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GEOLOGY OF THE SOUTHERN COAST BELT AND ADJACENT PARTS OF THE INTERMONTANE BELT

Overview

The Coast Belt is one of five major morphogeological belts in the Canadian segment of the North American Cordillera. It extends for 1700 km (between lats. 49°N and 62°N), is between 100-200 km wide, and reaches elevations of over 4000 m, although most summits are 2000-3000 m high. It is built across the domain of Cordilleran accreted terranes (initial 87Sr/86Sr <= 0.704), and comprises mainly Late Jurassic to early Tertiary granitic rocks of largely quartz-dioritic to granodioritic composition. Features that define the Coast Belt as a tectonic entity are mid-Cretaceous to early Tertiary in age and include northwest- and north-trending contractional and strike-slip fault systems, and a nearly continuous suite of Late Cretaceous- early Tertiary granitic rocks. Both of these features cut across terrane boundaries and are recognized as fundamental tectonic elements of the Coast Belt orogen. The southern Coast Belt (between latitudes 49° and 51°) is unique in that it contains rocks generally accepted as being of oceanic origin. It can be divided into eastern and western parts based on the distribution of dated plutonic rocks and terranes.

The western Coast Belt features mainly Middle Jurassic to mid-Cretaceous plutonic rocks (ca. 165-95 Ma) which intrude low-grade supracrustal arc sequences ranging in age from Middle Triassic to late Early Cretaceous (Bowen Island Group, Harrison Lake Formation, Gambier-Fire Lake Group). It is bounded to the west by Wrangellia and to the east by high-grade thrust nappes of the Coast Belt Thrust System. As first recognized by Crickmay (1930), the western Coast Belt represents a coherent and rigid crustal block that acted as a foreland buttress during early Late Cretaceous (92-96 Ma) west-directed thrust faulting. Wrangellia is the western component of this foreland. The eastern part of the western Coast Belt is imbricated along west-directed thrust faults and appears to have been underplated beneath high grade thrust nappes of the Coast Belt Thrust System.

The eastern Coast Belt features Mississippian to late Middle Jurassic oceanic rocks of the Bridge River terrane. The long time spanned by this terrane (at least ca. 350-160 million years) suggests that it represents a former large ocean basin. It contains pelagic facies (radiolarian chert) as young as late Bathonian to middle Callovian (ca. 163-158 Ma). Furthermore, the pelagic facies grade into clastic rocks of Late Jurassic (?) and Early Cretaceous age (Cayoosh Assemblage). These rocks occur both as coherent units and as dismembered lenses within a tectonic mélange. They are structurally interleaved with Triassic island arc assemblages and overlying clastic sequences of the Cadwallader terrane and Tyaughton basin, are variably metamorphosed and are intruded by a suite of Late Cretaceous and early Tertiary granitic plutons.

The southwestern Intermontane Belt comprises Quesnel, Cache Creek and (north of lat. 52°N) Stikine terranes, with plutonic rocks ranging from Late Triassic to earliest Tertiary (212-62 Ma). To the north (between latitudes 51-52°N), Late Cretaceous-early Tertiary plutonic rocks are emplaced in Stikine terrane and in Cretaceous strata that may be correlative with the Gambier Group. Farther south, such strata are restricted to the western Coast Belt.

Rocks of the North Cascade orogen are correlated with Methow, Bridge River, Chilliwack and (locally) Harrison terranes. Most of the plutonism and metamorphism is Late Cretaceous-early Tertiary. Notably absent from the Cascade orogen is Wrangellia and Middle Jurassic through Early Cretaceous granitic rocks, which have long been recognized as fundamental elements of the western Coast Belt.

Tectonic Assemblages

Conceptual tectonic models of the western Canadian Cordillera, as it may have appeared in early to middle Jurassic time, portray ancestral terranes of the Coast and Insular belts as an array of island arc festoons and oceanic plateaus situated outboard of an accretionary/fore-arc complex, a setting similar to that of the present southwest Pacific plate margin. In Mesozoic time (perhaps concurrently with opening of the North Atlantic Ocean basin), the North American continent started to move actively (in "absolute" terms) across the ocean basin, generating widespread upper-plate magmatism, and accreting ensimatic material first to the margin of the North American plate (ca. 185 Ma) and then to the ancient continental margin (?150 Ma). By these processes, Cordilleran crust was formed.

CRUSTAL STRUCTURE

COAST BELT

Major structures affecting the entire Coast Belt are mid-Cretaceous to early Tertiary and include systems of both west and east-vergent contractional faults, right-lateral strike-slip faults and Eocene extensional faults in the southern Coast Belt segment of the LITHOPROBE transect, seismic reflections, some of which align with thrust faults at surface, indicate that the Coast Belt is a two-sided contractional orogen comprising a stack of rootless tectonic flakes. The distribution of high-pressure thrust systems in the southern Coast Belt and northern Cascades suggests that the Coast Belt-Wrangellian block may represent a tectonic flake that was incorporated into a crustal scale accretionary complex in Late Cretaceous and early Tertiary time. A modern analogue of this accretionary complex is the Cenozoic accretionary complex west of Vancouver Island, which includes several underplated terranes of crustal dimensions.

The Coast Belt Thrust System (CBTS) is the leading edge of a west-vergent contractional belt that formed along the inboard margin of the Insular superterrane in late Cretaceous time. The foreland of this contractional belt comprises a system of east-dipping frontal thrusts that imbricate Jurassic and Early Cretaceous supracrustal arc sequences and related plutonic suites of the western Coast Belt. These faults root eastward into an imbricate zone of folded thrusts and out-of-sequence reverse faults across which the metamorphic gradient has been structurally inverted. To the east and structurally above the imbricate zone is a folded stack of high-pressure thrust sheets comprising metamorphosed island arc and oceanic rocks that form the eastern Coast Belt. These rocks represent the exhumed crustal root of the Coast Belt Thrust System.

Relative timing relationships between fold and fault structures of the CBTS indicate a two-stage history of Late Cretaceous shortening: an early stage of Alpine-style folding and thin-skinned thrusting above a basal decollement followed by high-angle reverse faulting, out-of-sequence thrusting and southwest-directed telescoping of the metamorphic hinterland over flanking supracrustal arc sequences of the western Coast Belt (Journeay and Csontos, 1989; Journeay, 1990a). Fold and thrust nappes root to the northeast beneath the high-grade crystalline core of the south-central Coast Belt, and are interpreted to have formed during impingement and northeastward underplating of the Insular superterrane in Late Cretaceous time.

