Geological Survey of Canada

CURRENT RESEARCH
2002-A10

Structural geology of eastern Bella Coola map area, southwest British Columbia

J.B. Mahoney, L.C. Struik, L.J. Diakow, M.G. Hrudey, and G.J. Woodsworth

2002

Natural Resources Canada Ressources naturelles Canada

Canada

Catalogue No. M44-2002/A10E-IN
ISBN 0-662-31444-1

A copy of this publication is also available for reference by depository libraries across Canada through access to the Depository Services Program's website at http://dsp-psd.pwgsc.gc.ca

A free digital download of this publication is available from the Geological Survey of Canada Bookstore web site:

http://gsc.nrcan.gc.ca/bookstore/

Click on Free Download.

Authors' addresses

J.B. Mahoney *(mahonej@uwec.edu)*
Department of Geology
University of Wisconsin at Eau Claire
Eau Claire, Wisconsin, U.S.A. 54702-4004

L.C. Struik *(bstruik@nrcan.gc.ca)*
G.J. Woodsworth *(glennw@nrcan.gc.ca)*
Geological Survey of Canada
101-605 Robson Street
Vancouver, British Columbia V6B 5J3

L.J. Diakow *(Larry.Diakow@gems2.gov.bc.ca)*
Geological Survey Branch
British Columbia Ministry of Energy and Mines
P.O. Box 9320, 5th Floor,
1810 Blanshard Street
Victoria, British Columbia V8W 9N3

M.G. Hrudey *(hrudey@geo.ucalgary.ca)*
Department of Geology and Geophysics
University of Calgary
2500 University Drive N.W.
Calgary, Alberta T2N 1N4

Structural geology of eastern Bella Coola map area, southwest British Columbia[1]

J.B. Mahoney, L.C. Struik, L.J. Diakow, M.G. Hrudey, and G.J. Woodsworth

GSC Pacific, Vancouver

Mahoney, J.B., Struik, L.C., Diakow, L.J., Hrudey, M.G., and Woodsworth, G.J., 2002: Structural geology of eastern Bella Coola map area, southwest British Columbia; Geological Survey of Canada, Current Research 2002-A10, 9 p.

Abstract: Rocks of the eastern Bella Coola (NTS 93 D) map area record several distinct deformational events representing episodic extension, contraction, and transpression in the region. Extension may have been coeval with the generation of volcanic sequences of the Jurassic Hazelton Group and Lower Cretaceous Monarch sequence. Lower Cretaceous Monarch sequence rocks exhibit tight, northeast-vergent folds and minor thrust faults. This contractional belt is cut by ductile protomylonitic to mylonitic transpressional shear zones (10–1000 m wide) that affect most rocks in the western portion of the mapped area, and are themselves cut by various granite and tonalite bodies. Brittle faults cut all rocks of the area and form prominent, north-south-trending topographic linear features.

Résumé : Les roches de la partie est de la région cartographique de Bella Coola (SNRC 93 D) révèlent plusieurs épisodes distincts de déformation intermittente par distension, compression et transpression dans la région. Il est possible que la distension ait été contemporaine de la mise en place des séquences volcaniques du Groupe de Hazelton du Jurassique et de la séquence de Monarch du Crétacé inférieur. Les roches de cette dernière séquence présentent des plis serrés à vergence nord-est, ainsi que des failles de chevauchement de faible importance. Les roches de cette bande de déformation par compression sont recoupées par des zones de cisaillement ductile par transpression (de 10 à 1 000 m de largeur), qui montrent des textures protomylonitiques à mylonitiques. Ces zones de cisaillement recoupent la plupart des roches dans la partie ouest de la région cartographique et sont elles-mêmes interrompues par diverses massifs de tonalite et de granite. Des failles fragiles recoupent toutes les roches de la région et forment des linéaments topographiques remarquables d'orientation nord-sud.

[1] Contribution to of the Bella Coola Targeted Geoscience Initiative Project.

INTRODUCTION

The Bella Coola (NTS 93 D) region of the Canadian Cordillera (Fig. 1) contains the boundary between the Intermontane and Insular superterranes. The paleogeographic position, geological history, and timing of amalgamation of these superterranes are a matter of debate (Cowan et al., 1997 and references therein). The eastern part of the Bella Coola map area is underlain by Jurassic and Cretaceous volcanic and sedimentary rocks assigned to the Stikine terrane of the Intermontane superterrane. These rocks are intruded by westerly increasing volumes of plutonic rocks of the Coast Plutonic Complex, which is cut by the Coast shear zone, a 1200 km long northeast-side-up structure active mainly between about 65 and 55 Ma (Rusmore et al., 2001 and references therein). Andronicos et al. (1999) speculated that the shear zone may be a major transpressional structure that accommodated thousands of kilometres of displacement. At the latitude of Bella Coola, rocks of the Insular superterrane are located west of the Coast shear zone.

