the Kingsvale Group (Rice, 1947) by Tipper and Jeletzky (1968). Thorkelsen (1985), working in the type area near Kingsvale, south of Merritt, has shown that rocks previously attributed to the Kingsvale Group are part of the Spences Bridge Group, based on field relationships and radiometric age determinations. This group comprises a sequence of intercalated andesitic to rhyolitic lavas and clastic rocks of mid-Cretaceous age. It may, in part, be time-equivalent to the Battlement Ridge Group of this report, but is separated from the study area by major tectonic boundaries such as the Fraser and Yalakom fault systems.

The Battlement Ridge group is informally subdivided into a clastic unit at the base, the Silverquick formation (Unit 6), and a gradationally overlying volcanic unit, the Powell Creek formation (Unit 7). The base of the group is defined by an angular unconformity that separates it from the underlying Mesozoic strata; this relationship is well exposed in the Warner Pass map area (Glover and Schiarizza, 1987), and its presence is inferred at the base of the group in the Taylor Creek basin, on the Noaxe Creek map sheet (Figure 1-9-4).

THE SILVERQUICK FORMATION (UNIT 6)

The Silverquick formation comprises two members; the lower member is composed of poorly stratified, clast-supported and locally crossbedded pebble to cobble conglomerates with minor sandstone interbeds (less than 10 per cent). Sandstones are commonly maroon weathering. Finer grained intervals contain abundant stick and leaf fossils. The conglomerates contain mainly chert clasts, together with sedimentary and intermediate volcanic clasts, and a minor proportion of metamorphic and plutonic clasts. Paleocurrents suggest derivation from the east. This member attains a maximum thickness of 1500 metres in the Taylor Creek area; here, these rocks are interpreted as braided river deposits. To the northwest, in the northeast part of the Warner Pass map area, this member is thinner and was probably deposited in a submarine fan environment. This unit also occurs in the core of a syncline, northeast of Relay Creek, on the Noaxe Creek map sheet.

The upper member of the Silverquick formation includes similar braided river deposits but the conglomerates are dominated by basic to intermediate volcanic clasts that vary from cobble to boulder size. Although many beds are composed exclusively of these lithologies, they are clearly interbedded with chert-rich conglomerates typical of the lower member. The upper member is only exposed in the Taylor Creek area on the Noaxe Creek map sheet, where it grades upward into volcanic breccia of the overlying Powell Creek formation. It is correlated with the dominantly volcaniclastic rocks of Unit 6a in the Warner Pass map area (Glover and Schiarizza, 1987).

THE POWELL CREEK FORMATION (UNIT 7)

This formation is equivalent to Units 6b and 6c, in the Warner Pass map area (Glover and Schiarizza, 1987); the proposed type section, northwest of Powell Creek, has a total thickness of 1550 metres, but the top is not exposed. It comprises dominantly volcanic breccia and lapilli tuff of andesitic to basaltic composition, intercalated with finer grained tuff, basaltic to andesitic flows and epiclastic sediments. It can be locally subdivided into a lower massive unit and an upper bedded unit; the latter is dominated by andesitic lahars and epiclastic sediments. These units are best exposed in the vicinity of Powell Creek and Battlement Ridge in the Warner Pass map area, but also occur northeast of Relay Creek on the Noaxe Creek map sheet. Elsewhere in the present study area the lower and upper parts of the Powell Creek formation are undifferentiated.

VOLCANIC ROCKS OF PROBABLE EOCENE AGE (UNIT 8)

This unit comprises predominantly andesites to rhyolites; it extends from Red Mountain to the northeastern corner of the map area, where it attains a thickness of about 800 metres. These rocks lie unconformably above conglomerates of the Jackass Mountain Group (Unit 3b). They comprise mainly reddish brown-weathering, platy to massive, aphyric andesitic to dacitic flows; they are locally vesicular and/or amygdaloidal and are columnar jointed in places. Flow breccias and/or brick-red regolith zones locally mark flow contacts. Massive andesite flows at the base of the succession are porphyritic, and contain phenocrysts of pyroxene, hornblende and plagioclase. Discontinuous units of light grey to white-weathering flow-banded rhyolite, commonly with phenocrysts of quartz and/or feldspar, occur at three different stratigraphic levels within the Red Mountain succession. The most extensive unit is locally more than 150 metres thick. The rhyolites include significant zones of flow breccia, vesicular glass and glassy breccia. Siliceous sinter (?) deposits displaying botryoidal growth structures occur locally.

Sedimentary rocks are uncommon in the Red Mountain succession. They comprise lenses of rusty brown and chalky white-weathering thin-bedded volcanic sandstone and siltstone which range up to several tens of metres thick. They occur along rhyolite-andesite contacts, or as lateral equivalents of rhyolite. Volcanic conglomerate outcrops at one locality, 2.5 kilometres northeast of Red Mountain summit, where it separates a rhyolite unit from underlying andesite. It comprises unsorted, angular dacitic to andesitic volcanic clasts, up to 80 centimetres in size, within a friable siltstone matrix. North-northeast-trending dykes of andesite and felsite are locally common. Dykes of the same orientation and plugs, composed of quartz-biotite-hornblende-feldspar porphyry, appear to grade into flow-banded rhyolite in places.

The Red Mountain volcanics are not dated. They are assigned an Eocene age on the basis of their unconformable relationship to underlying Jackass Mountain Group rocks, and their lithologic similarity to volcanic rocks to the north and northeast which have yielded several Eocene radiometric ages (Mathews and Rouse, 1984). These Eocene volcanics host the Blackdome epithermal gold deposit 10 kilometres to the north.