The timing of early-stage thrusting is bracketed by the emplacement of syn-orogenic plutonic suites, which yield U-Pb zircon dates of 97+/- 1 Ma and 96 +6/-3 Ma. Late-stage shortening is bracketed by syn- and post-kinematic plutons, which yield U-Pb zircon dates of 94 +/- 2 Ma and 91 +4/-3 Ma, respectively. In the intricate zone, the episode of deformation is bracketed by the emplacement of syn- and post-kinematic plutons, which yield U-Pb zircon dates of 96 +6/-3 Ma and 94 +6/-5 Ma, respectively. The development of thick-skinned out-of-sequence thrusts in the hinterland of the CBTS signals a northeastward migration of the deformation front in Late Cretaceous time. This shift in the locus of thrusting resulted in southwestward telescoping and structural inversion of the metamorphic hinterland and may account for the complex stacking order and thermal history along the boundary between the western and eastern Coast belts (Journeay, 1990a). Westernmost parts of the southern Coast Belt largely preserve evidence for Jurassic (185-155 Ma) contraction and Jura-Cretaceous extension.

The total amount of shortening accommodated by subduction (?) and/or displacement across the Coast Belt Thrust System is unknown, but must be considerable. McGroder (1991) suggested a minimum of 500 km of shortening across the Cascade orogen to the south. In addition, there is an unknown amount of dextral, orogen-parallel translation. The complex structures, including the "tectonic flaking" recorded by surface structures and by seismic reflection data, makes it difficult to restore these terranes to their relative Jurassic paleogeography.

In the eastern Coast Belt, southwest-directed fold nappes and thrust faults are cut by northeast-directed thrust faults and by sinistral and dextral transcurrent faults of Late Cretaceous and early Tertiary age (Schiarizza et al., 1990; Journeay et al., 1992). These structures are in turn truncated by the Fraser Fault and offset more than 100 km to the south into the Cascades of northern Washington. Northeast-directed thrust faults of the southern Coast Belt intersect and displace west-directed thrusts at depths of between 9-18 km (3-6s two-way travel time) below the southeastern Coast Belt, and apparently root westward into a decollement zone at the base of the continental lithosphere. These structures are considered to be part of the east-vergent Waddington Fold and Thrust Belt, which root westward beneath high-grade metamorphic rocks of the Central Gneiss Complex along strike to the northwest. Cross-cutting plutons indicate that these faults were most likely active between 86-88 Ma. East-directed thrust faults of northern Washington root westward beneath the Cascade metamorphic core and are interpreted to have been active between 100-88 Ma (McGroder, 1990).

Intermontane Belt

In southern British Columbia, the Cache Creek terrane was thrust eastwards over Quesnellia (and the Ashcroft Formation) in Early to Middle Jurassic. The timing of thrusting is based on soft-sediment structures and slaty cleavage in the Ashcroft Formation, which indicate that deformation must have occurred not long after consolidation. However, Monger (1986) has suggested that thrusting may have been coextensive with deeper level deformation and the emplacement of granitic rocks in the Eagle Plutonic complex. The Eagle Plutonic Complex involves the westernmost margin of Quesnellia and is dated at 160-155 Ma (Callovian-Oxfordian). This complex is along strike with and separated from the Cache Creek by a belt of overlapping mid-Cretaceous (ca. 105 Ma) continental volcanics (Spences Bridge Group). There is no recognized Jurassic deformation in coeval rocks of Methow terrane, which are separated from the Eagle complex by the Pasayten Fault (Fig. 1).

Restoration of about 140 km of dextral strike-slip displacement on the Eocene Fraser Fault put Cache Creek rocks west of the Fraser River (near lat. 52°N), in the hinterland of the Intermontane thrust system as described by Travers (1978). Like its counterpart east of the Fraser River, the western Cache Creek terrane was thrust northward over Early Jurassic rocks in post-Middle or post-Late Jurassic time. These Early Jurassic rocks resemble coeval Sinemurian (Hazelton) strata. The maximum age of deformation in this region is constrained by the presence of Pitlophyllum (a seed fern), which occurs in Early Jurassic conglomerates involved in the thrusting.

METAMORPHISM

Metamorphic grade varies considerably across the southern Coast Belt. In the western (foreland) part of the belt, rocks that occur in septa range in age from Triassic to Early Cretaceous and are mostly of greenschist facies. Higher metamorphic grades occur near contacts with larger plutons. The grade locally drops to zeolite facies in Jurassic rocks of the central Coast Belt, near Harrison Lake, and to lawsonite-albite facies in Early Cretaceous rocks along the west shore of Harrison Lake. Within 20 km to the east, across the imbricate zone of the Coast Belt Thrust System, metamorphic grade rises to sillimanite-kyanite facies. A preliminary synthesis of available data suggests that peak metamorphic conditions (associated with 92-96 Ma thrust faulting) are 7.0-9.6 kb and 600-750°C, and drop off to 3.7-6.1 kb and 575-690°C by 84 Ma. The metamorphic grade of the eastern Coast Belt decreases along strike towards the northwest. Some metamorphism in the western Coast Belt may be older and related to granitic intrusions and(?) Jurassic contraction.

In the easternmost Coast Belt, metamorphic grade generally decreases northeasterly through greenschist to prehnite-pumpellyite facies. Near Lillooet, high greenschist grade rocks are exposed in slivers bounded by outward-dipping Tertiary normal faults. Based on cross-cutting relationships with dated plutonic rocks, metamorphism in this part of the eastern Coast Belt is interpreted to be Late Cretaceous and early Tertiary in age. 40Ar/39Ar dating in adjacent parts of the eastern Coast Belt reveals a history of Late Triassic (221 Ma) blueschist facies metamorphism, locally preserved in rocks of the Bridge River terrane, followed by Early or mid-Cretaceous (ca. 130 Ma or 110-95 Ma) regional and/or contact metamorphism.

High-grade regional metamorphism in the Coast Belt is closely associated with Late Cretaceous and early Tertiary structures. Where most completely studied (near lats. 540 and 50°N), high pressure/medium temperature (7-8 kb, 600- 650°C), regional metamorphism is associated with west- directed thrust faults and mid-Cretaceous epidote-bearing plutons, and is succeeded by low pressure/high temperature (~4 kb) contact metamorphism associated with the emplacement of Late Cretaceous-early Tertiary plutons. Widespread greenschist facies metamorphism is associated with Late Cretaceous-early Tertiary deformation and with earlier episodes of Jurassic deformation and plutonism. Zeolite, lawsonite-albite and blueschist facies metamorphism is developed locally in central southern Coast Belt.