Geological mapping during the 2001 field season concentrated on the eastern part of the Bella Coola 1:250 000 map area (NTS 93 D), and focused on the area north of the Bella Coola River, south of the Dean River, between Dean Channel and the western boundary of Tweedsmuir Provincial Park (Fig. 2). This investigation is a part of the Geological Survey of Canada's Targeted Geoscience Initiative investigating the geological environment, history, and volcanic-hosted massive-sulphide (VMS) potential of eastern Bella Coola map area. The initiative includes scientists from the Geological Survey of Canada, the British Columbia Ministry of Energy and Mines, the University of British Columbia, and the University of Wisconsin at Eau Claire.

REGIONAL GEOLOGY

The eastern Bella Coola map area is underlain by two main lithostratigraphic groups cut by a diverse suite(s) of plutons. These rocks are exposed in two northwest-trending map panels that include, from east to west, 1) an eastern panel characterized by bimodal volcanic strata of the Hazelton Group (Baer, 1973); and 2) a western panel dominated by the Monarch sequence (Struik et al., 2002), a thick succession of Lower Cretaceous volcanic and sedimentary rocks correlative with the informally named 'Monarch volcanics' (van der Heyden, 1990, 1991; Rusmore et al., 2000). Rocks of the Monarch sequence were deposited on Jurassic to Early Cretaceous plutonic rocks. Plutons of probable Jurassic to Tertiary age are most prevalent in the western panel but also comprise

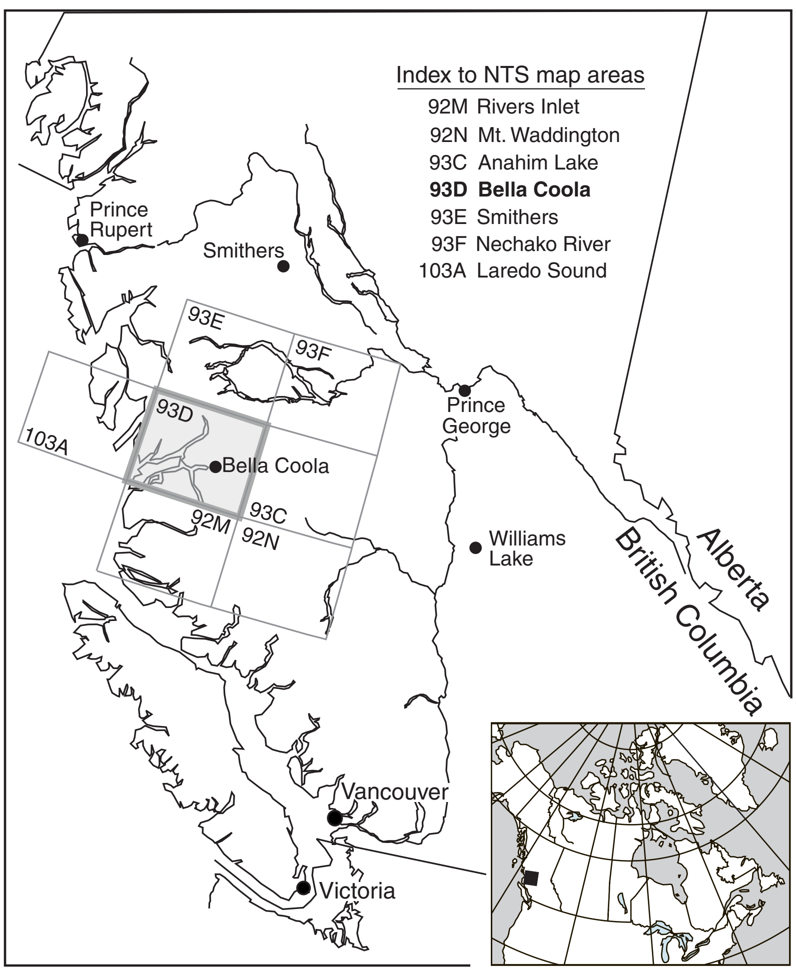

Figure 1.

Location of the eastern Bella Coola Targeted Geoscience Initiative (TGI) Project in the south-central Coast Mountains of British Columbia.

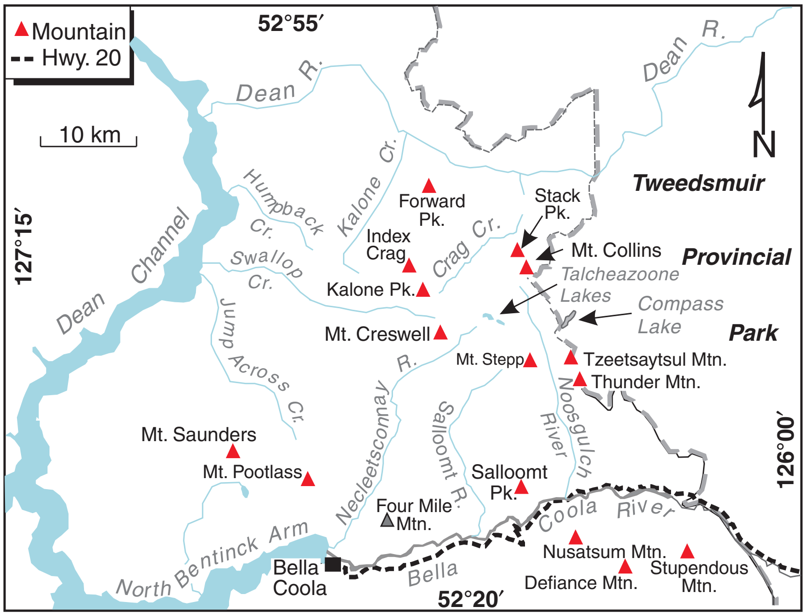

Figure 2.