MIOCENE PLATEAU LAVAS (UNIT 9)

Flat-lying plateau basalts of Unit 9 unconformably overlie older rocks in the western part of the map area. The basalts occur as medium to dark grey, commonly rusty brown-weathering flows intercalated with minor amounts of volcanic breccia and volcanic conglomerate. They outcrop most extensively along the western edge of the map area, north of Relay Creek, where they overlap the Yalakom fault and adjacent rock units along an erosional surface with a shallow regional dip to the north. The unit is about 350 metres thick in this area. The basalts cap several ridges to the south, including Relay Mountain, where 300 to 350 metres of volcanic flows are exposed.

INTERMEDIATE TO FELSIC INTRUSIVE ROCKS

Porphyritic to equigranular intrusive rocks, ranging in composition from diorite to granodiorite, occur as small stocks, plugs and dyke swarms distributed sporadically through the map area. Most of these are Early Tertiary and (?) Late Cretaceous in age.

A small stock, composed of equigranular biotite-hornblende quartz diorite and granodiorite, occurs along the southern boundary of the map sheet, and outcrops mainly to the west and south of Eldorado Mountain. It intrudes the fault contact between the Taylor Creek Group on the east and Cadwallader Group on the west. An age of 63 Ma (Early Paleocene) has recently been obtained by potassium-argon dating of biotite from the stock (K.M. Dawson, personal communication, 1987).

Hornblende feldspar porphyry occurs as dyke swarms and small plugs within Units 5 and 7 between Relay Creek and the Yalakom fault. It comprises variable proportions of hornblende and feldspar phenocrysts, up to several millimetres in size, within a massive, grey aphanitic matrix. Carbonate and propylitic alteration is common within the porphyry and adjacent country rocks. These rocks are similar to hornblende feldspar porphyries which outcrop extensively in the Warner Pass map area (Unit A of Glover and Schiarizza, 1987). There, they were thought to be related to volcanics of the Powell Creek formation (Unit 7) of this report, and to be in part Early Tertiary in age. This will be tested by potassium-argon age determinations on samples collected from both Warner Pass and Noaxe Creek map areas during the past summer.

Hornblende feldspar porphyry also occurs in the southeastern corner of the map area, where it cuts ultramafic rocks of the Shulaps complex, mainly east and southeast of Big Dog Mountain. These porphyries locally contain biotite and grade into equigranular diorite and quartz diorite (Leech, 1953). Weakly sheared hornblende feldspar porphyry dykes, from which a sample was taken for radiometric dating, also occur locally within the Yalakom fault zone, east of Big Dog Mountain.

Light grey to white-weathering porphyritic bodies containing variable proportions of feldspar, hornblende, biotite and quartz phenocrysts intrude the Eocene (?) volcanic rocks at Red Mountain. Similar porphyries occur at Big Sheep Mountain, where they may be associated with felsic extrusive rocks (Leech, 1953), and as several stocks and plugs north of Tyaughton Creek. These porphyritic bodies are commonly carbonate altered, and locally contain zones of argillic alteration. They are probably Eocene in age, based on their close association with Eocene (?) volcanic rocks at Mount Sheba (Glover and Schiarizza, 1987) and at Red Mountain. Samples from these two areas, and of similar porphyries elsewhere in the map area, were collected for radiometric dating.

Intrusive rocks in the vicinity of Poison Mountain consist of hornblende feldspar porphyry and hornblende-biotite-feldspar porphyry. They occur as three separate stocks which outcrop south, southwest and west of the summit. A fourth stock, which is dominantly feldspar-phyric, occurs 3 kilometres to the east. Porphyry copper-gold mineralization occurs within and adjacent to the outer portion of the southwestern stock, where biotite partially replaces hornblende. Several potassium-argon dates obtained on biotite and hornblende from the mineralized stock give ages of 57 and 59 Ma (Late Paleocene to Early Eocene) (W.J. McMillan, personal communication, 1987).

STRUCTURE

OVERVIEW

The Yalakom fault divides the map into two parts. Northeast of the fault relatively widely spaced northwest and northeast-trending faults dominate the map pattern in an area mosty underlain by gently dipping sandstones and conglomerates of the Jackass Mountain Group. To the southwest, an intricate network of northwest-trending anastamosing faults, some of which merge with the Yalakom fault, separates most of the map units into relatively small, structurally discrete, lenticular blocks. Bedding attitudes are generally steep to vertical, especially close to high-angle faults, and their strikes are commonly to the northwest, but northeast trends occur locally in fault slices, probably due to rotation during strike-slip movement. Small-scale folds only occur in the less competent units and are generally disharmonic; fold axes vary in plunge but usually trend toward the northwest.

This map pattern, together with the nature and orientations of small-scale structures, kinematic indicators and the general lack of any penetrative deformation, indicate that Mesozoic rocks in the area underwent a protracted period of major dextral wrench faulting under brittle conditions at high crustal levels.

The mid-Cretaceous deformational event, documented by structures in rocks of the Taylor Creek Group and older units in the Warner Pass area (Glover and Schiarizza, 1987), is obscured by the later dextral wrench faulting in the present study area. However, there is some evidence for pre-middle Jurassic deformation in the older rocks of the Tyaughton Group, Cadwallader Group and Bridge River complex.