MODELS OF COAST BELT EVOLUTION

With the advent of plate tectonics, the Coast Belt initially was identified as a Jurassic to Tertiary magmatic arc formed above an east-dipping subduction zone, a view that persists. Although most workers would agree that subduction- related magmatism probably created most rocks within the belt, the nature and distribution of structures and metamorphic rocks within it show that arc magmatism is only part of a far more complex tectonic history.

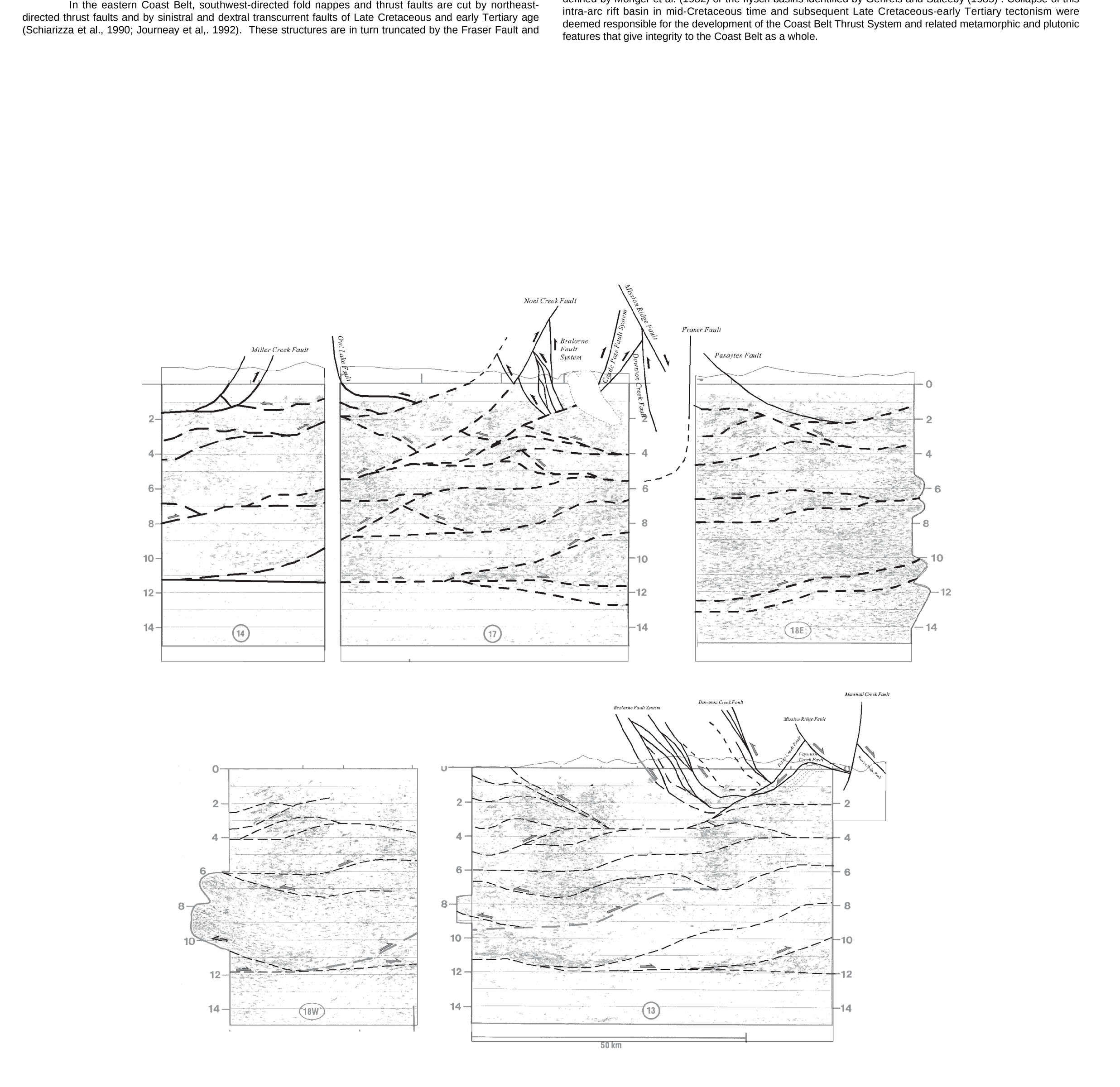
As long ago as 1881, Dawson surmised that the Coast Range (sic) had undergone great uplift, metamorphism and "Appalachian-type folding" in addition to the introduction of great masses of hornblendic granite. In the northern Cordillera, Gabrielse and Wheeler (1961) saw the Coast Belt as the focus of long-lived plutonism and uplift. They interpreted the Coast Belt as the geanticlinal core of their Pacific orogen, flanked by divergent thrust systems. In their view, east-vergent thrusts were antithetic to the dominant west-vergent thrust system. Godwin (1975) explained the distribution of porphyry copper deposits and crustal thickening, shown by the metamorphic grade of the central Coast Belt (ca. lat. 54°N), as the result of imbrication along two Late Cretaceous-early Tertiary east-dipping subduction zones, one west of the Queen Charlotte Islands and the other on the west margin of the Coast Belt.

The distribution of tectonostratigraphic terranes in the Cordillera and the time-space relationships between these terranes led Monger et al. (1982) to view the dominant structure and metamorphism in the Coast Belt as the result of mid-Cretaceous accretion (or collision) of amalgamated western intraoceanic arc terranes (Wrangellia-Alexander-Insular superterrane) along the leading edge (Jurassic) of the North American Plate. The suture in this model, outlined by terrane boundaries, more- or-less follows early Late Cretaceous structures of the west-directed Coast Belt Thrust System.

Gehrels and Saleeby (1985) suggested that the Insular Superterrane moved northwards along the western edge of North America in Jura-Cretaceous time, finally accreting to the continental margin in the Late Cretaceous. They proposed that Jura-Cretaceous flysch basins formed along the western Cordilleran margin from southern Alaska to California in response to transtension associated with northward translation of the Insular superterrane. Plafker (1990) also proposed that the Insular Superterrane was translated northwards from Californian latitudes, but in Late Cretaceous time. He viewed the linear, high-grade Coast Belt as an Andean-type arc largely formed within a Jura-Cretaceous fore-arc setting. Early Tertiary granites were related to Kula-Farallon-North American triple junction.

