Pootlass High-Strain Zone near Bella Coola (NTS 093D/02, 07), West-Central British Columbia: Preliminary Observations

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KEYWORDS: transpression, terrane-boundary tectonics, strain partitioning, sinistral shear zone, Bella Coola, Mount Pootlass

INTRODUCTION

The Pootlass high-strain zone (PHSZ) was first recognized by Mahoney *et al*. (2002) as a part of the Targeted Geoscience Initiative to map the Bella Coola map sheet (NTS 093D) and was referred to as the Jump Across shear zone. The PHSZ lies to the east of the Coast shear zone, a continental-scale zone interpreted to have accommodated significant dextral translation in the late Cretaceous and represents the boundary between the Intermontane and Insular Belts at this latitude (Hollister and Andronicos, 2006). The width, lateral extent, kinematics, timing and tectonic significance of the PHSZ are not well known. This report presents field data collected during the first of two planned field seasons near Bella Coola, BC (Fig 1), and is part of a two-year MSc degree undertaken by the first author. The purpose of this research is to constrain the timing, kinematics, extent and significance of the PHSZ and to place it in a regional geological and tectonic context.

REGIONAL GEOLOGY

The Bella Coola area lies within the Intermontane Belt, close to the boundary with the Insular Belt, which is located just to the west of the field area (Fig 1). Results from a Targeted Geoscience Initiative (Struik *et al*., 2002; Struik and Veljkovic, 2001) divide the Bella Coola map sheet into two northwest-trending parallel belts of island arc volcanic and sedimentary rocks (Haggart *et al*., 2003; Haggart *et al.*, 2006). The eastern belt is mostly early to mid-Jurassic in age and is composed of volcanic and sedimentary rocks belonging to the Hazelton Group (Haggart *et al*., 2004). The western belt, which includes the focus area of this paper, is mostly early to mid-Cretaceous in age and consists predominantly of volcanic and sedimentary rocks of the Monarch assemblage, with some volcanic and sedimentary rocks of the Salloomt assemblage and Hazelton Group (Haggart *et al*., 2004; Struik *et al*., 2002). Obscuring these two panels is a diverse suite of plutonic rocks ranging in age from Jurassic to Eocene (Haggart *et al*., 2004). The volume

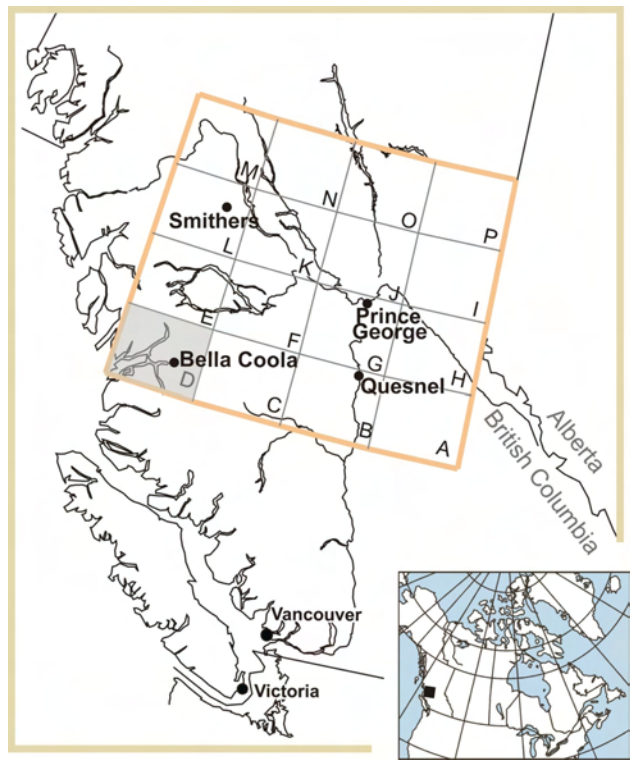

Figure 1. Location map of the field area near Bella Coola, southwestern BC.

of plutonic rock intruding crustal units increases to the west (Haggart *et al*., 2003; Fig 2).

A well-developed system of northeast-trending, northeast-verging folds and some thrust faults occur in the eastern portion of the Bella Coola map sheet (Mahoney *et al.*, 2002). The folds vary in their geometry from close to isoclinal and occur at the outcrop and map scale. Axial planar cleavages are well developed in slaty units. Mahoney *et al*. (2002) correlate this fold system to the Late Cretaceous regional-scale Waddington fold and thrust belt (Rusmore and Woodsworth, 2000). The western part of the Bella Coola map sheet is dominated by high-angle shear zones, the largest of which is the focus of this report.

2006 FIELDWORK PROGRAM

Fieldwork, conducted during July and August 2006, consisted of geological mapping with a focus on structural features associated with the Pootlass high-strain zone. The purpose of the fieldwork was to characterize the geometry and kinematics of the Pootlass high-strain zone, to deter-

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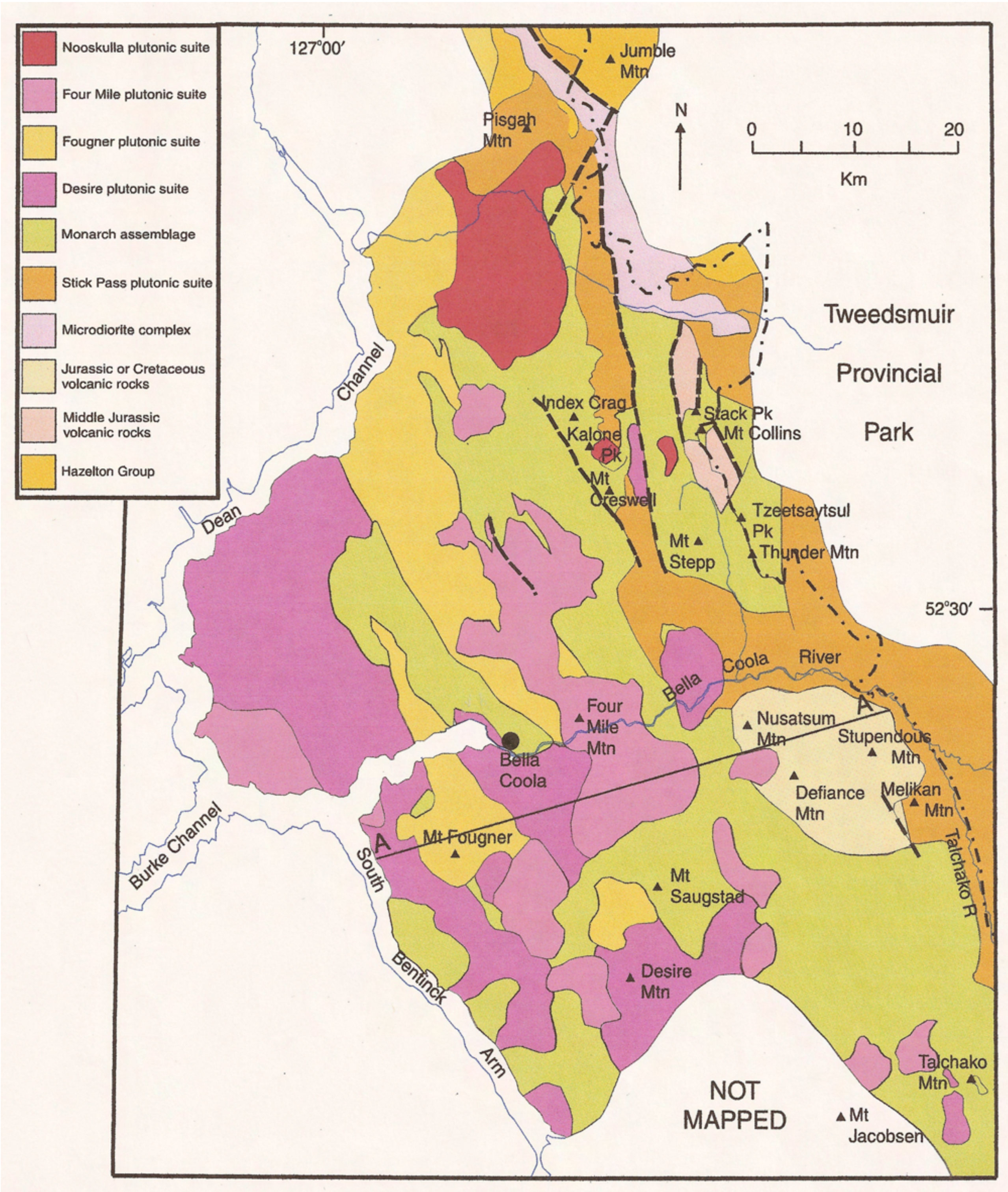