POST-MIDDLE CRETACEOUS STRUCTURES

THE YALAKOM FAULT

The Yalakom fault has a length of at least 230 kilometres; estimates of dextral strike-slip offset along the fault range from 80 to 190 kilometres (Tipper, 1969). Monger (1985) has correlated the Yalakom and Hozameen faults across the Fraser fault system, to which he attributed 70 to 90 kilometres of dextral strike-slip displacement that occurred during Late Cretaceous and/or Early Tertiary time. Potter (1983, 1986) proposed that the Yalakom and Fraser faults belong to the same system and suggested that significant dextral displacement occurs on both from 40 to 45 Ma.

In the map area the fault is poorly exposed, but its trace indicates that it is steeply dipping. For much of its length it is the locus of a narrow discontinuous zone of serpentinized peridotite. The most compelling evidence for transcurrent movement along the fault derives from the presence of contrasting mid-Cretaceous successions on either side, a feature that was pointed out by previous workers (for example, Kleinspehn, 1982, 1985). Kinematic indicators such as fibrous mineral growth and slickensides along and adjacent to the fault, northeast of Mud Creek, indicate that at least some of this movement was right lateral in nature.

Volcanic rocks of the Powell Creek formation, truncated by the fault in the northern part of the area, provide a probable upper limit of Cenomanian (earliest Late Cretaceous) for transcurrent movement along the fault. Plateau basalts of probable Miocene age, which truncate the fault in the Dash Creek area, currently provide the only lower constraint in the Noaxe Creek map area. However, forthcoming potassium-argon radiometric dates of hornblende from porphyry dykes, emplaced along the fault zone southwest of the Yalakom River, may provide a minimum age for the early history of movement.

STRUCTURES NORTHEAST OF THE YALAKOM FAULT

In this area, the structural pattern is dominated by northwest and northeast-trending faults and by east-trending folds which are probably related to dextral movement along the Yalakom fault system. Around Red Mountain faults that trend north-northwest to east-northeast may be younger structures related to Eocene and/or later dextral movement along the Fraser fault system.

Several northeast-trending faults were mapped in the southeastern part of the belt, where they are inferred on the basis of abrupt truncations of lithologic units or changes in facing direction. Faults of this group were also observed in outcrops along Churn Creek, in the north-central part of the area. The orientation of these faults is that expected for antithetic left-lateral strike-slip faults related to right-lateral displacement along the Yalakom fault. Left-lateral movement was demonstrated locally along minor faults of this orientation northeast of the Yalakom River.

An east-trending syncline occurs within the Jackass Mountain Group north of the Shulaps ultramafic complex, where it is outlined by exposures of Unit 3ak turbidites along the Yalakom River; this fold is apparently truncated to the west by the Yalakom fault. An easterly trending syncline is inferred from opposing dip and facing directions within Unit 3ak on either side of Dash Creek. Its probable extension to the east of a northwest-trending fault was mapped in rocks of Unit 3f along Churn and Lone Valley creeks. These folds may comprise part of a right-handed fold set (Campbell, 1958; Wilcox *et al.*, 1973) related to dextral movement along the Yalakom fault.

Rocks of Units 3 and 8 are bounded to the west by the north-northwest-trending Red Mountain fault. This fault apparently truncates or offsets a number of northeast-trending faults. One of these earlier faults, which separates Units 3cg and 3ak, north of Poison Mountain, can be matched with a similar fault on the opposite side of the Red Mountain fault, east of the upper Yalakom River. If this correlation is valid then the Red Mountain fault may have 4 kilometres of apparent right-lateral displacement along it.

Bedding attitudes in the volcanic succession of Unit 8 at Red Mountain are generally shallow dipping. The structure within these rocks is dominated by north-northeast-trending extensional faults and fractures that are probably Eocene and/or younger in age (Figure 1-9-5). These may have developed in conjunction with dextral wrench fault along the Fraser fault system (Mathews and Rouse, 1984; Price *et al.*, 1985).

North of Red Mountain an easterly trending fault is inferred separating sandstones of Unit 3 from volcanic rocks of Unit 8 which outcrop along the northern edge of the map area. This probably represents a vertical displacement of a few hundred metres, but the fault is not exposed and its dip is unknown. This fault was interpreted as part of the Hungry Valley thrust by Tipper (1978), and was inferred to extend to the west, across Churn and Dash creeks. Here, a northwest-trending fault that separates the Jackass Mountain Group from the Powell Creek formation is closely constrained by outcrops along these creeks; highly fractured rocks of Unit 3 are cut by northwest-striking, predominantly steeply dipping fault surfaces which locally display shallowly plunging slickensides. These features indicate strike-slip movement along this fault zone rather than thrusting, as proposed by Tipper.

STRUCTURES SOUTHWEST OF THE YALAKOM FAULT

Three major northwest-trending faults of probable regional extent that occur southwest of the Yalakom fault can be traced across the map area: the Relay Creek fault, the Castle Pass fault and the Tyaughton Creek fault. To the northwest these faults strike subparallel to the Yalakom fault but all swing sharply to the south at about the latitude of the Shulaps ultramafic complex. There is evidence that these are wrench faults; a minimum right-lateral offset of 8 kilometres along two of them is proposed.