Most recently, van der Heyden (1992) has suggested that the Coast Belt is a long-lived (ca. 165-47 Ma) Andean-style magmatic arc that was built across terranes that were accreted by Middle Jurassic time (ca. 170 Ma) along the Cache Creek suture. The suture lies mostly in the Intermontane Belt. This interpretation is based on (1) the presence of Middle and Late Jurassic granites on both sides of the Coast Belt near lat. 53°N, (2) the absence of any record of oceanic crust within the Coast Belt north of lat. 51°N, and (3) the general eastward younging of granitic rocks across Insular and Coast belts.

Oceanic rocks of the Bridge River Complex occur in fault slivers of the eastern Coast Belt south of lat. 51°N. They have been correlated with rocks of the southern Cache Creek, based on similarities in age and tectonic setting. This correlation implies that oceanic crust (of Cache Creek- Bridge River type) was never present within or along the Coast Belt north of lat. 51°N. To account for the Jura- Cretaceous clastic deposits, Van der Heyden (1992) suggested that western parts of the Coast Belt (today in Insular and southwestern Coast belts) were rifted from eastern parts forming an intra-arc rift basin, located more-or-less along the trace of the suture defined by Monger et al. (1982) or the flysch basins identified by Gehrels and Saleeby (1985). Collapse of this intra-arc rift basin in mid-Cretaceous time and subsequent Late Cretaceous-early Tertiary tectonism were deemed responsible for the development of the Coast Belt Thrust System and related metamorphic and plutonic features that give integrity to the Coast Belt as a whole.



Geology by J.M. Journeay and J.W.H. Monger (1994)
Map compilation by J.M. Journeay

Digital base map from Geomatics Canada published at the same scale.
Generalized and modified by the Geological Survey of Canada

Any revisions or additional geological information known to the user would be welcomed by the Geological Survey of Canada

Digital geological cartography by S. Churchill, R. Cocking, D. Dunn, J.M. Journeay, G. Rae and M. Sandhu

Magnetic declination 1994, 20°30' East, decreasing 7.3' annually. Readings vary from 20°23' E in the SW corner to 20°37' in the NE corner of the map

Elevations in feet above mean sea level

Geologic contact (defined, approximate, assumed)
Limit of Quaternary cover
Fault contact, displacement uncertain (defined, approximate, assumed)
Crustal suture, teeth indicate upthrust block (defined, approximate, assumed)
Reverse or thrust fault, teeth indicate upthrust block (defined, approximate, assumed)
Normal fault, solid dot indicates downthrown block (defined, approximate, assumed)
Strike-slip fault, arrows indicate relative sense of displacement (defined, approximate, assumed)
Anticline, upright/overturned (defined, approximate, assumed)
Syncline, upright/overturned (defined, approximate, assumed)

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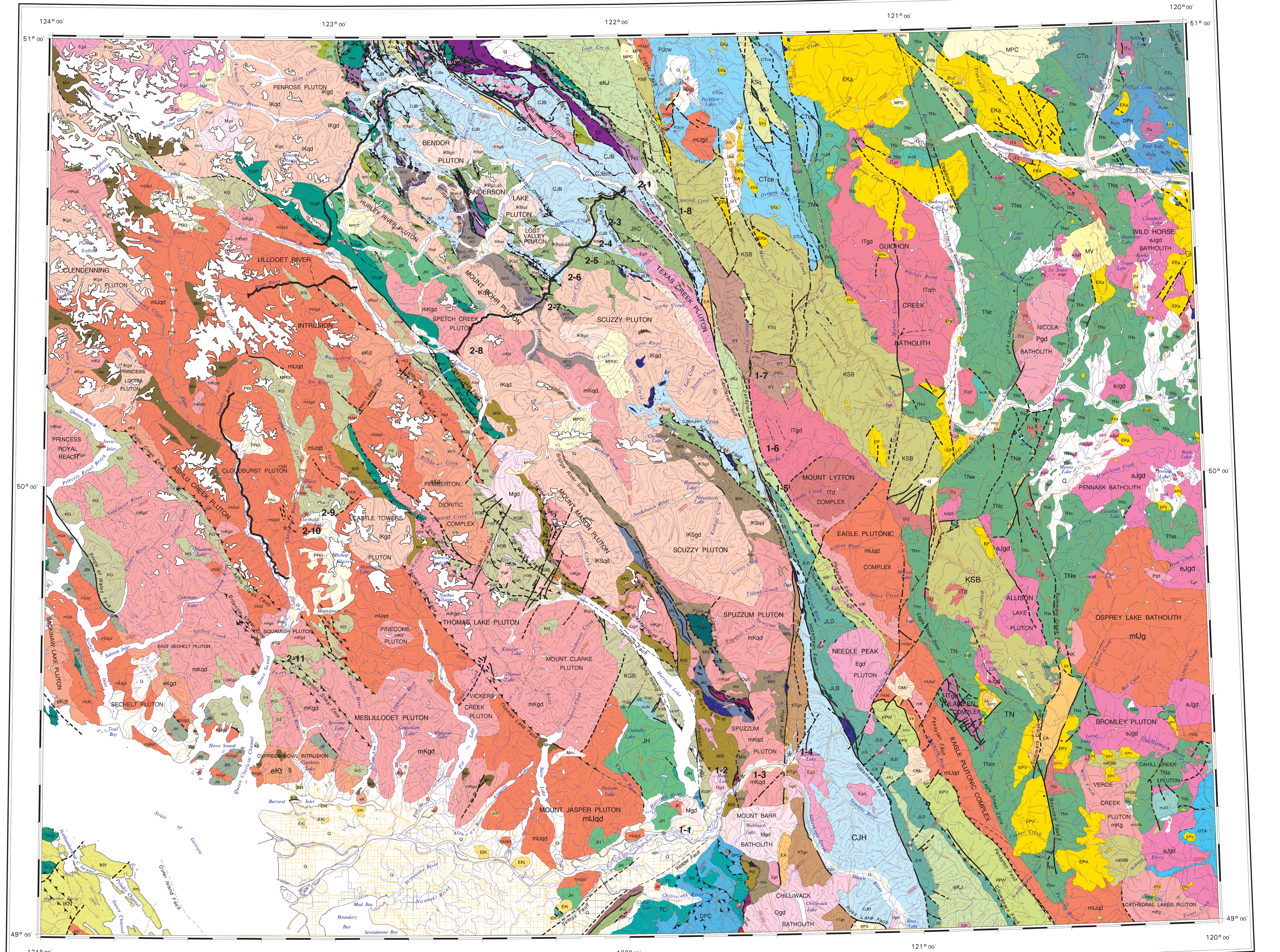
References: ASHCROFT, HOPE, PEMBERTON, VANCOUVER map-area reference lists (numbered entries).