Figure 2. Regional geology of the Bella Coola area, southwestern BC.

mine the distributions of rock types and to determine the extent of deformation within the zone. Three areas of the high-strain zone were mapped at a 1:10 000 scale: Mount Pootlass, Falls Camp and Snootli Peak. The areas were accessed via helicopter out of Bella Coola. Oriented samples were collected for structural analyses, petrology and age dating.

MOUNT POOTLASS

Two ridges leading up to the summit of Mount Pootlass were mapped. The eastern ridge is characterized by strongly foliated and folded, sheeted layers of granodiorite, alternating with foliation-parallel and folded, sheeted mafic layers (Fig 3, 4). The southern ridge is dominated by laminated and strongly folded and sheared metasedimentary rocks, with local intrusions of deformed plutonic rocks (Fig 4).

The peak of Mount Pootlass is composed entirely of plutonic rocks, most of which are deformed granodiorite and diorite with sheeted mafic intrusions. The plutonic rocks on Mount Pootlass are interpreted to be a part of the 119 ±2 Ma Desire plutonic suite (Gehrels and Boghossian, 2000).

Eastern Ridge: Lithology and Structural Features

The granodiorite that characterizes most of the eastern ridge of Mount Pootlass is composed of quartz, feldspar, biotite and hornblende, with sparse fine-grained garnet. Toward the eastern end of the ridge, the granodiorite includes interlayered felsic and mafic layers that are separated by abrupt contacts. Mafic plutonic layers are medium to fine grained, rich in biotite and hornblende and show some evidence of chilled margins. The felsic layers are medium to fine grained and contain predominantly quartz and feldspar. These felsic and mafic layers are foliation-parallel sheeted intrusions with thicknesses ranging from approximately 0.15 to 1.5 m. One relatively small (30 m wide) package of fine-grained, finely laminated metasedimentary rocks interlayered with granodiorite occurs near the middle of the eastern ridge. At the eastern end of the eastern ridge, the PHSZ is truncated by an undeformed, coarse-grained pluton composed of quartz, feldspar, muscovite and biotite, which is interpreted by Haggart *et al*. (2004) as part of the 68 Ma Fougner plutonic suite. At the juncture of the eastern and southern ridges on Mount Pootlass, a small plug of coarse-grained amphibole-rich magnetic gabbro is in intrusive contact with the granodiorite to the east and the metasedimentary rocks to the west.

All rocks of the eastern ridge, excluding the undeformed pluton, exhibit a dominant subvertical foliation striking approximately 300° (Fig 5).

The dominant foliation is compositional, here termed a transposition foliation, F_T (*see* below), with layers defined by alternating mafic (biotite and amphibole) and felsic (quartz and feldspar) minerals. In addition, protomylonite and mylonite fabrics were also identified within the foliation, defined by aligned and elongated biotite, amphibole and feldspar grains, with alignment and elongation being more pronounced and better developed toward the eastern end of the eastern ridge. The predominant foliation exhibits a very slight gradual rotation from north-northwest to north along the eastern ridge.

Figure 3. Looking to the south. Foliated, folded and sheeted granodiorite and felsic and mafic layers; eastern ridge, Mount Pootlass, Bella Coola, southwestern BC.

Mineral lineations are stretching lineations, defined by elongate (rodded) quartz and feldspar grains (Fig 6) in granodiorite, and are well developed near the peak of Mount Pootlass, as well as near the eastern end of the ridge. Mineral lineations trend approximately 140° and plunge very slightly to the south (Fig 7).

The ‘sheeted’ intrusive rocks on the eastern ridge are polydeformed. The most well-developed and dominant folds are upright, isoclinal folds that trend roughly toward 130° and plunge toward the south at approximately 25° (Fig 7, 8). These isoclinal folds are southwest-verging, with subvertical western limbs and steeply eastward-dipping eastern limbs. The isoclinal folds are refolded into Type 3 interference patterns (Ramsay and Huber, 1983), generally associated with progressive deformation and interpreted here as F_1 and F_2 folds (Fig 9).

The axial surfaces of the dominant folds are subparallel to foliation; therefore, the foliation may be a composite of two foliations (S_T). The F_1 and F_2 folds are overprinted by gently undulating folds (F_3) with wavelengths on the order of several metres and near-vertical fold axes with a subvertical axial surface orientation of roughly 215°. In some localities, the F_3 folds are observed folding the limbs and the hinges of the F_T folds.

Abundant boudinage of mafic layers within the granodiorite occurs throughout the eastern ridge and attests a significant component of flattening. The boudinage are formed within the main foliation (S_T) but are deformed by F_3. Quartz and feldspar-rich felsic bands form the neck folds.

On horizontal surfaces, perpendicular to the foliation, ductile shear-sense indicators in the granodiorite provide evidence for both dextral and sinistral senses of movement at the eastern end of the eastern ridge; however, to the west, kinematic indicators show a predominantly sinistral sense of shear. Shear-sense indicators observed consist of dragfolds in quartz and feldspar stringers, brittle-ductile extensional shear bands and asymmetric foliation orientations. Further detailed mapping must be completed at the eastern end of the ridge to produce a more detailed recording of the kinematics.