Northeastern part of Bella Coola map area showing locations of geographical features referred to in the text.

scattered stocks in the eastern panel (Baer, 1973; Fig. 3). Each of these main lithological divisions is described in greater detail in companion papers (Diakow et al., 2002; Hrudey et al., 2002; Struik et al., 2002), and they are briefly summarized below.

Hazelton Group

The Hazelton Group is extensively exposed east of Noosgulch River and Kalone Creek, between Thunder Mountain in the southeast and Forward Mountain in the northwest. Neither the top nor the bottom contacts of the Hazelton succession has been mapped in the eastern Bella Coola area. The Hazelton Group varies in composition along the northwest-trending belt and probably represents coalescing deposits from one or more volcanic centres (Diakow et al., 2002). It is dominated by mafic flows and associated fragmental rocks intercalated with locally significant rhyolite volcanic and associated rhyolite volcanogenic sedimentary rocks (Fig. 3). At Thunder Mountain, basalt and basaltic andesite flows with lesser reworked tuff breccia predominate in a thick, southwest-dipping monocline more than 1300 m thick. A short distance towards the northwest, near Mt. Collins, there is a dramatic lateral change into hundreds of metres of rhyolite mass-flow deposits. Farther northwest, between Stack and Forward peaks, the section is once again dominated by mafic rocks similar to those at the Thunder Mountain section; however, thin intervals of important fossiliferous feldspathic sandstone and tuffaceous mudstone are also present.

Monarch sequence

The informally named Monarch sequence forms a thick succession of andesitic flows, fragmental rocks, volcaniclastic sandstone, tuff, and slate underlying a broad region west of Noosgulch River and Kalone Creek in the east, and Dean Channel in the west (Struik et al., 2002). Olive green dacite to andesite flows and associated breccias and tuff breccias dominate the succession, although intercalated sediments form continuous stratigraphic sections up to several hundred metres in thickness. Stratigraphy within this sequence is complex, complicated by abrupt lateral facies changes and structural deformation. The base of the section is exposed in one locality north of Salloomt Peak, where polymict conglomerate with plutonic and volcanic clasts gradationally overlies a quartz diorite pluton which yields a 134 ±0.3 Ma U-Pb zircon age (van der Heyden, 1991). The contact between the Monarch sequence and the Hazelton Volcanic Group has not been found in the map area.

Jurassic to Tertiary plutonic rocks

The western part of the map area is dominated by Jurassic to Tertiary intermediate plutonic rocks that also form volumetrically significant plutons cutting both the Monarch sequence and the Hazelton Group to the east. These plutons range from very-fine- to medium-grained diorite and microdiorite associated with the Hazelton Group to fine- to coarse-grained, hornblende and pyroxene-bearing quartz diorite, diorite and granodiorite, and hornblende and biotite-bearing granodiorite and tonalite (Hrudey et al., 2002). Medium- to coarse-grained, biotite- and/or muscovite-bearing granite forms massive exfoliated domes in the southern portion of the map area (Fig. 3). Plutons are generally massive, and magmatic and structural foliation are locally evident (Hrudey et al., 2002). Crosscutting relationships in the area are complex, and accurate delineation of the intrusive sequence awaits geochronology results.