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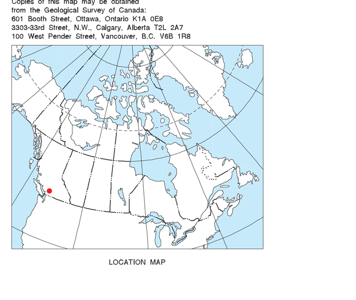

LOCATION MAP

PRELIMINARY MAP
GEOLOGY

GEOLOGY OF THE SOUTHERN COAST AND INTERMONTANE BELTS
BRITISH COLUMBIA

Scale 1:500 000 - Échelle 1/500 000

Kilometres 10 0 10 20 30 40 Kilomètres

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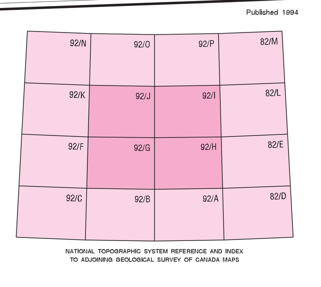

NATIONAL TOPOGRAPHIC SYSTEM REFERENCE AND INDEX TO ADJOINING GEOLOGICAL SURVEY OF CANADA MAPS

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L E G E N D

STRATIFIED ROCKS

PLEISTOCENE AND RECENT

Q — Thick drift, alluvium, glaciofluvial and lacustrine deposits, till, colluvium, and landslide deposits

PRG — GARIBALDI GROUP: andesite, basalt and dacite flows and pyroclastic rocks

TERTIARY

MIOCENE and PLIOCENE

PRv — "Valley basalt", basalt flows

MPC — CHILCOTIN GROUP: basalt ("plateau basalt"), olivine basalt, minor tuff

MPD — DEADMAN RIVER FORMATION: tuff, breccia, sandstone, shale, conglomerate

MPS — SKAGIT FORMATION: felsic and intermediate flows and tuffs

MPCC — CREVASSE CRAG VOLCANIC COMPLEX: felsic and intermediate flows and tuffs

OLIGOCENE and MIOCENE

Mv — Brigade Lake Basalt: olivine basalt flows

PALEOCENE and EOCENE

OMc — COQUIHALLA FORMATION: intermediate and felsic pyroclastic rocks and flows

EA — ALLENBY FORMATION: sandstone, shale, conglomerate, coal; includes Hat Creek and Coldwater beds

EP — PRINCETON GROUP: andesite and basalt flows and pyroclastic rocks; local rhyolite, sandstone and shale

EKa — KAMLOOPS GROUP: andesite and basalt flows and pyroclastic rocks; local rhyolite, sandstone and shale

UPPER CRETACEOUS - EOCENE

EKl — BURRARD FORMATION: sandstone, shale, conglomerate; includes local basaltic flows (or sills) and dykes of Oligocene age

Eb — Undifferentiated basalt

EPv — Hornblende-phyric intermediate volcanic flows; local mafic and felsic flows; volcaniclastics

CRETACEOUS

UPPER CRETACEOUS

lKN — NANAIMO GROUP: sandstone, shale and conglomerate; correlative units near Vancouver include LIONS GATE MEMBER of BURRARD FORMATION

lKPC — POWELL CREEK FORMATION: andesite volcanic flow and flow breccia, lapilli tuff, volcanic sandstone and conglomerate

EARLY and LATE CRETACEOUS

KSq — SILVERQUICK CONGLOMERATE: pebble and cobble polymictic conglomerate containing clasts of chert, volcanic rocks and sandstone; lesser amounts of interbedded sandstone and shale; upper part of formation includes interbedded andesite breccia and chert- and volcanic-pebble to cobble conglomerate

KP — PASAYTEN GROUP: undifferentiated sandstone, shale, argillite, conglomerate and arkosic sandstone; minor red tuff and chert grain sandstone. As mapped, the PASAYTEN GROUP lies east of Chuwanten Fault and is probably a nonmarine facies equivalent of uppermost JACKASS MOUNTAIN GROUP, which lies west of Chuwanten Fault

KPW — WINTHROP FORMATION: arkose, conglomerate, argillite and minor red beds and tuff

KPV — VIRGINIAN RIDGE FORMATION: chert grain sandstone, argillite

KSB — SPENCES BRIDGE GROUP: mafic, intermediate and felsic flows, pyroclastic rocks and intercalated sandstone, shale and conglomerate of PIMAINUS CREEK FORMATION (P), overlying mafic andesite flows and minor sedimentary rocks of SPIUS CREEK FORMATION (S)

KG — GAMBIER GROUP: intermediate, felsic and mafic volcanic rocks; intercalated conglomerate, sandstone and shale; includes FIRE LAKE GROUP

KGB — BROKENBACK HILL FORMATION: interbedded crystal tuff, volcaniclastic sandstone, phyllite, lapilli tuff, minor flow banded rhyolite quartz and feldspar-phyric rhyolite; andesite and volcanic breccia

KGP — PENINSULA FORMATION: conglomerate and arkosic sandstone; conglomerate contains clasts of andesite, rhyolite and feldspar porphyry with minor chert, quartz and granite

KT — TAYLOR CREEK GROUP: undifferentiated conglomerate; calcareous sandstone; micaceous quartzofeldspathic sandstone and siltstone; shale; minor intermediate to felsic volcanic flows, tuff and breccia

KTL — LIZARD FORMATION: interbedded muscovite-rich arkosic sandstone and shale; chert pebble conglomerate and polymictic conglomerate; minor amounts of chert-rich sandstone and conglomeratic sandstone; volcanic conglomerate; volcanic breccia and tuff

KTD — DASH FORMATION: chert pebble conglomerate; chert-rich sandstone and shale; conglomerate that conformably overlies BRIDGE RIVER COMPLEX contains clasts of blueschist, greenschist, metachert and serpentinite

JURASSIC and CRETACEOUS

MIDDLE JURASSIC and LOWER CRETACEOUS

eKJ — JACKASS MOUNTAIN GROUP: arkosic sandstone, siltstone, shale, conglomerate, lithic sandstone, granule conglomerate and conglomeratic sandstone

HAUTERIVIAN to BARREMIAN

JKRM — RELAY MOUNTAIN GROUP: siliceous siltstone, calcareous siltstone and sandstone; conglomeratic sandstone

UPPER OXFORDIAN to VALANGINIAN

lKRM3 — Dark grey shale and siltstone; sandstone and calcareous sandstone

JKRM2 — Sandstone and siltstone; calcareous sandstone, coquina; conglomerate and conglomeratic sandstone containing mainly volcanic and plutonic clasts