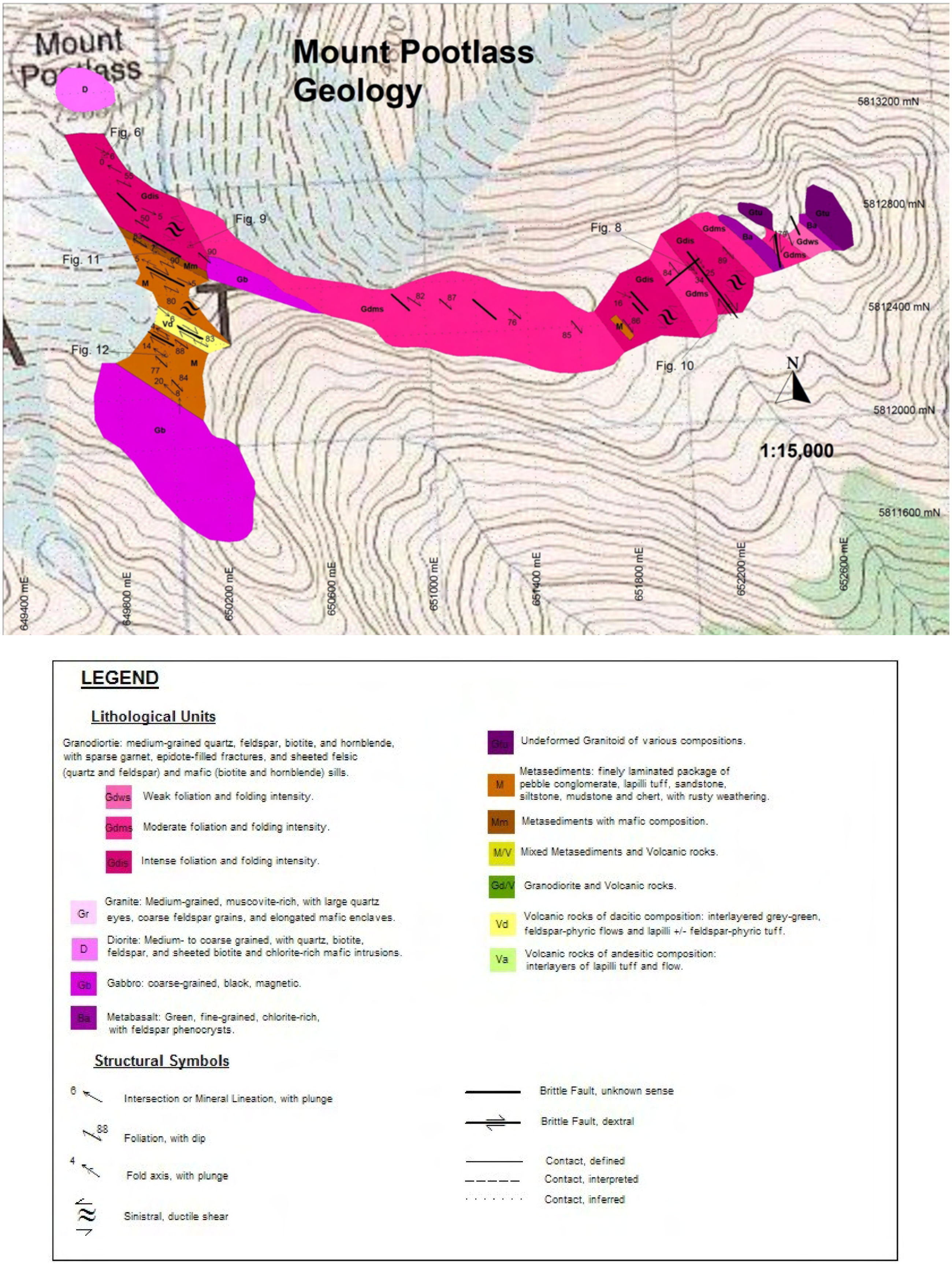

Figure 4. Geology of eastern and southern ridges of Mount Pootlass, Bella Coola, southwestern BC, 1:15 000 scale.

Brittle faults are common and contain dextral fabrics typically associated with light to dark green mafic sills that are composed almost entirely of platy foliated chlorite and often juxtaposed against a very fine grained and competent felsic layer that is composed predominantly of quartz and feldspar with sparse garnet (Fig 10).

The felsic unit has a well-developed foliation defined by bands of slight variation in colour and/or translucency of the rock. Both the mafic chlorite-rich unit and the felsic unit are each generally between 0.1 and 1 m in width. Brittle faults are oriented parallel to the dominant foliation and occur within plutonic and metasedimentary units.

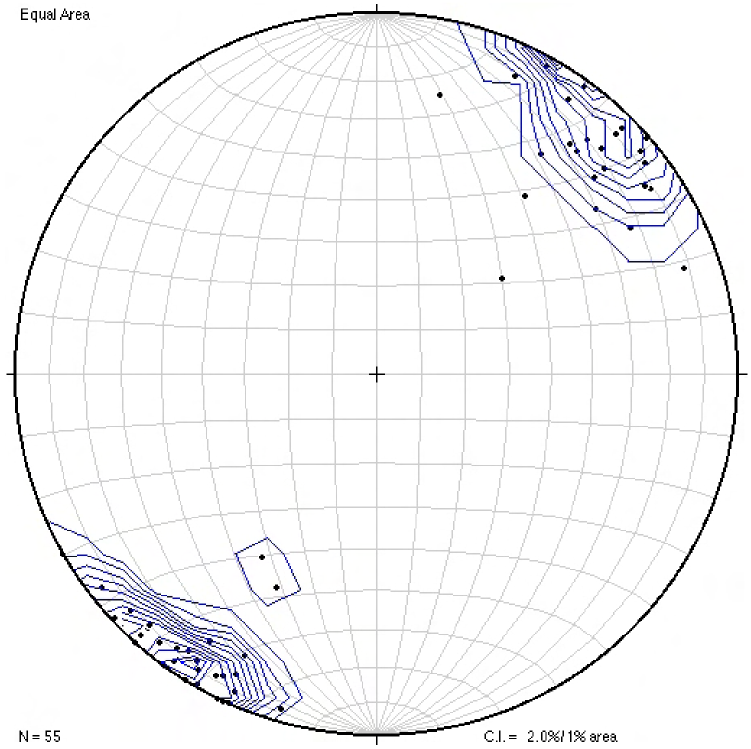

Figure 5. Stereonet diagram showing poles to foliation; Mount Pootlass, Bella Coola, southwestern BC. Abbreviation: C.I., contour interval.