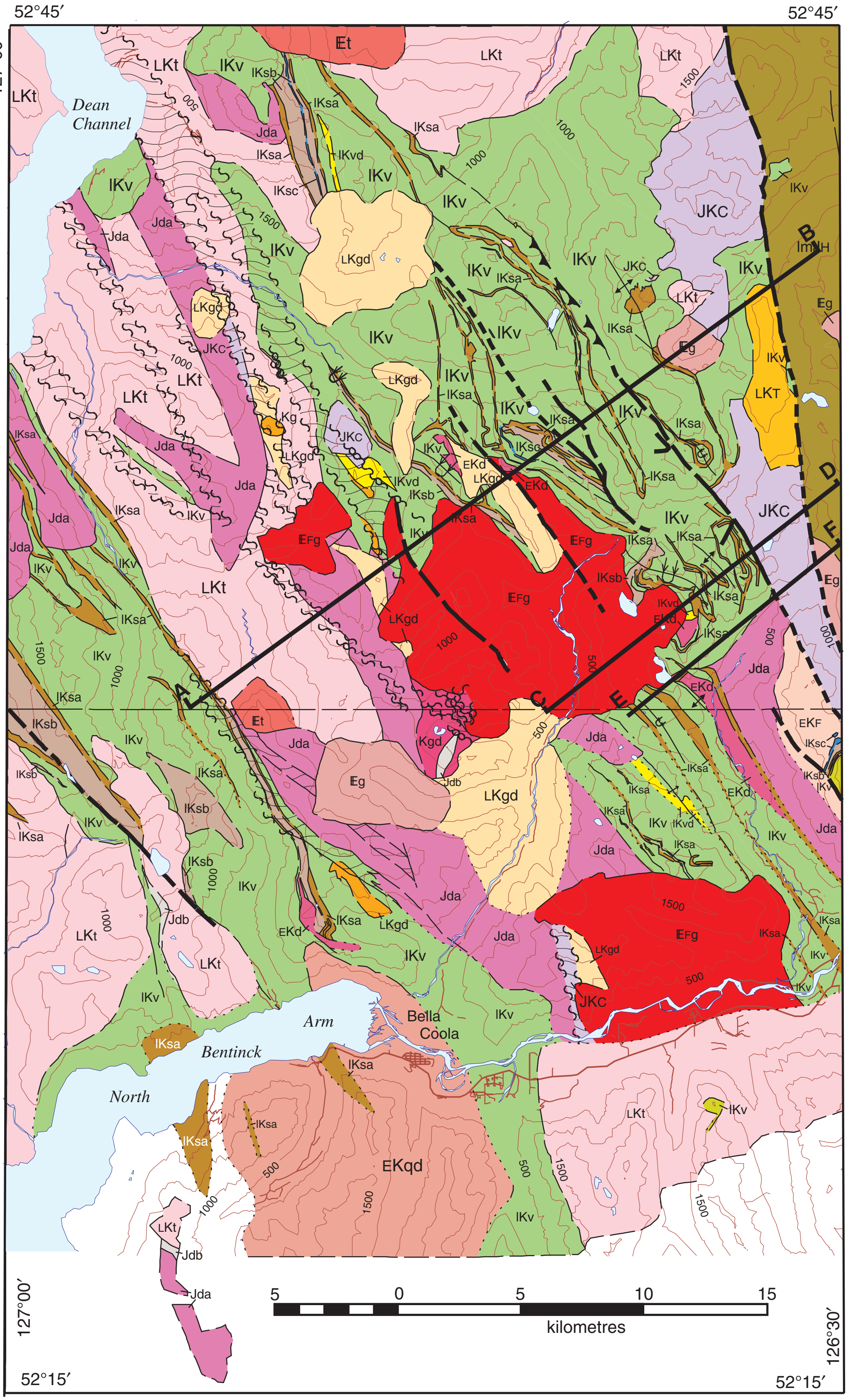

Figure 3. Geological map and legend for NTS map areas 93 D/10 and part of 93 D/07. Contours interval is 500 m. Structure sections are shown in Figure 5.

Legend for Figure 3

STRATIFIED ROCKS

LOWER CRETACEOUS

Monarch sequence (lKva - lKvd)

lKv — *Andesite:* mostly fragmental breccia, lapilli and ash tuff, agglomerate, granule conglomerate, sandstone, and greywacke; pyroclastic rocks are dominated by heterolithic intermediate and locally abundant felsic pyroclasts; some flows, aphanitic to plagioclase±rare augite-phyric, locally calcite-chlorite-quartz-amygdaloidal, flow breccia, dykes, small microdiorite stocks; olive to olive-grey, locally maroon

lKvd — *Rhyolite, dacite:* fine grained tuff, sedimentary rocks

lKsa — *Slate, argillite, siltstone, sandstone:* rusty argillite, laminated siltstone, feldspathic sandstone (arkose), minor granule-pebble conglomerate

lKsb — *Sandstone:* feldspathic arkose, argillite

lKsc — *Conglomerate:* rounded granule to cobble, feldspathic, granitic, and volcanic clasts

MIDDLE JURASSIC

mJH — *Hazelton Group:* andesite, basaltic andesite; massive flows, aphanitic to plagioclase±augite-phyric lava, locally coarsely plagioclase-phyric, locally amygdaloidal, fragmentals, dykes, small microdiorite stocks, flow breccia, minor slate and volcaniclastic rock; olive-grey to dark grey, locally maroon

INTRUSIVE ROCKS

(?) EOCENE

EFg — *Four Mile suite:* granite; biotite and muscovite±garnet; medium grained, equigranular; pink, weathers white

Eg — *Granite, granodiorite:* biotite; medium grained, equigranular; weathers yellow

Et — *Tonalite:* biotite; medium grained; white; sheet jointed

(?) CRETACEOUS

Kgd — *Granodiorite:* biotite, hornblende; medium to fine grained, equigranular; grey

Kg — *Granite and granodiorite:* biotite, hornblende; medium to fine grained, equigranular; grey