The Relay Creek Fault

The Relay Creek fault has been traced along Relay Creek from east of Big Creek on the Warner Pass map sheet (Glover *et al.*, 1987), to the southeast, across the present study area, from where it probably merges with the Marshall Creek fault (Roddick and Hutchison, 1973; Woodsworth, 1977; Potter, 1983, 1986). If this correlation is valid, it would give the Relay Creek – Marshall Creek fault system a total length of at least 145 kilometres to its truncation by the Fraser fault system, south of Lillooet (Potter, 1986). In the northwest part of the Noaxe Creek map area the Relay Creek fault separates steeply dipping to vertical, northeast-facing strata of the Taylor Creek Group on the northeast from older, generally southwest-facing strata of the Relay Mountain Group on the southwest.

A minimum estimate of 8 kilometres right-lateral offset is obtained by using the truncation of the Upper Jurassic Relay Mountain Group along the fault from Noaxe Creek to Relay Creek (Figure 1-9-6). The timing of movement along this fault is poorly constrained, but the Marshall Creek fault, its correlative in the Bridge River area, displaces probable Eocene volcanic rocks and is itself truncated by the Mission Ridge pluton (Potter, 1983), biotite from which has yielded a potassium-argon date of 44 Ma (Woodsworth, 1977). Thus, this part of the fault system was active in the Middle Eocene.

The Castle Pass Fault

This fault was traced from near Graveyard Creek, in the Warner Pass map area (Glover *et al.*, 1987), to the southeast, into the Noaxe Creek map area, where it forms the northeast boundary of the principal exposures of Tyaughton Group rocks. South of Tyaughton Creek it truncates rocks of the Cadwallader Group on the west; east of the fault a 5-kilometre-wide, overturned, easterly dipping panel, comprising rocks of the Taylor Creek and Battlement Ridge groups, provides evidence for post-Cenomanian large-scale folding of rocks in this area. A recent potassium-argon radiometric age determination of 63 Ma (Paleocene) on biotite from the Eldorado stock (K.M. Dawson, personal communication, 1987), which truncates the Castle Pass fault along the southern margin of the map area, provides a lower age limit for movement along the fault.

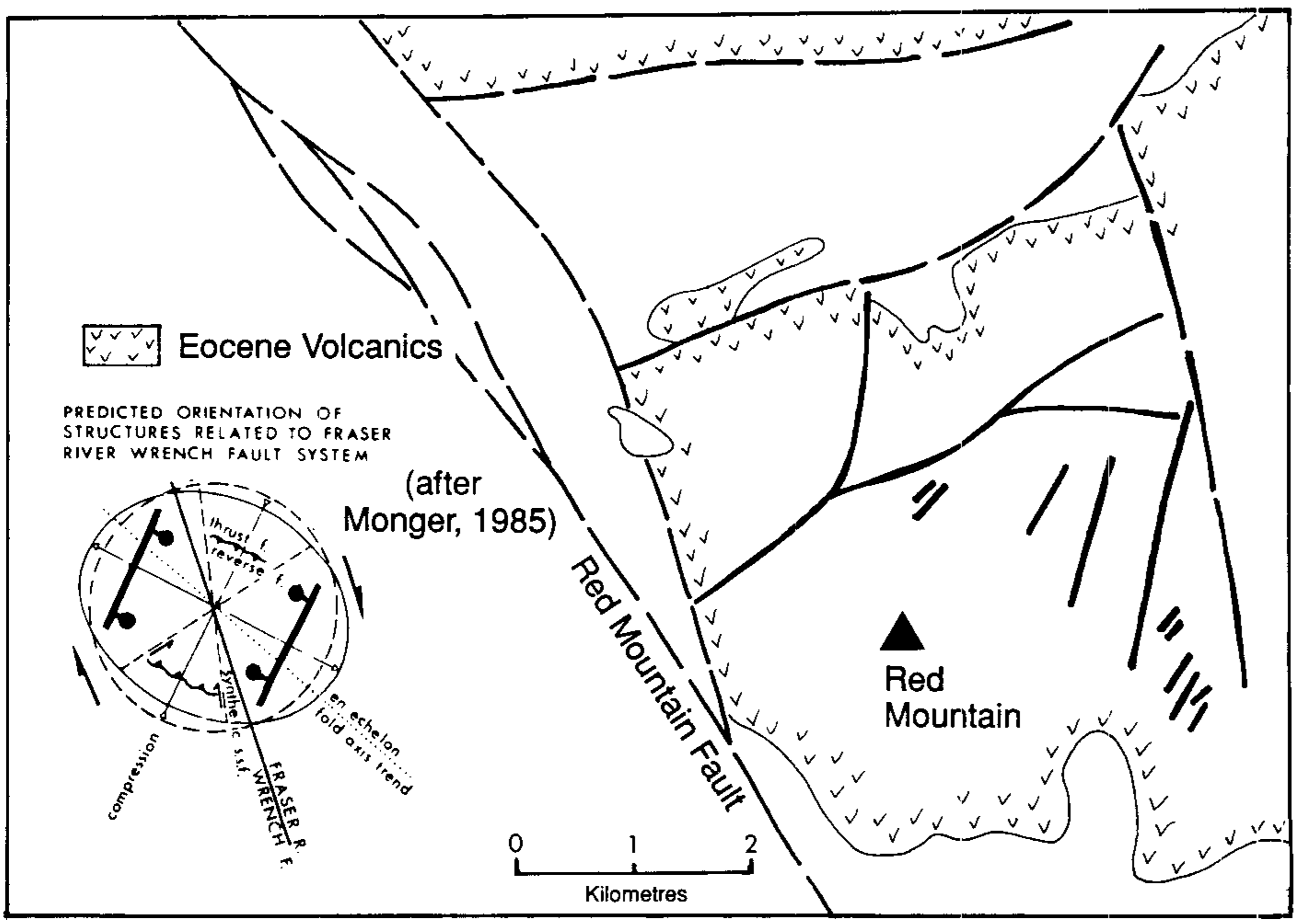


Figure 1-9-5. Tertiary structures, Red Mountain area; Noaxe Creek map area.