Southern Ridge: Lithology and Structural Features

The southern ridge of Mount Pootlass is dominated by a succession of finely laminated, well-foliated and isoclinally folded metasedimentary rocks, with interlayers of dacitic to andesitic lapilli tuff and flows. The metasedimentary rocks consist of pebble conglomerate, sandstone, siltstone and mudstone as well as more tightly laminated siltstone, mudstone and chert. Garnet is rare in the metasedimentary layers. The metasedimentary package is interlayered with very felsic, fine-grained, highly strained rocks, possibly rhyolite, and with amphibole-rich mafic dikes and sills that are folded with the rest of the sedimentary package.

A large undeformed pluton ranging from diorite to gabbro with abundant enclaves, including two large (10 by 20 m) rotated metasedimentary rafts, is located at the south end of the southern ridge. This pluton is interpreted to be a part of the 119 ±2 Ma Desire plutonic suite (Gehrels and Boghossian, 2000).

The sedimentary package on Mount Pootlass reached a maximum of amphibolite facies metamorphism, as indicated by the abundant hornblende in more mafic rocks. Pelitic rocks are composed mostly of quartz, chlorite, muscovite and garnet and may represent greenschist facies. Detailed petrological analyses will be completed in the coming year.

Toward the peak of Mount Pootlass, the metasedimentary rocks are in sharp contact with the pluton, where many fractures are infilled with epidote. At the contact, the felsic layers in the metasedimentary rocks are abundant and have brittle-ductile dextral dragfolds and fractures, a succession of very tight isoclinal folds and mafic chlorite-rich fault-related material (possibly cataclasite). The granodiorite includes many felsic and mafic sheets near the contact with the metasedimentary rocks, as described for the eastern ridge section above. The peak of Mount Pootlass is composed of a coarse-grained diorite.

The plutonic rocks have a well-developed subvertical foliation striking 310°, which is very similar to that described for the eastern ridge (Fig 5). The foliation is especially well developed, as exhibited by pronounced mineral alignment and elongations, in the granodiorite near the contact with the metasedimentary rocks, as well as in an area 250 to 350 m from the summit. An L-tectonite also occurs

Figure 6. Pen points toward 300°. Elongated (rodded) quartz and feldspar in granodiorite; junction of southern and eastern ridges, Mount Pootlass.

in this zone, as indicated by rodded quartz and feldspar grains and a lack of foliation in the granodiorite (Fig 6), and many mafic layers that display sinistral shearing as indicated by dragfolds in felsic stringers. Near the junction between the eastern and southern ridges of Mount Pootlass, the plutonic rocks exhibit melt injection textures and passive folding and shearing, indicating that the intrusive activity is likely syndeformational (Fig 11).

The bedding of the metasedimentary package is difficult to discern due to the strong foliation. Intersection lineations between bedding and the dominant cleavage foliation (F_T) are widespread, with values averaging a trend of 130° and a subhorizontal plunge (Fig 7).

Metasedimentary and intrusive rocks are isoclinally folded, with axial planes parallel to the dominant foliation. Isoclinal fold axes trend toward approximately 310° and are subhorizontal (Fig 7). Folding on this ridge is similar to the eastern ridge in that fold hinges exhibit refolding along the same trend, indicating progressive refolding, with F_2 folds folding F_1 and with fold axes for F_1 and F_2 being subparallel. Furthermore, a gentle overprinting folding episode (F_3) is also exhibited in the metasedimentary sequence with a subvertical fold axis trending roughly 245°.

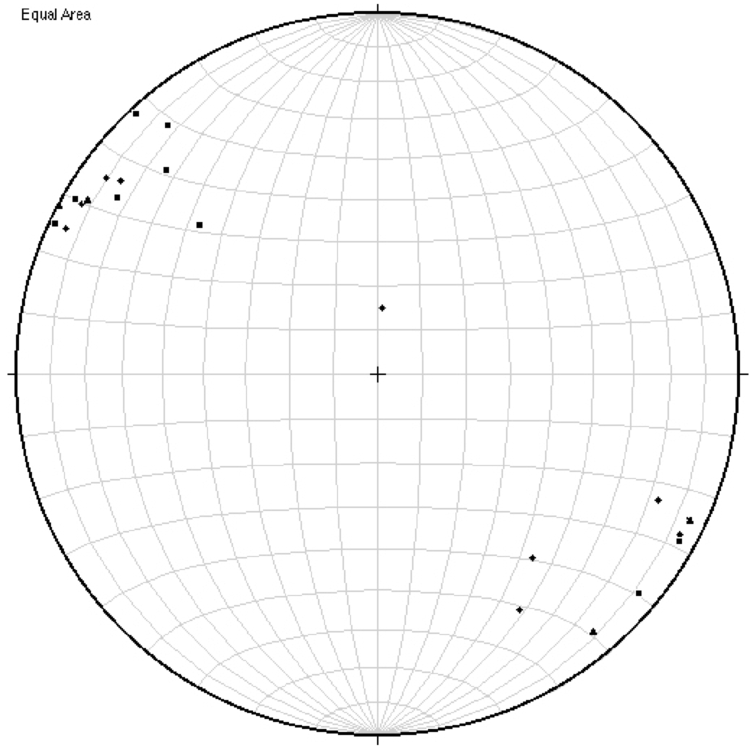

Figure 7. Stereonet diagram showing F_T fold axes (diamonds), intersection lineations (squares) and mineral lineations (triangles); Mount Pootlass, Bella Coola, southwestern BC.

Flattening is indicated by boudinage of the mafic layers within the metasedimentary package and the granodiorite. Boudinage is not as common on the southern ridge of Mount Pootlass as it is on the eastern ridge.

Sinistral ductile shear-sense indicators occur in both the metasedimentary and plutonic rocks. Shear-sense indicators used include 1) metasedimentary rock layers dragfolded in a ductile manner (Fig 12) and 2) felsic stringers elongated oblique to the dominant foliation in mafic, amphibole-rich dikes, similar to those seen at Falls Camp (Fig 17).

Brittle faults are distributed along the southern ridge and up toward the summit of Mount Pootlass. Similar to the eastern ridge, the brittle faults typically occur within mafic layers that are altered to chlorite and adjacent to a fine-grained felsic unit that is composed predominantly of quartz and feldspar with sparse garnet. A dextral strike-slip shear sense is provided by Reidel fault geometries located on the horizontal surface perpendicular to the foliation (Fig 10). The foliation is defined by platy chlorite.

FALLS CAMP

Lithology and Structural Features

The Falls Camp area is characterized by interlayered and laminated metasedimentary rocks and dacitic to andesitic flows and tuff with rare basaltic flows, as well as granodiorite (Fig 13).

Volcanic rocks comprise fine-grained, very competent, grey-green flows and elongated lapilli and/or feldspar-phyric tuff. Recrystallized quartz eyes and feldspar laths occur in some localities. Dacite tuff is composed predominantly of fine-grained quartz and muscovite±amphibole,

Figure 8. Looking north. West-verging, isoclinally folded (F_T) felsic and mafic sheets in granodiorite. Fold width approximately 2 m; eastern ridge, Mount Pootlass, Bella Coola, southwestern BC.