CALLOVIAN to LOWER OXFORDIAN

muJRM1 — Siliceous shale, siltstone and fine grained sandstone; medium to coarse grained sandstone, calcareous sandstone and calcareous siltstone, pebble conglomerate containing mainly felsic and intermediate volcanic rocks

LOWER JURASSIC to LOWER CRETACEOUS

JKC — CAYOOSH ASSEMBLAGE: undifferentiated graphitic phyllite, tuffaceous phyllite, siltstone thinly laminated siltstone/sandstone turbidite, volcaniclastic sandstone, shale; arkosic sandstone, quartzose sandstone; thinly layered graphitic quartzite; minor limestone, volcanic tuff, breccia and intermediate to mafic flows; includes rocks previously mapped as BREW GROUP, LILLOOET GROUP and, locally, RELAY MOUNTAIN GROUP

JKCu — Upper Member: graphitic siltstone, shale, phyllite, arkosic sandstone, quartzose sandstone, thinly laminated siltstone/sandstone turbidite (Unit 4); thin-bedded graphitic phyllite, siltstone, volcaniclastic sandstone, and calcareous sandstone (Unit 5), locally containing Neocomian bivalves

JKCm — Middle Member: thin- and thick-bedded volcaniclastic sandstone, graphitic siltstone, minor limestone (Unit 3)

JKCl — Lower Member: graphitic phyllite, siltstone, thin laminated siltstone/sandstone turbidite (Unit 1); tuffaceous phyllite, minor lapilli tuff and tuff breccia (Unit 2)

JKv — Sedimentary Rock of Vedder Mountain: blocks of Upper Jurassic radiolarian chert, sandstone, basalt and limestone in a matrix of graphitic argillite and phyllite

JURASSIC

LATE JURASSIC

lJK — KENT FORMATION: conglomerate, massive volcanic sandstone, dark grey siltstone and argillite; conglomerate clasts include black shale, chert, interbedded tuff and volcanic flows

lJB — BILLHOOK FORMATION: intermediate volcanic flows, flow breccia and volcaniclastic sandstone

MIDDLE JURASSIC

mJM — MYSTERIOUS CREEK FORMATION: dark grey to black shale, siltstone, fine grained green to grey sandstone, argillite and tuff

mJv — Undifferentiated andesite to dacite tuff and minor sediments

EARLY and MIDDLE JURASSIC

mJA — ASHCROFT FORMATION: argillite, siltstone, sandstone and conglomerate; minor carbonate

JH — HARRISON LAKE FORMATION: intermediate and felsic flows and pyroclastic rocks; local argillite, conglomerate, calcareous siltstone, shale and sandstone. Flows include massive and columnar jointed dacite, rhyolite and dark green, locally amygdaloidal plagioclase andesite porphyry. Pyroclastic rocks include lapilli tuff, volcanic breccia, crystal tuff and volcanic conglomerate

JL — LADNER GROUP: undivided slate, phyllite, argillite, tuff, sandstone and argillite; mafic to intermediate volcanics. As mapped, this unit locally includes Late Jurassic fine grained sandstone and conglomerate of Thunder Lake Sequence

JLD — DEWDNEY CREEK FORMATION: sandstone, siltstone; local mafic to intermediate volcanic flows and related pyroclastic rocks

JLB — BOSTON BAR FORMATION: slate, graphitic phyllite, thinly laminated siltstone/sandstone turbidite, argillite and tuffaceous siltstone

JLC — LAST CREEK FORMATION: calcareous sandstone, siltstone, shale and conglomerate; siliceous argillite, silty limestone

JBI — BOWEN ISLAND GROUP: intermediate and felsic flows, locally mafic; volcaniclastic sandstone and intercalated pelite; minor carbonate and conglomerate; metamorphosed to greenschist facies

Js — Undivided brown calcareous sandstone, siltstone and conglomerate; dark grey shale and calcareous shale

LATE TRIASSIC and EARLY JURASSIC

TC — CULTUS FORMATION: argillite, sandstone, derived mainly from volcanic sources and minor carbonate

TRIASSIC

TCC — CAMP COVE FORMATION: siliceous argillite, argillite, mafic volcanic rocks

TT — TYAUGHTON GROUP: undivided conglomerate, sandstone and siltstone

TTu — Upper Member: green and grey sandstone, conglomeratic sandstone, conglomerate and shale; limestone conglomerate

TTl — Lower Member: massive to thick-bedded limestone-volcanic conglomerate and conglomeratic sandstone; red to brown thin- to medium-bedded sandstone, thin- to thick-bedded grey limestone

TS — SPIDER PEAK FORMATION: basalt, locally pillowed

TK,Q — Mafic volcanics, locally pillowed, amphibolite and marble, probably correlative with the KARMUTSEN and QUATSINO FORMATIONS of Vancouver Island

TCd — CADWALLADER GROUP: undivided mafic and intermediate volcanic flows; limestone; conglomerate with limestone, granite, diorite and volcanic clasts; intercalated sandstone and siltstone; locally metamorphosed to greenschist facies

TCdH — HURLEY FORMATION: thin- to thick-bedded sandstone, calcarenite and shale; lesser amounts of limestone-volcanic conglomerate and volcanic sandstone; locally includes greenstone, limestone-greenstone breccia and pebbly mudstone

TCdP — PIONEER FORMATION: green to purple, commonly amygdaloidal, pillowed and massive greenstone, greenstone breccia and tuff, minor felsic volcanic flows

TN — NICOLA GROUP: undifferentiated mafic to felsic volcanic rocks, minor sedimentary rocks

TNw — Western volcanic facies: mafic to felsic volcanic rocks, minor flows, pelite, sandstone, local limestone

TNc — Central volcanic facies: intermediate plagioclase and pyroxene porphyry pyroclastic rocks, locally pillowed and feldspar porphyry flows, minor volcanic conglomerate and limestone

TNe — Eastern volcanic facies; mafic augite and hornblende porphyry pyroclastic rocks, intercalated argillite

TNs — Sedimentary facies; argillite, sandstone, tuff, local carbonate beds and carbonate-clast conglomerate; local chert-carbonate-volcanic conglomerate

TNm — Metamorphic rocks including amphibolite, foliated diorite, mylonite and chlorite schist derived from NICOLA GROUP

Tu — Undifferentiated sedimentary and volcanic rocks of Triassic age, but of uncertain correlation

CARBONIFEROUS to MIDDLE JURASSIC

CJB — BRIDGE RIVER COMPLEX: undifferentiated chert, pelite and mafic volcanic rocks; minor olistostromal carbonate; gabbro and associated ultramafic rocks; local mélange and talc-carbonate schist