(?) LATE CRETACEOUS

LKgd — *Granodiorite:* biotite, hornblende; medium grained, equigranular; light grey

LKt — *Tonalite:* biotite, hornblende; medium to coarse grained, equigranular; grey;llocally sheet jointed

LKT — *Talcheazoone pluton:* quartz diorite: biotite, hornblende, medium grained; white; foliated; pendants of amphibolite

(?) EARLY CRETACEOUS

EKqd — *Quartz diorite:* biotite, hornblende; medium grained, equigranular; grey; sheet jointed; ca. 119 Ma

EKd — *Microdiorite:* hornblende, some gabbro and amphibolite, locally subvolcanic to Monarch sequence andesite; equigranular; light grey to grey

EKF — *Firvale suite:* granodiorite: chlorite-epidote-altered hornblende, rare hornblende-quartz monzonite; medium grained, equigranular; off-white to greenish; ca. 134 Ma

JURASSIC AND (?) CRETACEOUS

JKC — *Crag Creek intrusive complex:* ±pyroxene, hornblende diorite, minor quartz diorite and gabbro invaded by hornblende granodiorite to monzogranite and younger rhyolite, plagioclase-phyric and aphanitic andesite and basalt; subvertical and locally sheeted dykes

(?) JURASSIC

Jda — *Diorite:* hornblende, ±biotite; medium grained, equigranular; foliated

Jdb — *Hornblende diorite, gabbro, hornblendite:* heterogeneous, pegmatitic; medium and coarse grained; locally foliated

STRUCTURAL GEOLOGY

Rocks in the eastern Bella Coola map area have been affected by several distinct deformational events recording episodic extensional, contractional, and transpressional tectonism in the region. The timing of these events is equivocal; the contractional and transpressional events are relatively well constrained by crosscutting relations, whereas the timing of the extensional events is less clear.

Extensional deformation

The widespread occurrence of north-trending basalt to andesite dykes and dyke swarms associated with both the Jurassic Hazelton Group and the Lower Cretaceous Monarch sequence suggests that east-west extensional events may have been an important factor in arc development. A cryptic east-west-directed extensional event associated with the emplacement of voluminous basalt to andesitic volcanic edifices and subvolcanic intrusions of the Jurassic Hazelton Group is inferred on the basis of north-trending sheeted dyke swarms southwest of Thunder Mountain and near Forward Peak. Ray et al. (1998) reported the occurrence of northeast-trending, high-angle faults that appear to have controlled the emplacement of quartz porphyry and andesitic dykes in the Nifty area. Although many of these dykes are oblique to the main north-trending dyke swarms, one of these quartz porphyry dykes yielded a U-Pb zircon age of 164.2 +1.2/-0.9 Ma, indicating Middle Jurassic high-angle faulting (Ray et al., 1998).

A roughly east-west-directed extension event that controlled emplacement of the Lower Cretaceous Monarch sequence is inferred on the basis of widespread, north-trending andesite dykes that cut plutonic rocks that clearly crosscut dioritic intrusions associated with the Hazelton Group. These relationships are best exposed in the Crag Creek intrusive complex, which consists of a complex succession of intrusions that includes an older component of hornblende diorite, gabbro, and hornblendite. These form the country rock to a sequence of dykes that, from old to young, consist of hornblende biotite granodiorite, rhyolite, plagioclase-phyric andesite, and aphanitic andesite. The granodiorite and andesite dykes are very abundant and closely spaced locally, forming sheeted complexes that occupy up to 60% of the exposures (Fig. 4). The dykes are generally 0.2 to 2 m thick and more than 10 to 20 m long. The dykes trend northerly (±30º) and have jigsaw extensional contacts. The andesite dykes resemble the volcanic rocks of the Lower Cretaceous Monarch sequence. Importantly, similar dykes cut the 134 ±0.3 Ma Firvale pluton north of Salloomt Peak, and are interpreted as feeder dykes to the overlying Monarch sequence.

The entire eastern Bella Coola map area is cut by series of high-angle, north-trending brittle faults and fractures that truncate rocks of all ages and exert a strong control on topography. These features form distinctive north-south topographic lineaments that correspond with a rectilinear pattern of drainages in the easternmost part of the map area and are obvious on topographic maps and aerial photographs. These brittle structures locally contain fault gouge and breccia zones. Movement along these structures is typically cryptic, but, where displacement can be demonstrated, movement is down-to-the-east. An example of these structures occurs in the Noosgulch River valley, where plutonic rocks are juxtaposed against the Hazelton Group.