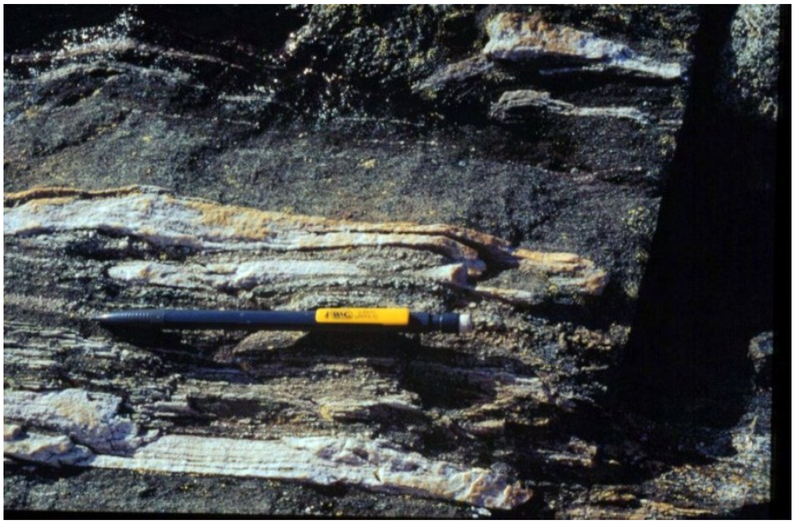

Figure 9. Refolded F_{1-2} fold in granodiorite indicating progressive deformation; eastern ridge, Mount Pootlass, Bella Coola, southwestern BC.

Figure 10. North is to the left. Felsic stringer in a mafic layer of a brittle fault exhibiting dextral shear sense; eastern ridge, Mount Pootlass, Bella Coola, southwestern BC.

biotite and trace to 1% pyrite. Volcanic units are on average moderately foliated, defined by the alignment of mica, feldspar and amphibole, and some are segregated into felsic and mafic bands with layer thicknesses averaging from 5 to 25 cm. Metasedimentary rocks are finely laminated and fissile with a slaty cleavage. The metasedimentary rocks vary in composition and grain size from chert to mudstone and siltstone, with sparse garnet. Layers are mostly dark with rusty weathering and vary in thickness from approximately 1 to 10 cm.

The potential metamorphic grade of the sedimentary package in the Falls Camp area is interpreted as greenschist facies because of the quartz, chlorite, muscovite and sparse garnet assemblage; however, it may reach amphibolite facies, as indicated by abundant hornblende in more mafic rocks.

The granodiorite at the Falls Camp area is characterized by many quartz and biotite stringers and veins. The granodiorite includes felsic and mafic sheeted dikes. Sheeted sills of granodiorite with thicknesses of approximately 0.1 to 1 m occur within the dacitic to andesitic flows and tuff.

An undeformed pluton, interpreted by Haggart *et al.* (2004) as being part of the 63.3 ±0.3 Ma Four Mile plutonic suite (van der Heyden, 2004), occurs at the northeast end of the Falls Camp area, with very coarse grained and equigranular quartz, feldspar and biotite. Felsic sills within the metasedimentary package appear to increase in frequency with proximity to this pluton, and therefore may be related melt injections.

Bedding in the metasedimentary rocks is subparallel with the main foliation. Intersection lineations between bedding and foliation are widespread, trending roughly 315° with a plunge of between 10 and 20° (Fig 14, 15). All rock units in the Falls Camp area, except for the undeformed pluton, exhibit a subvertical dominant foliation striking approximately 330° (Fig 16). This foliation is marked by aligned feldspar, amphibole and mica in the granodiorite and volcanic rocks. In metasedimentary rocks,

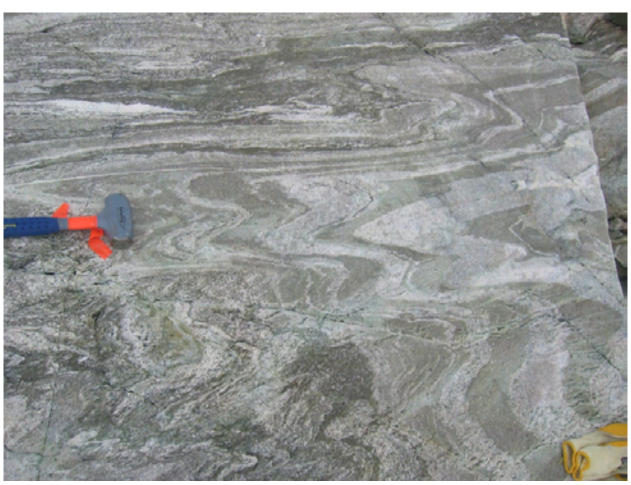

Figure 11. Hammer to the northwest. Passive, high-temperature folding in granodiorite near to junction of southern and eastern ridges; Mount Pootlass, Bella Coola, southwestern BC.

Figure 12. Pen points toward 300°. Sinistral ductile dragfold in metasedimentary rocks; southern ridge, Mount Pootlass, Bella Coola, southwestern BC.

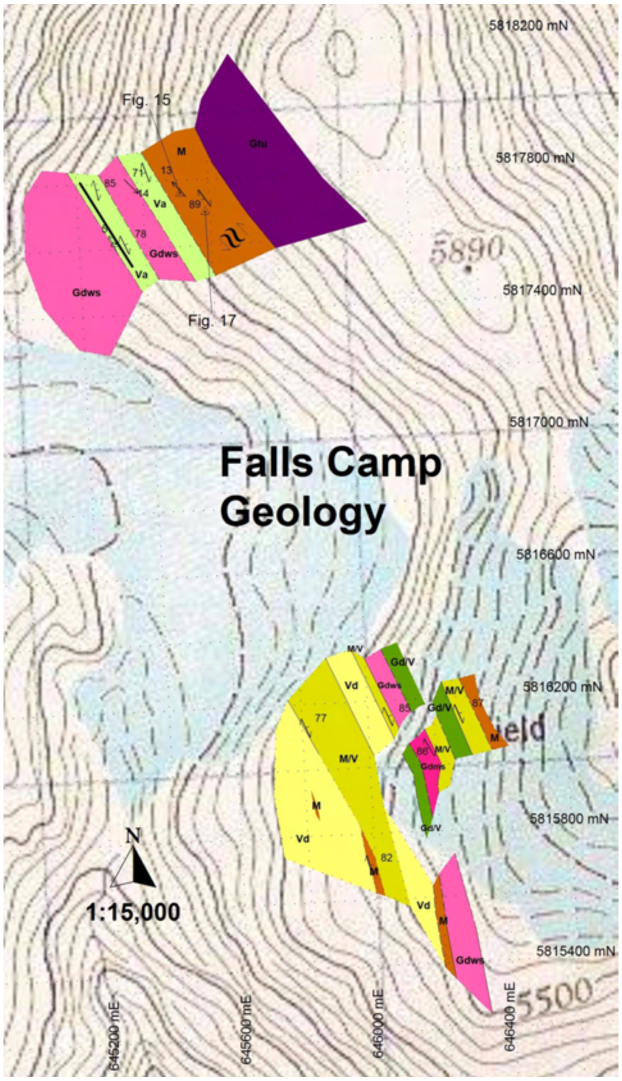

Figure 13. Geology of Falls Camp, Bella Coola, southwestern BC., 1:15 000. *See* Figure 4 for map legend.