CJBs — Radiolarian chert, siltstone, argillite, sandstone; minor amounts of greenstone, limestone and serpentinite

CJBg — Pillowed and massive greenstone and limestone (Lower Norian); lesser amounts of radiolarian chert, argillite, diabase, sandstone and pebbly mudstone

CJBb — Blueschist, greenschist, phyllite, metachert; also includes non-schistose pillowed and massive greenstone containing minor blue amphibole and minor limestone

CJBm — Light to dark grey phyllite, quartz phyllite, calcareous phyllite, metachert, green chlorite schist, greenstone, marble and biotite-quartz schist; metamorphosed equivalents of BRIDGE RIVER COMPLEX

CJB,H — BRIDGE RIVER (B) and HOZAMEEN (H) COMPLEXES: radiolarian chert, argillite, mafic volcanic rocks, and local mélange; BRIDGE RIVER and HOZAMEEN COMPLEXES are probably the same unit, dextrally offset by the Tertiary Fraser Fault

CJBm,Hm — Siliceous schist, quartzose phyllite, chlorite and actinolite schist, local biotite-garnet schist; metamorphosed equivalents of BRIDGE RIVER and HOZAMEEN COMPLEXES

CJH — HOZAMEEN COMPLEX: radiolarian chert, pelite, mafic volcanic rocks, minor olistostromal carbonate and associated gabbro and ultramafic rocks

CJC — CACHE CREEK COMPLEX: undivided argillite, siltstone, chert, carbonate, basalt and tectonic mélange

PJcw — Western belt: argillite, siltstone, chert, volcaniclastic Pavilion beds

PTcc — Central belt: mainly massive carbonate of MARBLE CANYON FORMATION; local thin-bedded carbonate, argillite and tuff; minor basalt and chert

CTce — Eastern belt: tectonic mélange containing blocks of chert, carbonates basalt, rare gabbro, ultramafic and felsic rocks; matrix of mélange comprises chert and argillite

CARBONIFEROUS to TRIASSIC

CTu — Undifferentiated meta-augite porphyry, chlorite schist, argillite, phyllite, volcanic sandstone and semi-schist; local small carbonate bodies of both Carboniferous and Triassic ages; in part equivalent to NICOLA GROUP; in part equivalent to HARPER RANCH GROUP

Pc,Cc — Undivided Permian limestone

ORDOVICIAN to TRIASSIC

OTA — APEX MOUNTAIN COMPLEX: argillite, chert greywacke, mafic volcanic rocks, minor carbonate and ultramafic rocks; includes BRADSHAW, INDEPENDENCE, OLD TOM, and SHOEMAKER FORMATIONS, and metamorphosed quartz-rich clastics in western Nicola Pluton

DEVONIAN to PERMIAN

DPC — CHILLIWACK GROUP: mafic and felsic volcanic rocks, carbonate, pelite, sandstone and minor conglomerate

DPH — HARPER RANCH GROUP: argillite, cherty argillite, siltstone, volcanic and chert-grain sandstone, chert pebble conglomerate, carbonate and felsic to mafic volcanic rocks

PLUTONIC ROCKS

LATE TERTIARY

(5.3 - 40 Ma)

MIOCENE (5.3 - 16 Ma)

Mgd — Granodiorite of MOUNT BARR PLUTON

OLIGOCENE (24 - 29 Ma)

Ogd — Granodiorite of CHILLIWACK PLUTON and smaller satellitic bodies

EARLY TERTIARY

(40 - 64 Ma)

Egd — Granodiorite and monzogranite (gd) of NEEDLE PEAK, MISSION RIDGE, MOUNT OUTRAM and TEXAS CREEK PLUTONS (46 - 58 Ma); small bodies of intermediate (i) composition

CRETACEOUS - TERTIARY

Pgd — Granodiorite (gd) of southern NICOLA COMPOSITE PLUTON, small granite (g) bodies near Siwash Creek and Whitehead Lake (62 - 64 Ma)

KTi — Undivided hornblende-feldspar, quartz-feldspar and hornblende-biotite-quartz-feldspar porphyries

CRETACEOUS

Kgd — Granodiorite (gd) and quartz diorite (qd) of probable Cretaceous age

LATE CRETACEOUS (68 - 84 Ma)

lKB — BENDOR PLUTONIC SUITE: undivided granodiorite (gd), quartz diorite (qd), biotite tonalite (t) and granite (g); includes TRUAX, BENDOR, ANDERSON LAKE, LOST VALLEY, DOWNTON CREEK and CAYOOSH PLUTONS

LATE CRETACEOUS (84 - 91 Ma)

lKS — SCUZZY PLUTONIC SUITE: granodiorite (gd), quartz monzonite (qm), hornblende and biotite quartz diorite (qd); includes SCUZZY, MOUNT MASON, MOUNT ROHR and HURLEY RIVER plutons

MID - CRETACEOUS (mainly 91 - 105 Ma; locally as old as 112 Ma)

mK — Coast Belt: quartz diorite (qd), granodiorite (gd), tonalite and diorite (d) of SPUZZUM PLUTON and related bodies; including BREAKENRIDGE ORTHOGNEISS, PORTEAU, CASTLE TOWERS, MESLILLOOET(?), LILLOOET RIVER TONALITE, MT. CLARKE, PITT LAKE, MARLBOROUGH, STAVE GLACIER, SPETCH CREEK, PRINCESS ROYAL REACH, MISTY LAKE, BIG JULIE and SQUAMISH plutons.
Intermontane Belt: granodiorite (gd), monzogranite (g) of FALLS LAKE PLUTONIC SUITE, granite (g) of CATHEDRAL LAKES and VERDE CREEK plutons

mKSBi — Felsic intrusions, probably subvolcanic equivalents of SPENCES BRIDGE GROUP

EARLY CRETACEOUS (112 - 145 Ma)

eK — Coast Belt: quartz diorite (qd), granodiorite (gd) and minor diorite (d) of (112 - 135 Ma), includes GOAT LAKE, PRINCESS LOUISA, QUATAM, MALASPINA, CYPRESS BOWL, QUARRY BAY, SECHELT LAKE, WEST REDONDA and EAST SECHELT plutons, and PEMBERTON DIORITE COMPLEX

JURASSIC AND CRETACEOUS

JK — Undivided granodiorite (gd), quartz diorite (qd) and diorite (d) of Jurassic and Cretaceous age