Figure 4. *Andesite sheeted dykes (to the right of the hammer) of the Crag Creek intrusive complex.*

Contractional event

A well developed system of northwest-trending, northeast-vergent folds and some thrust faults is associated with the Monarch sequence in the central portion of the map area. Structures vary from outcrop-scale, close to tight, locally isoclinal, asymmetric to recumbent, shallowly to steeply plunging folds that generally vary from 10 to 50 m in wavelength and 25 to 100 m in amplitude, to map-scale folds with similar geometry displaying wavelengths of hundreds of metres and strike lengths of kilometres (Fig. 5). Axial planar cleavage is well developed in slaty intervals; coarser-grained sedimentary rocks display a sympathetic spaced cleavage. Fold axial planes and associated axial-planar cleavage strike northwest and dip southwest throughout the map area. Vergence direction is uniformly northeast.

Low-angle, brittle shear zones characterized by stacked, anastomosing successions of small reverse faults, associated horses and duplex structures, strong cleavage development, truncated recumbent folds, and offset dykes are locally evident. Measurable offset on any individual thrust fault is small (1–20 m); cumulative displacement on each fault zone is unknown.

Strain partitioning was an important factor during contractional deformation, wherein thin- to thick-bedded volcaniclastic sedimentary rocks accommodated a significant proportion of the strain. Sedimentary successions locally display tight to isoclinal, overturned to recumbent folds, strong cleavage development, and near-bedding-parallel decollement horizons (thrust faults). Thick volcanic sequences, on the other hand, appear relatively unaffected, with structural deformation limited to widely spaced (tens of metres), high-angle, southwest-dipping fractures and (?)reverse faults.

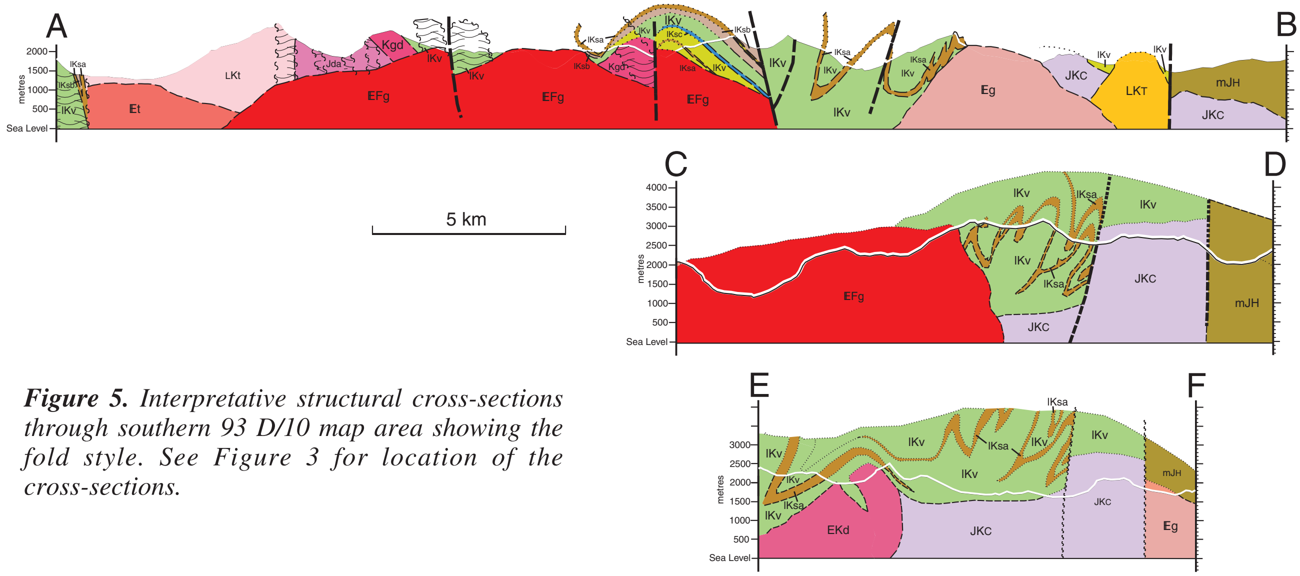

Figure 5. *Interpretative structural cross-sections through southern 93 D/10 map area showing the fold style. See Figure 3 for location of the cross-sections.*

The precise timing of contractional deformation is unclear. Volcaniclastic sedimentary rocks overlying the Firvale pluton, north of Salloomt Peak, contain mesoscopic northeast-vergent folds and minor displacement thrust faults, providing a post-134 Ma lower limit on deformation. The upper age limit on contractional deformation is unconstrained. Several plutons, including the Four Mile two-mica granite, intrude northwest-trending folds, but the age of these bodies is currently uncertain. We infer these plutons to be Eocene or younger, but precise ages await geochronological results. At present, field evidence suggests that contractional deformation is Early Cretaceous to Tertiary.

Regional analysis suggests that the fold and thrust system within the eastern Bella Coola map area is part of the eastern Waddington thrust belt (Rusmore and Woodsworth, 1994; Rusmore et al., 2000). The eastern Waddington thrust system is a northeast-vergent thrust belt that formed along the western margin of Stikinia in the Late Cretaceous (Rusmore and Woodsworth, 1994). The fold and thrust system in the eastern Bella Coola map area is included as part of this system on the basis of similarities in structural style, including northwest-trending folds and thrusts, northeast vergence, and projection along strike. Both systems involve Lower Cretaceous volcanic strata of the Monarch sequence (Rusmore et al., 2000). Timing constraints in the Bella Coola map area are consistent with the Late Cretaceous age of the eastern Waddington thrust belt.