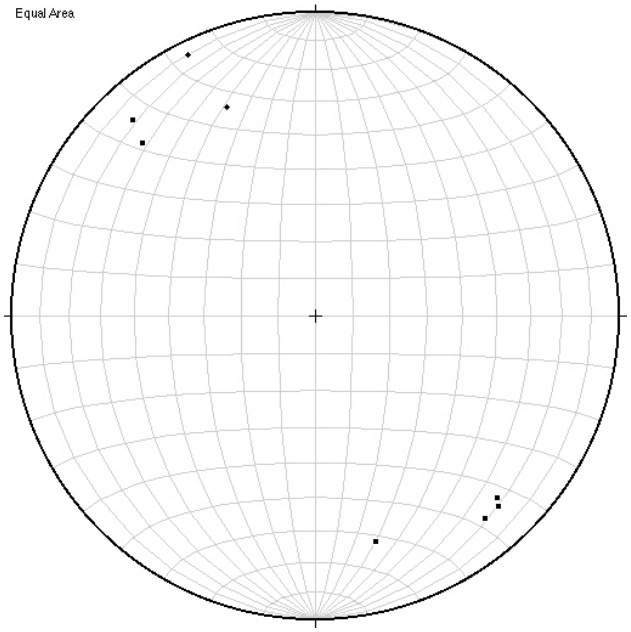

Figure 14. Stereonet diagram showing F_T fold axes (diamonds) and intersection lineations (squares); Falls Camp, Bella Coola, southwestern BC.

the foliation is compositional with laminated layers cleaving along the dominant foliation direction. The foliation is weakly to moderately well developed compared to the foliation on Mount Pootlass. All rocks are also isoclinally folded with subhorizontal fold axes trending 330° (Fig 14).

Folds are southwest-verging, upright and often show brittle extensional fractures in fold hinges, especially in the granodiorite sheets. Gentle, undulating folds overprint the upright folds in metasedimentary rocks, with a subvertical fold axis orientation of roughly 215°. One sheath fold was spotted in the metasedimentary rocks, indicating a very high strain regime. Flattening in the area is indicated by boudinage of the mafic layers in the metasedimentary rocks.

Although folding and cleavage development dominate, there are areas where sinistral shearing is apparent, especially in mafic dikes with felsic minerals elongate on an angle oblique to the dominant foliation (Fig 17). Ductile sinistral shear bands and lapilli with a sinistral sense of shear also occur in volcanic tuff.

There is a roughly 4 m wide, recessively weathered brittle fault in volcanic rocks in the northwest end of the Falls Camp area. The fault is aligned with the dominant foliation (~330°) and the sense of movement is unclear.

SNOOTLI PEAK

Lithology and Structural Features

The Snootli Peak zone includes plutonic rocks ranging from granite to diorite to gabbro, metasedimentary rocks, as well as andesitic and basaltic volcanic rocks (Fig 18). Toward the eastern end of the mapped area, a well-foliated, medium-grained, muscovite-rich granite exhibits large quartz eyes and feldspar grains, some of which are elon-

Figure 15. Arrow points toward approximately 330° and indicates the orientation of the intersection lineation in metasedimentary rocks between bedding and cleavage; Falls Camp, Bella Coola, southwestern BC.

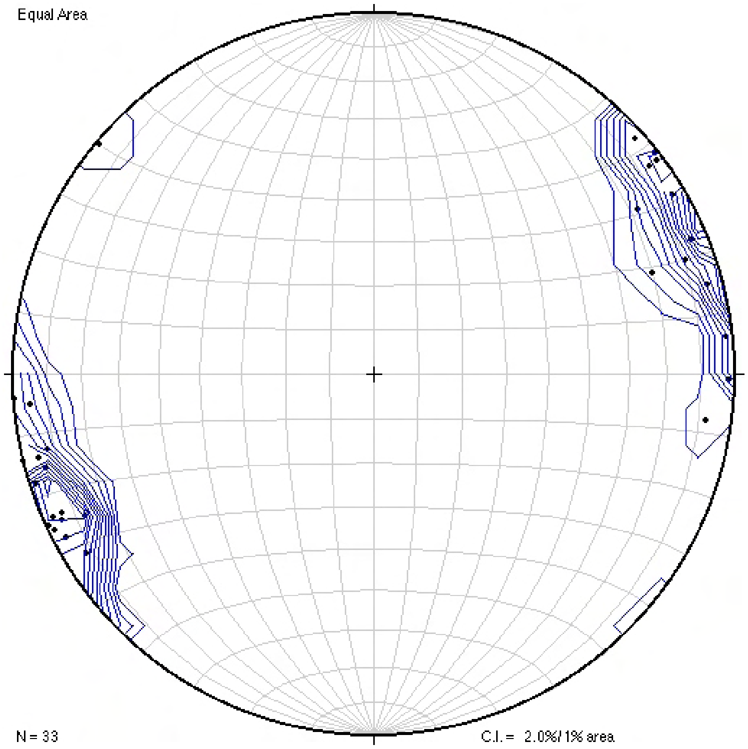

Figure 16. Stereonet diagram showing poles to foliation; Falls Camp, Bella Coola, southwestern BC. Abbreviation: C.I., contour interval.

gated. Mafic enclaves formed predominantly of chlorite are also elongated. Very fine-grained felsic layers (20–30 cm wide) occur within the granite, as well as mafic sills (0.05–1 m thick) composed of green fine-grained chlorite with quartz and feldspar phenocrysts. Mafic sills are commonly boudinaged. Dark grey to black, very coarse to medium-grained, undeformed, magnetic gabbro occurs in two localities with magnetite, epidote and trace to 1% pyrite.

A well-foliated diorite outcrops across a significant proportion of the centre of the mapped area. This unit is composed predominantly of fairly coarse grained biotite, elongated quartz and feldspar with some epidote-rich patches. A fine-grained dark green unit, comprising approximately 10% of the area mapped as diorite, has biotite 'books' and fine, elongated feldspar grains.

Figure 17. Pen points toward approximately 330° along compositional foliation in metasedimentary rocks. Orange pencil indicates felsic stringers in mafic layer that are oblique to the foliation and indicate sinistral shear sense; Falls Camp, Bella Coola, southwestern BC.