JURASSIC

EARLY MIDDLE JURASSIC - LATE JURASSIC (145 - 187 MA)

mJ — Western Coast Belt: tonalite (t), quartz diorite (qd), granodiorite (gd) and diorite (d); includes MOUNT JASPER, MALIBU, THORNBOROUGH, HORSESHOE BAY, CLOUDBURST, ASHLU CREEK, SECHELT, RYAN RIVER and ELBOW LAKE plutons.
Intermontane Belt: granite (g) and granodiorite (gd) of OSPREY LAKE and CAHILL CREEK plutons, quartz diorite (qd), granodiorite (gd) and gneiss (gn) of EAGLE PLUTONIC COMPLEX, granodiorite (gd) of MOUNT MARTLEY pluton (145 - 166 Ma)

EARLY JURASSIC (187 - 200 Ma)

eJ — Intermontane Belt (194 - 198): granodiorite (gd) of WILD HORSE, DOUGLAS LAKE, PENNASK, BROMLEY and CAHILL CREEK plutons

LATE TRIASSIC (205 - 212 Ma)

lTu — Intermontane Belt: ultramafic rocks (u), gabbro (gb), diorite (d), syenite (s) and granite (g) of TULAMEEN, COPPER MOUNTAIN, IRON MASK and related intrusions

lTd — Diorite and amphibolite of MOUNT LYTTON COMPLEX: diorite of HEDLEY INTRUSIONS (small diorite plutons in NICOLA GROUP)

lTgd — Granodiorite (gd), quartz monzonite (qm) of GUICHON CREEK, ALLISON LAKE and northern parts of NICOLA COMPOSITE PLUTON; granodioritic phases (gd) of MOUNT LYTTON COMPLEX (206 - 212 Ma)

TRIASSIC

Tgd — Undivided Triassic granodiorite

PERMIAN - TRIASSIC

PT — Undivided granodiorite (gd), diorite and amphibolite (d)

PTm — Irregularly layered gneisses, layered quartzfeldspathic rocks, amphibolite and mylonite of MOUNT LYTTON COMPLEX; similar rocks on west side of NICOLA BATHOLITH

PERMIAN

PV — VEDDER COMPLEX: amphibolite, gneiss, minor ultramafic rocks

PALEOZOIC and PROTEROZOIC

PPY — Coast Belt: diorite and gabbro of YELLOW ASTER COMPLEX

OPHIOLITE COMPLEXES

PERMIAN

PBC — BRALORNE COMPLEX: gabbro (gb), diorite (d), quartz diorite (qd), soda granite (g), harzburgite and peridotite (u), serpentinite (s) and talc-carbonate schist (s) of PRESIDENT ULTRAMAFIC SUITE, pillowed and massive greenstone flows, minor phyllite; includes some PIONEER GREENSTONE

PEL — EAST LIZA COMPLEX: undivided pillowed and massive greenstone, greenstone breccia, diabase, gabbro and serpentinite with minor limestone and chert

PALEOZOIC and MESOZOIC

Sh — SHULAPS COMPLEX: sheared and serpentinized harzburgite; wehrlite, websterite, dunite and clinopyroxenite, cut by quartz diorite dykes; serpentinite mélange (m); gabbro (gb), in part layered, with minor pyroxenite; diorite (d), pillowed and massive greenstone; minor chert, phyllite, sandstone and conglomerate

CJu — Undivided alpine-type ultramafic rocks, mostly associated with CACHE CREEK and BRIDGE RIVER and HOZAMEEN COMPLEXES and SPIDER PEAK FORMATION

METAMORPHIC ASSEMBLAGES

LATE CRETACEOUS and TERTIARY

KTgn — CUSTER GNEISS: pegmatitic granite gneiss, with pelitic schist and amphibolite derived from Mesozoic, Paleozoic (?) and Precambrian rocks, intruded and metamorphosed in Late Cretaceous and Tertiary (46 - 68 Ma). Metamorphic grade ranges from amphibolite facies to retrograde greenschist facies

EARLY LATE CRETACEOUS and LATE CRETACEOUS

MCC — CHISM CREEK SCHIST: mélange of pelitic schist, amphibolite, quartzite, phyllite, minor chert, limestone and ultramafic rock; derived from the BRALORNE COMPLEX, BRIDGE RIVER COMPLEX, CADWALLADER GROUP and CAYOOSH ASSEMBLAGE; metamorphosed in early Late Cretaceous (84 - 112 Ma) and Late Cretaceous (68 - 84 Ma). Mineral assemblages record high temperature/intermediate pressure Barrovian metamorphic field gradient (M1) ranging from middle greenschist to lower amphibolite facies and a younger, low-pressure Buchan overprint (M2) of greenschist to amphibolite facies

MSt — SETTLER SCHIST: garnet-biotite, staurolite, kyanite and sillimanite schist; local amphibolite including meta-pillow basalt; siliceous schist; includes greenschist-grade sandstone, pelite and broken formation south of Fraser River; protolith wholly or in part derived from the Jura-Cretaceous CAYOOSH ASSEMBLAGE; metamorphosed in mid- to early Late Cretaceous (84 - 105 Ma) and Late Cretaceous (68 - 84 Ma). Mineral assemblages record both high pressure/intermediate to high-temperature Barrovian metamorphic field gradient (M1) ranging from middle greenschist to lower amphibolite facies and a younger, low-pressure Buchan overprint (M2) of greenschist to amphibolite facies

MSl — SLOLLICUM SCHIST: mafic, intermediate and felsic meta-volcanic rocks, pelite, minor volcanic- and carbonate-clast conglomerate, protolith wholly or in part derived from GAMBIER and BILLHOOK CREEK formations; metamorphosed in mid- to early Late Cretaceous (84 - 105 Ma). Mineral assemblages record a high pressure/low-to intermediate temperature Barrovian metamorphic field gradient (M1) ranging from middle greenschist to amphibolite facies

MC — COGBURN SCHIST: meta-chert, pelite, amphibolite, marble, ultramafic rocks; derived in part from the BRIDGE RIVER and HOZAMEEN COMPLEXES; metamorphosed in mid- to early Late Cretaceous (84 - 105 Ma). Mineral assemblages record a high pressure/intermediate to high temperature Barrovian field gradient (M1) ranging from middle greenschist to amphibolite facies and a younger, low pressure Buchan overprint (M2) of greenschist to amphibolite facies

Mm — Undifferentiated garnet-biotite, kyanite and sillimanite schist; local amphibolite, felsic and mafic metavolcanic rocks; occurs small septa of the Coast Belt Granite Rocks

THgn — HORNET CREEK ORTHOGNEISS: undivided amphibolite, biotite-quartz-feldspar and hornblende gneiss (224 Ma)

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