A complex array of upwardly fanning high-angle reverse faults, similar to that described by Wilcox *et al.* (1973), is rooted along the Castle Pass fault in the western part of the map area (Umhoefer and Garver, 1987, in preparation) and provides evidence for transcurrent movement along the major fault. However, the magnitude of displacement is unknown.

The Tyaughton Creek Fault

This fault is poorly exposed for most of its length from east of Lorna Lake, in the Warner Pass map area (Glover *et al.*, 1987) to Spruce Lake in the southwest part of the Noaxe Creek map area, from where it apparently swings to the south (Cairnes, 1943; Tipper, 1978). The Tyaughton Group occurs mostly on the northeast side of the fault, but an isolated klippe of rocks attributed to this unit south of the fault near Lorna Lake (Glover and Schiarizza, 1987) indicates a right-lateral offset in the order of 10 kilometres (B to B′, Figure 1-9-6); supporting evidence is provided by matching the truncations of an older, northeast-trending fault on the Warner Pass map sheet, which gives a right-lateral offset of 8 kilometres (C to C′, Figure 1-9-6).

The timing of movement along this fault is unknown, but possible transcurrent offset of the Powell Creek formation along its western extension in the Warner Pass map area, suggests a post-Cenomanian age. This is contrary to our previous interpretation of largely vertical movement along this section of the fault, and further work is required in order to test these hypotheses.

Other Post-middle Cretaceous Structures Southwest of the Yalakom Fault

North-northwest-trending faults of shorter strike length merge with or are truncated by the major faults and are distributed throughout the intervening panels. In general, these faults juxtapose progressively younger rocks to the west. Their orientation relative to the major faults matches that of early-formed synthetic dextral strike-slip faults (Wilcox *et al.*, 1973) which is, in general, supported by measurements of fibrous mineral growth and slickenside orientations along them. However, many of these faults show evidence of late dip-slip movement.

In the panel northeast of the Relay Creek fault, bedding attitudes outline a complex, northwest-trending, doubly plunging syncline in rocks of the Silverquick formation (Unit 6), which are surrounded by and in fault contact with rocks of the Powell Creek formation (Unit 7). This contact is defined by northwest-trending faults that are subparallel to the Yalakom and Relay Creek faults on the northeast and southwest limbs of the fold. However, along the northwestern