Metasedimentary rocks in the Snootli Peak area have a very intense rusty weathering colour and consist of very fine-grained and very finely laminated mudstone and siltstone, with minor pebble conglomerate and lapilli tuff. Amphibole and biotite-rich mafic layers are interspersed throughout the metasedimentary rocks. Toward the western end of the mapped area, the sedimentary rocks are finely laminated and very siliceous, with an abundance of chert along with mudstone, siltstone and pebble conglomerate. The abundance of biotite and chlorite in the metasedimentary rocks indicate that they reached greenschist facies metamorphic conditions.

Most of the volcanic packages observed are andesitic in composition and are composed of lapilli tuff and flows, with thin fine-grained green, mafic interlayers. Volcanic rocks are fractured, leached and pervasively altered, with many randomly oriented quartz stringers near to a faulted contact with a metasedimentary package that occurs near the centre of the mapped area.

Volcanic rocks that outcrop at the eastern end of the mapped area are andesitic to basaltic in composition, with interlayers of lapilli tuff and flows averaging in thickness from 0.02 to 3 m. Many sills and dikes, ranging in composition from aplite to diabase, crosscut the volcanic package. A brittle deformation zone occurs to the east of the mafic volcanic package in a mafic chlorite-rich unit and is very similar to faults described for the Pootlass area. The deformation zone is approximately 5 m wide and extends along the dominant foliation for at least 200 m. Any sense of movement is unclear.

All rock units in the Snootli Peak area exhibit a dominant foliation, striking approximately 340° and dipping between 40 and 70° (Fig 19).

West-verging, upright, tightly spaced, isoclinal folds are common. Fold axes in the central mapped area generally trend toward the south, with southerly plunges ranging from 10 to 30°. However, in the spectacularly folded metasedimentary rocks toward the western end of the mapped area, folds have a northerly trend and plunge approximately 20° toward the north (Fig 20, 21). Fold hinges in the diorite are commonly composed of a fine-grained green mafic unit with biotite 'books' and parasitically folded felsic stringers. Gently undulating F_3 folds are well developed in the metasedimentary rocks (Fig 22). The F_3 fold axes trend toward approximately 060° with a plunge ranging from 70 to 80° (Fig 21).

Bedding in the metasedimentary package is subparallel to the dominant foliation and intersection lineations between the two generally trend toward 150° with southward plunges ranging from 5 to 30° (Fig 21). Toward the western end of the mapped ridge, intersection lineations in the metasedimentary rocks have a northerly trend and a plunge of approximately 5° (Fig 21).

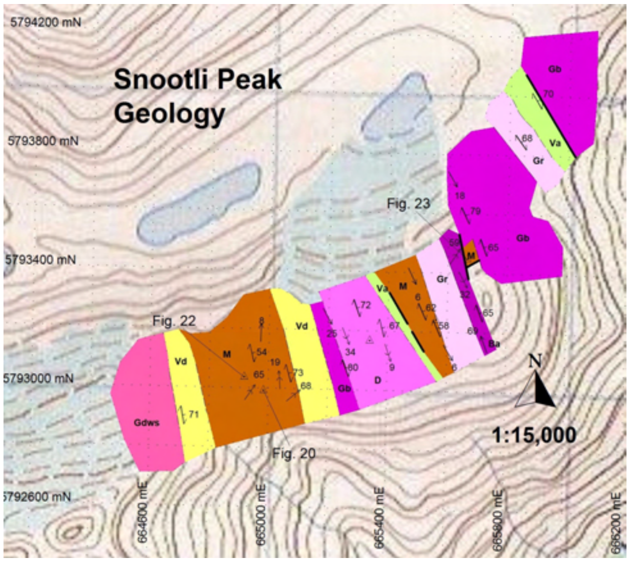

Figure 18. Geology of Snootli Peak, Bella Coola, southwestern BC; scale 1:15 000. *See* Figure 4 for map legend.

Metasedimentary and volcanic rocks include boudinage of mafic layers with wavelengths of approximately 1 m. Flattening is also indicated in metasedimentary rocks by conjugate kink bands (Fig 23).

Macroscopic evidence of ductile shearing is very rare in the Snootli Peak area. One small, ductile sinistrally sheared felsic dragfold in the metasedimentary package was identified, but the area is generally characterized by folding and cleavage development (*i.e.,* flattening).

Brittle faults of unknown movement sense are oriented parallel to the dominant foliation (340°) and occur between metasedimentary packages and volcanic rocks.

DISCUSSION

Metasedimentary rocks at Mount Pootlass, Falls Camp and Snootli Peak are interpreted as part of the same formation due to their lithological similarities and location along strike. At all localities, mudstone, siltstone, sandstone, pebble conglomerate, lapilli tuff and mafic amphibole-rich layers dominate. This sedimentary package corresponds to the description of the Monarch assemblage that outcrops between the Noosgulch River and the Dean Channel, by Mahoney *et al*. (2002): olive green dacite to andesite flows and associated breccia and tuff breccia dominate the succession, with intercalated sedimentary rocks, including volcaniclastic sandstone and slate, forming continuous stratigraphic sections up to several hundred metres in thickness. Mahoney *et al*. (2002) also report that stratigraphy within this sedimentary sequence is complex, complicated by abrupt lateral facies changes and structural deformation, as is seen on the southern ridge of Mount Pootlass. The base of the Monarch assemblage overlies a quartz diorite pluton that yields a 134 ±0.3 Ma U-Pb zircon age (van der Heyden, 1991). Regionally, the Monarch assemblage is interpreted to be Valanginian in age, partially on the basis of sparse ammonites noted by Struik *et al*. (2002).

The Hazelton Group of lower to mid-Jurassic sedimentary and volcanic rocks also has been reported to occur regionally (Haggart *et al*., 2004). This sedimentary package includes massively bedded basalt and basaltic andesite flows intercalated with crudely stratified fragmental rocks such as coarse-grained volcanic lithic arenite, arkosic sandstone, conglomerate, and minor, medium to thick-bedded calcareous sandstone and sandy limestone that are locally rich in fossils — gastropods, bivalves and ammonites (Haggart *et al*., 2003). More work is required, in particular age dating, in order to determine to which formation this package of deformed and metamorphosed sedimentary rocks belongs.