Transpressional event

A series of north- to northwest-trending, high-angle ductile shear zones (Fig. 6), herein referred to as the Jump Across shear zone, are exposed in the western portion of the map area between Four Mile Mountain and the ridges west of Jump Across Creek. These shear zones vary from a few metres in width to over a kilometre wide between Mt. Pootlass and Mt. Saunders. The concentration of the shear zones appears to increase from east to west. Flattening within the shear zones (as measured from deformed pluton enclaves) is moderate to intense, and protomylonite and mylonite are locally abundant. The shear zones contain deformed andesite, tuff breccia, sandstone, siltstone, slate, diorite, granodiorite, and tonalite, and the shear fabric is commonly gradational along shear-zone margins into the undeformed protolith. Shear fabric is defined by attenuated mafic enclaves and fractured, elongate to rotated, plagioclase porphyroclasts, and flattened to smeared biotite and quartz clots. Lineations are only locally well developed, defined by elongate quartz rods and streaked biotite.

On the eastern flank of Mt. Pootlass, foliation within the shear zone strikes about 300º and dips 60 to 75º north. The shear zone consists of protomylonite and mylonite characterized by zones of quartzofeldspathic (tonalitic) gneiss interleaved with 2 to10 cm bands of amphibolite. Amphibolite and meta-andesite increase in abundance to the west, and rusty-weathering, thin- to medium-bedded metasandstone and metasiltstone with bedding-parallel foliation form thick (tens to hundreds of metres) successions within the metavolcanic rocks. Synkinematic magmatism is indicated by metabasalt that locally cuts the gneissic foliation and is locally dismembered within the shear zone. Foliated to non-foliated hornblende diorite to granodiorite sills cut the gneissic fabric and contain xenoliths of amphibolite, but are themselves cut by thin ductile shear zones. Fabrics vary throughout the zones, consisting locally of subhorizontal to steeply plunging lineations and fold axes.

To the northwest, the shear zone on Mt. Saunders strikes approximately 330º, dips about 80ºNE, and consists primarily of medium-grained, equigranular, biotite quartz diorite sheared into plagioclase porphyroclastic protomylonite and mylonite. Slate and siltstone occurs in bands tens of metres thick, and sheared basalt and microdiorite form screens (tens of metres wide) within sheared biotite quartz diorite. Cryptocrystalline bands are centimetres to tens of centimetres thick within the augen quartz diorite to protomylonite with scattered 2 to 3 mm porphyroclasts of plagioclase. Lineations

Figure 6. *Shear fabrics from the Jump Across shear zone.* ***a****) Near-vertical mylonitic fabric in a deformed tonalite, showing rotated plagioclase porphyroclasts and elongate quartz rods. Can tab is 2.5 cm long.* ***b****) Synkinematic rhyolite dyke cutting shear zone on Mt. Pootlass. Gneissic tonalite and amphibolite bands contains subhorizontal stretching lineations. Dyke cuts gneissic tonalite, is folded about steeply plunging fold axes, and is truncated by later stage transpression.* ***c****) Steeply plunging isoclinal fold in andesite dyke and granitoid material; pencil is about 15 cm long.*

have variable trends and plunges, typically subvertical to the west to subhorizontal to the east. Shear-sense indicators are ambiguous, assuming simple shear characteristics. Attenuated mylonitic bands, and attenuated and boudinaged andesite dykes, indicate both left-lateral and right-lateral displacement. Rootless isoclinal folds in sheared dykes, mylonitic fabric, banded microdiorite, and vein quartz augen also indicate both sinistral and dextral displacement.

The age of the shear zone is unknown, but can be inferred to be Early Cretaceous to (?)Tertiary. Andesitic volcanic rocks and volcaniclastic sedimentary rocks within the system are correlated with the Lower Cretaceous Monarch sequence. The main portion of the shear zone between Mt. Pootlass and Mt. Saunders is clearly truncated by different plutonic phases. Near Mt. Saunders, the shear zone is truncated on the east by medium-grained, massive biotite tonalite. On the east flank of Mt. Pootlass, the shear zone is truncated by a medium- to coarse-grained biotite granodiorite. Each of these intrusions are inferred to be Tertiary in age, but precise age control awaits geochronology. Preliminary structural interpretations suggest the Jump Across shear zone records a multi-stage deformational history of complex transpressional flow.