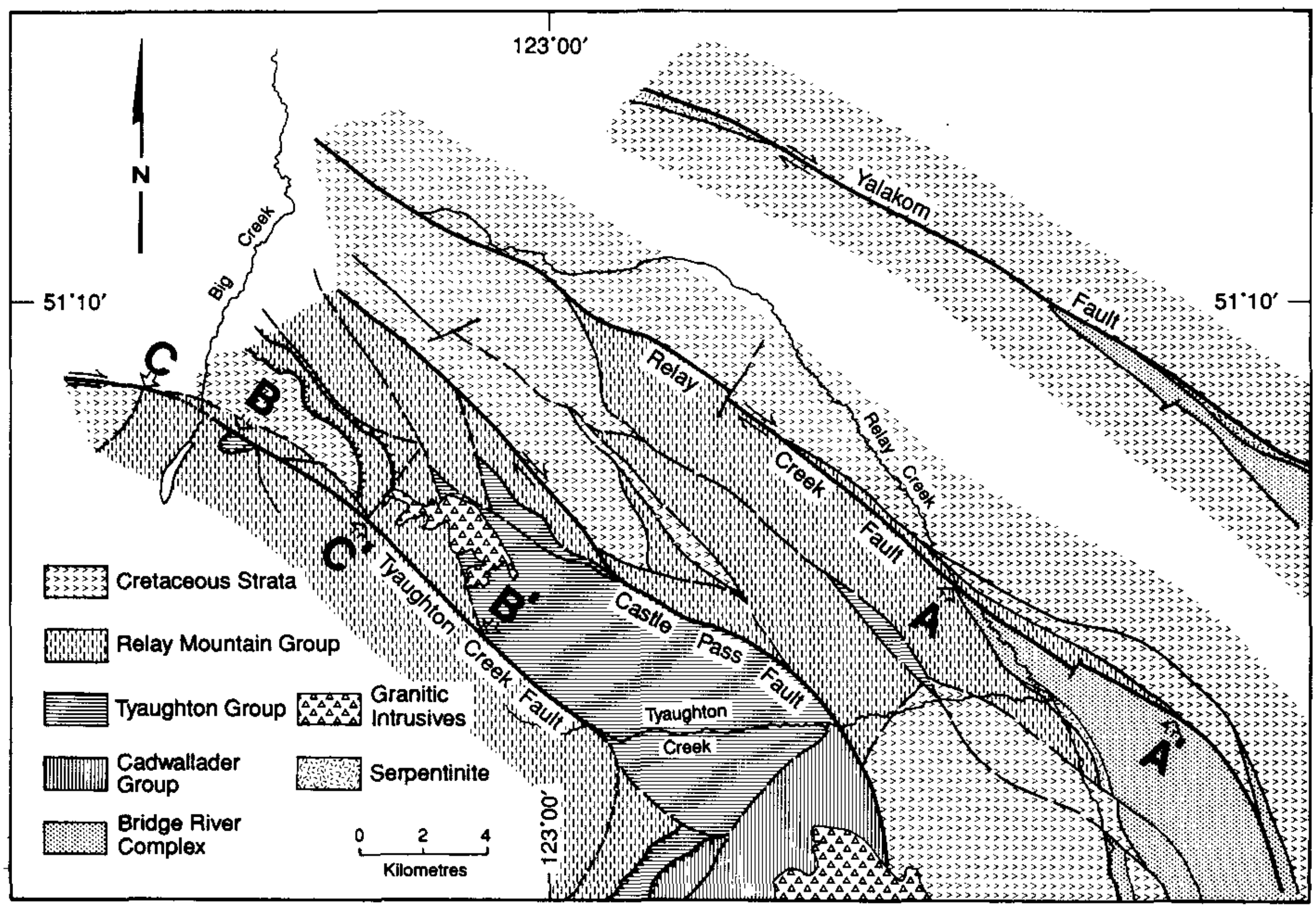


Figure 1-9-6. Probable piercing points and resulting right-lateral offsets along the Relay Creek and Tyaughton Creek fault zones, Noaxe Creek and Warner Pass map areas.

closure of the syncline, where rocks of Unit 7 apparently structurally underlie rocks of Unit 6, their contact may represent an early thrust that was subsequently folded. The outline of this syncline is reflected on a broader scale by stratigraphic and structural facing in the older rocks of the Taylor Creek Group to the northeast and southwest. This fold probably formed before or during the early stages of strike-slip faulting.

PRE-MIDDLE CRETACEOUS STRUCTURES

In the southwest part of the map area, excellent exposures and the well-defined internal stratigraphy of the Tyaughton Group permit detailed mapping of thrust faults, which are folded about axes with quite variable orientations; these folds are, in turn, truncated by north-northwest-trending high-angle faults, some of which have dextral strike-slip along them (P.J. Umhoefer, personal communication, 1987). The complex structural pattern that results implies polyphase deformation. Rusmore (1987) concluded that two phases of folding existed in rocks of the Cadwallader Group to the south. Similarly, Potter (1986), working to the southeast, found evidence for two phases of deformation in rocks of the Bridge River complex. These workers propose that these older rocks underwent a major deformational event in mid-Jurassic time (Umhoefer *et al.*, 1987). Small-scale north-easterly directed thrust faults observed in the Bridge River complex at the confluence of Noaxe and Tyaughton creeks may also belong to this phase of deformation. However, the complexity of structures typically associated with zones of major strike-slip faulting, which the Noaxe Creek map area undoubtedly represents, precludes this conclusion at this point in our study.

MINERAL OCCURRENCES

Mineral occurrences in the Noaxe Creek map area fall into two distinct groups: (1) generally low-grade gold and base metal occurrences with pyrite, minor arsenopyrite and/or pyrrhotite, associated with granitic intrusive rocks; and (2) minor cinnabar, stibnite and/or scheelite occurrences, associated with fault zones.

LOW-GRADE GOLD AND BASE METAL OCCURRENCES

Nearly all these occurrences appear to be small, with the exception of Poison Mountain, where significant chalcopyrite and molybdenite mineralization, with associated low gold values, occurs in a porphyry setting. Many of these prospects are hosted by carbonate and locally argillic-altered granitic stocks and dykes that are generally porphyritic. Some of the larger stocks exhibit chlorite-epidote alteration. Many of the dykes are structurally controlled by northwesterly trending faults. These mineral occurrences appear to range from an epithermal setting, for example, Big Sheep Mountain, to a porphyry setting, such as Poison Mountain. The associated intrusive rocks are probably Tertiary in age. The Blue Creek occurrences, Big Sheep Mountain and showings near Eldorado Mountain appear to be of this type (Cairnes, 1943; Dawson, 1982) but fall within the southern part of the map sheet, not covered during the 1987 field season. The principal occurrences of this type elsewhere on the map sheet are the upper Relay Creek claims and the Poison Mountain deposit, described below.

UPPER RELAY CREEK

Alteration and mineralization along upper Relay Creek are associated with a swarm of sills, dykes and small plugs which intrude volcanic and sedimentary rocks of Units 5 and 7. Interest in the area dates back to 1970 when it was explored for porphyry copper-molybdenum mineralization. More recent exploration by Consolidated Barrier Reef Resources Ltd. (now MFC Mining Finance Corporation) and by Esso Minerals Canada, the present operator, has concentrated on the area's gold potential. Carbonate alteration is widespread within both intrusive and country rocks; it is locally accompanied by chlorite-epidote alteration, silicification and minor clay alteration. Disseminated pyrite and/or pyrrhotite are common within and adjacent to the porphyries, and are locally accompanied by minor amounts of chalcopyrite, molybdenite, arsenopyrite and sphalerite. More intense pyritization is commonly associated with zones of silicification. Present interest is focused on the northwestern end of the altered belt, where gold values of 1 to 10 grams per tonne have been obtained from narrow quartz-carbonate and chalcedony veins which occur in association with broader zones of elevated gold values in the range of 50 to 300 parts per billion, and anomalously high values of arsenic (Dawson, 1981, Assessment Reports 9876, 11037). The narrow zones of higher grade mineralization reported to date are of limited extent.

POISON MOUNTAIN

The Poison Mountain copper-molybdenum-gold porphyry deposit occurs on the southwest slopes of Poison Mountain, 3 kilometres northeast of the Yalakom fault. The first lode claims were staked in 1935, after placer gold had been discovered along Poisonmount Creek in 1932 (Minister of Mines Annual Reports, 1933, pages A186 to A191; 1946, pages A101 to A102). Diamond drilling and trenching, carried out by various companies between 1956 and 1971, delineated a mineral inventory in the order of 175 million tonnes averaging 0.33 per cent copper, 0.015 per cent molybdenum and 0.3 gram per tonne gold (Seraphim and Rainboth, 1976). Additional drilling was carried out by Long Lac Mineral Exploration Ltd. in 1979 and 1980 (Brown, 1981, Assessment Report 8874), but no updated reserves were published.

Mineralization at Poison Mountain is associated with two granodiorite to quartz diorite stocks which intrude Jackass Mountain Group sedimentary rocks of Unit 3ak. The stocks comprise relatively unaltered cores of hornblende plagioclase porphyry which grade outwards into biotite plagioclase porphyry in which the biotite is an alteration product of hornblende. The highest grade mineralization occurs within the biotite-altered border phases and adjacent biotite hornfels. It consists mainly of pyrite, chalcopyrite, molybdenite and bornite, which occur as disseminations and fracture fillings, and in veins associated with quartz (Seraphim and Rainboth, 1976). Calcite and gypsum also occur as hydrothermal minerals, and pyrite, together with magnetite and hematite, forms an irregular halo around the mineralized zone. Chlorite-epidote alteration occurs sporadically within Jackass Mountain Group rocks for several kilometres around the deposit, but is not distinctly concentrated around the mineralized porphyries. Intrusion, potassic alteration and mineralization at Poison Mountain is about 58 Ma in age (Paleocene) as indicated by potassium-argon dating of hornblendes and biotites from the mineralized system (W.J. McMillan, personal communication, 1987).

MERCURY, ANTIMONY AND TUNGSTEN OCCURRENCES

Cinnabar, stibnite and/or scheelite mineralization is found associated with some of the major fault zones in the area. Most showings are hosted by orange to rusty weathering carbonatized and silicified serpentinite that locally contains up to 5 per cent green fuchsitic mica, mainly between Noaxe and Mud creeks (Figure 1-9-7). They are located along or close to a north-northwest-trending fault zone that forms the western margin of a panel of serpentinized peridotite and variable lithologies of the Bridge River complex. Narrow, carbonate-altered feldspar porphyry dykes, that occur locally along the fault zone, may be related to these mineral occurrences. These prospects include the Tungsten King and Tungsten Queen, where scheelite was discovered in 1939 and which produced a small tonnage of high-grade ore over the following two years (Cairnes, 1943). The property was intermittently explored for tungsten and antimony up to 1984. The showings comprise scheelite and stibnite in a stockwork of quartz and calcite veins that cut a carbonate alteration zone containing mariposite. Previous workers have thought that the protolith was limestone within lenses in the Bridge River complex. However, the mineralized zone is on strike with partially carbonatized serpentinite, and, although limestone lenses do occur nearby, there is no indication of skarn development. Apex, a mercury showing in a similar setting, occurs northeast of Quartz Mountain, and is hosted by carbonatized and silicified serpentinite within the Yalakom fault