CONCLUSIONS

The structural evolution of eastern Bella Coola map area records several distinct deformational events of probable Jurassic to Tertiary age. The earliest deformational event was a possible east-west extensional event associated with deposition of the Lower to Middle Jurassic Hazelton Group. A similar extensional event, indicated by the presence of polymict volcanic- and plutonic-clast conglomerates and north-trending dyke swarms, accompanied the emplacement of the Lower Cretaceous Monarch sequence. The contact between the Hazelton Group and the Monarch sequence is not exposed, but is inferred to be a depositional contact, based on the presence of a nonconformity between Monarch sequence and the Firvale pluton, a Lower Cretaceous pluton that intrudes the Hazelton Group.

Inferred Late Cretaceous contraction formed a northwest-trending, northeast-vergent fold system with subordinate thrusting. This system is best developed in the interbedded volcanic flows and sedimentary rocks of the Monarch sequence. The contractional event was superseded by development of wide, northwest-trending, steeply dipping ductile shear zones in the western part of the map area. This shear system involves several different phases of (?)Jurassic to Cretaceous plutonic rocks and the Monarch sequence, and is cut by various, possibly Tertiary, plutons. The shear zone records extensive contraction and multi-directional flow. A series of prominent north-trending fractures and brittle faults have resulted in prominent topographic lineaments throughout the map area. The fractures and faults cut rocks of all ages throughout the map area.

ACKNOWLEDGMENTS

The geological mapping skills and observational abilities of Sarah Gordee, April Johnson, Edna Kaiser, Heather Sparks, Sarah White, and Lori Snyder are greatly appreciated. Richard and Pat Lapointe of West Coast Helicopters provided excellent helicopter support for the project, and Kim and Dawn Meiers of Glacierview Resort provided facilities and communications. The University of Wisconsin at Eau Claire Office of University Research provided additional logistical assistance.

REFERENCES

Andronicos, C., Hollister, L.S., Davidson, C., and Chardon, D.
1999: Kinematics and tectonic significance of transpressive structures within the Coast Plutonic Complex, British Columbia; Journal of Structural Geology, v. 21, p. 229–243.

Baer, A.J.
1973: Bella Coola — Laredo Sound map areas; Geological Survey of Canada, Memoir 372, 122 p.

Cowan, D.S., Brandon, M.T., and Garver, J.I.
1997: Geologic tests of hypotheses for large coastwise displacements — A critique illustrated by the Baja British Columbia controversy; American Journal of Science, v. 297, p. 117–173.

Diakow, L.J., Mahoney, J.B., Johnson, A.D., Gleeson, T.G., Hrudey, M.G., and Struik, L.C.
2002: Middle Jurassic stratigraphy hosting VMS mineralization in eastern Bella Coola map area, southwest British Columbia; *in* Geological Fieldwork 2001, (ed.) B. Grant; British Columbia Ministry of Energy and Mines, Paper 2002-1.

Hrudey, M.G., Struik, L.C., Diakow, L.J., Mahoney, J.B., Woodsworth, G.J., Sparks, H.A., Kaiser, E.A., and Gleeson, T.P.
2002: Plutonic rocks of the eastern Bella Coola map area, southwest British Columbia; Geological Survey of Canada, Current Research 2002-A9.

Ray, G.E., Brown, J.A., Friedman, R.M., and Cornelius, S.B.
1998: Geology of the Nifty Zn-Pb-Ba prospect, Bella Coola District, British Columbia; *in* Geological Fieldwork 1997; British Columbia Ministry of Employment and Investment, Paper 1998-1, p. 20-1 to 20-28.

Rusmore, M.E. and Woodsworth, G.J.
1994: Evolution of the eastern Waddington thrust belt and its relation to the mid-Cretaceous Coast Mountains arc, western British Columbia; Tectonics, v. 13, p. 1052–1067.

Rusmore, M.E., Gehrels, G.E., and Woodsworth, G.J.
2001: Southern continuation of the Coast shear zone and Paleocene strain partitioning in British Columbia-southeast Alaska; Geological Society of America Bulletin, v. 113, p. 961–975.

Rusmore, M.E., Woodsworth, G.J., and Gehrels, G.E.
2000: Late Cretaceous evolution of the eastern Coast Mountains, Bella Coola, British Columbia; *in* Tectonics of the Coast Mountains, Southeastern Alaska and British Columbia, (ed.) H.H. Stowell and W.C. McClelland; Geological Society of America Special Paper 343, p. 89–106.

Struik, L.C., Mahoney, J.B., Hrudey, M.G., Diakow, L.J., Woodsworth, G.J.,, Haggart, J.W., Poulton, T.P., Sparks, H.A., and Kaiser, E.A.
2002: Lower Cretaceous stratigraphy and tectonics of eastern Bella Coola map area, southwest British Columbia; Geological Survey of Canada, Current Research 2002-A11.

van der Heyden, P.
1990: Eastern margin of the Coast Belt in west-central British Columbia; *in* Current Research, Part E; Geological Survey of Canada, Paper 90-1E, p. 171–182.
1991: Preliminary U-Pb dates and field observations from the eastern Coast Belt near 52°N, British Columbia; *in* Current Research, Part A; Geological Survey of Canada, Paper 91-1A, p. 79–84.

Geological Survey of Canada Project 000025