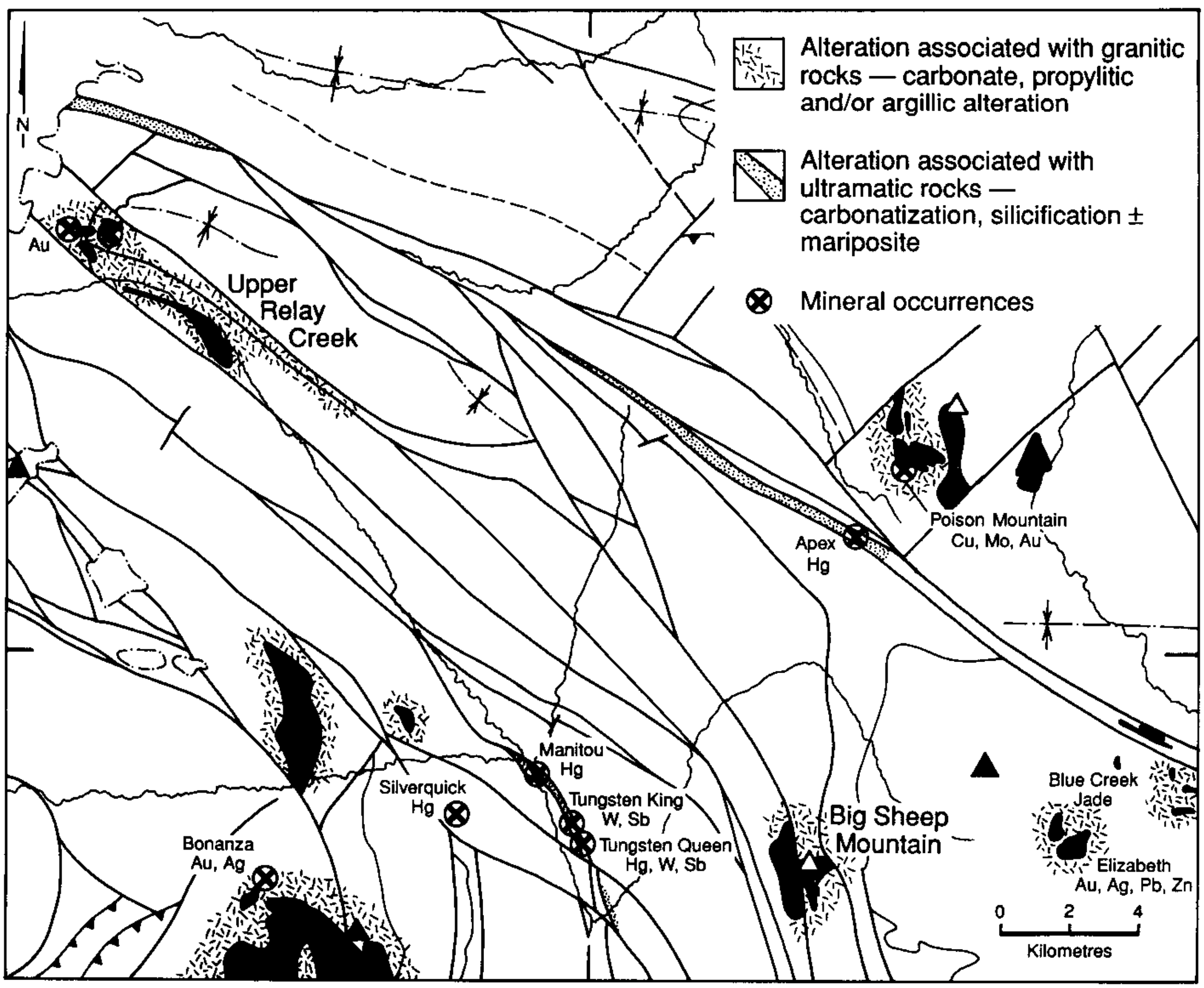


Figure 1-9-7. Mineral occurrences and alteration zones, Noaxe Creek map area.

zone. There are no gold values known to be associated with these showings.

The Manitou or Empire Mercury mine is located at the confluence of Mud Creek with Tyaughton and Relay creeks (Figure 1-9-7). The earliest record of underground workings is 1931; up to the end of 1940, twenty flasks of mercury had been produced (Cairnes, 1943). A substantial program involving refurbishing of some underground workings and a 7000-metre percussion drilling program was completed by Empire Mercury Corporation Ltd. in 1966 (Minister of Mines Annual Report, 1966). This property was not visited, but cinnabar was reported by Cairnes to occur along north-northwest and east-trending shear zones in volcanic rocks of the Bridge River complex. The Silverquick mercury showing (Minister of Mines, Annual Report, 1964) south of Tyaughton Creek occurs along a northwest-trending shear zone in conglomerates of the Silverquick formation. No gold values have been reported from these mercury, antimony and tungsten showings.

TECTONIC IMPLICATIONS

Much of the Noaxe Creek map area is underlain by rocks of Cretaceous age; this report documents the character and distribution of lithologic units in this succession, and, in part establishes their internal and external structural and stratigraphic relationships. The tectonic implications of this study are summarized as follows:

(1) The thick sequence of Taylor Creek Group sediments represents a period of major tectonic activity during the Albian (110 to 100 Ma). The chert-pebble conglomerates with minor ultramafic clasts and detrital chromite clearly record uplift of the Bridge River complex and Shulaps ultramafic complex close to the Tyaughton trough. Basin-wide events such as rapid deepening and shallowing suggest that the entire basin responded to tectonic events simultaneously. Lack of basin asymmetry, local fault-derived breccias and irregular paleocurrents suggest that strike-slip faulting was not important during deposition of the Taylor Creek Group.

(2) Sedimentary and epiclastic rocks of the Silverquick formation and overlying andesitic volcanic strata of the Powell Creek formation represent the inception and establishment of a continental volcanic arc that succeeded a period of major mid-Cretaceous compressional tectonics in the southwestern part of the Canadian Cordillera.

(3) Mesozoic rocks in the Noaxe Creek map area have undergone late Cretaceous and/or early Tertiary brittle deformation and displacements within a wide zone of dextral wrench faulting which can be related to two stress regimes: an early one associated with a north-south compressional axis that produced major northwest-trending dextral faults such as the Yalakom, Relay – Marshall Creek, Castle Pass and Tyaughton fault systems, together with northwesterly trending synthetic dextral faults and northeast-trending antithetic sinistral faults, and a later stress regime, defined by a north-northeast compressional axis and related to dextral movement along the Fraser fault system. In the north-eastern part of the map area, this later regime produced the north-northwest-trending Red Mountain fault and north-northeast-trending-tensional faults and fractures, together with minor faults that match the orientations expected for synthetic and antithetic strike-slip faults.

ACKNOWLEDGMENTS

The authors would like to thank Drs. Howard Tipper and Terence Poulton of the Geological Survey of Canada for providing fossil identifications, together with their continued advice and support. We are grateful to Dr. Margaret Rusmore of Occidental College, Los Angeles, for her guidance in the field through rocks of the Cadwallader Group. We thank Dr. Neil Church of the British Columbia Geological Survey Branch for showing us through the geology of the northern part of the Bridge River mining camp. Discussions with Dr. Lawrence Dick of Chevron Minerals Limited have proved extremely useful; he has helped us to question the economic implications of this regional study, for which we are grateful. Paul Umhoefer of the University of Washington has made a considerable contribution to our understanding of the stratigraphy and structure in the Tyaughton and Relay Mountain groups and their tectonic implications. Janet Riddell and Dorothy Payne are gratefully acknowledged for their tenacious assistance in the field and for their independent mapping contribution, without which we would still be in the bush.

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