A previous structural analysis of the Bella Coola map sheet has been presented by Mahoney *et al*. (2002), who report several distinct deformational phases recording extension, contraction and transpression. Early east-west extension resulted in the deposition of Hazelton Group and Monarch assemblage volcanic and sedimentary rocks, as well as the injection of north-trending andesite dikes that cut plutonic rocks (Mahoney *et al*., 2002). Contraction in the Bella Coola region formed a northwest-trending, northeast-vergent and shallowly plunging fold system that is best developed in the Monarch assemblage. Folds vary from close to tight, asymmetric to recumbent and are locally isoclinal (Mahoney *et al*., 2002). Fold axial planes strike northwest and dip southwest throughout the eastern Bella Coola map area (Mahoney *et al*., 2002). This folding system is interpreted by Mahoney *et al*. (2002) to be part of the Waddington fold and thrust belt, based on similarities in structural style, including northwest-trending folds and

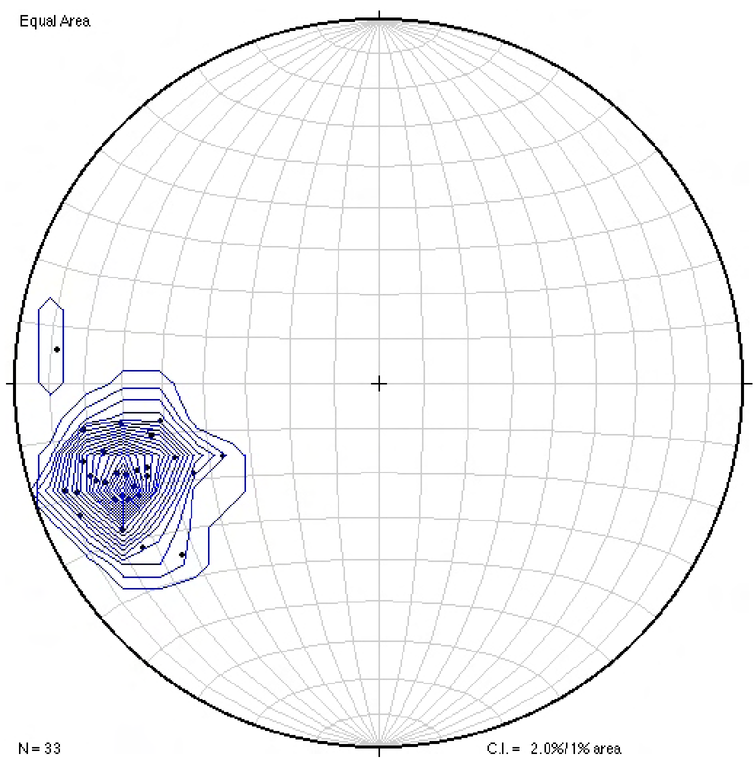

Figure 19. Stereonet diagram showing poles to foliation; Snootli Peak, Bella Coola, southwestern BC. Abbreviation: C.I., contour interval.

Figure 20. Looking north. West-verging F_T fold hinge in metasedimentary rocks at the western end of mapped area; Snootli Peak, Bella Coola, southwestern BC.

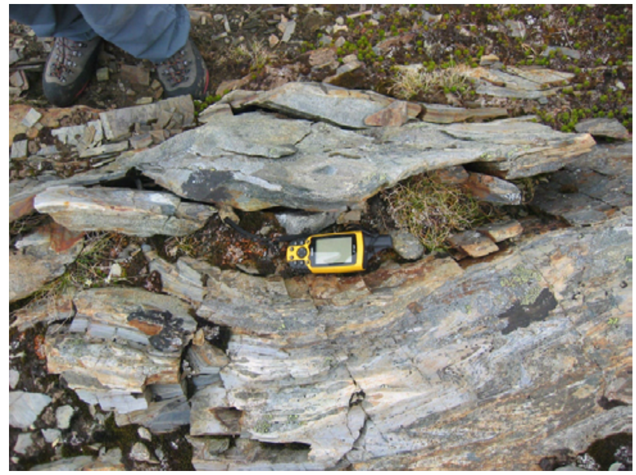

Figure 22. North is to the left. The GPS unit is in the fold hinge of a gentle F_3 fold. Below the GPS unit in outcrop is an F_T fold hinge folded by the F_3 fold; Snootli Peak, Bella Coola, southwestern BC.

thrusts, northeast vergence and projection along strike. Mahoney *et al*. (2002) suggest that field evidence indicates that this episode of contractional deformation is Early Cretaceous to Tertiary in age.

Transpression of the Bella Coola map sheet area is evidenced by northwest-trending, steeply dipping ductile shear zones occurring between Mount Pootlass and Mount Saunders (north of Falls Camp) that involve Jurassic and Cretaceous plutonic rocks and the Monarch assemblage (Mahoney *et al*., 2002). Mahoney *et al*. (2002) describe mineral lineations defined by rodded quartz that indicate significant stretch and moderate to intense flattening is indicated by boudinage of mafic layers in plutonic and metasedimentary rocks on Mount Pootlass, similar to the structure reported here.

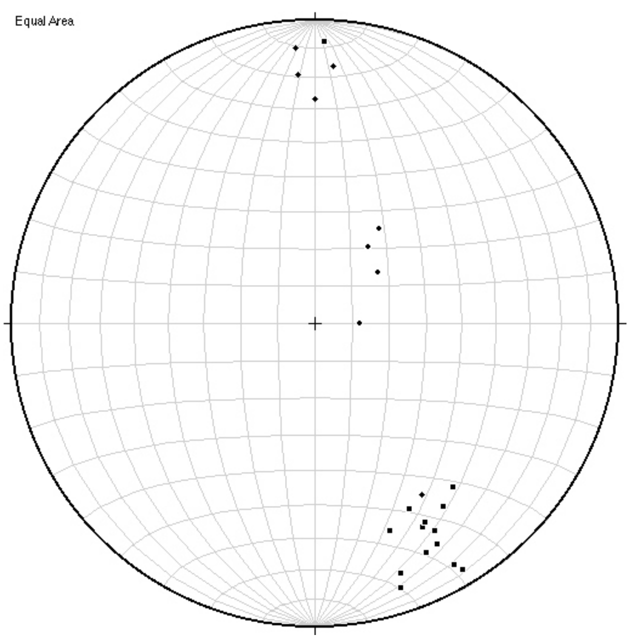

Figure 21. Stereonet diagram showing F_T fold axes (diamonds), F_3 fold axes (circles) and intersection lineations (squares); Snootli Peak, Bella Coola, southwestern BC.

The major folding phase reported in this paper (F_{1-2}) occurs on Mount Pootlass, at Falls Camp and at Snootli Peak, and is characterized by isoclinal west to southwest-verging upright and tightly spaced folds displayed in plutonic, volcanic and metasedimentary rocks. Fold axes of this episode are mostly subhorizontal or slightly southerly plunging. The major folding episode is most evident in intrusive sheets at the eastern end of the eastern Mount Pootlass ridge (Fig 8) and in metasedimentary rocks at the western end of the Snootli Peak area (Fig 20). A west to southwest-verging orientation for this folding episode in the study area presented in this paper contrasts with the northeast-verging direction presented by Mahoney *et al*. (2002). This indicates that whereas the northeast-verging folds described by Mahoney *et al*. (2002) have been attributed to the Waddington thrust belt, the major folding event (F_{1-2}) presented in this paper is likely related to the mid-Cretaceous contraction of the Coast Belt that has been reported to have been accommodated primarily by the development of southwest-verging thrust faults that were active

Figure 23. Pen points to approximately 330° along the dominant foliation in the metasedimentary rocks. Conjugate kink bands indicate flattening. Green pencil trends toward 342°, yellow pencil trends toward 012°; Snootli Peak, Bella Coola, southwestern BC.

between 100 and 91 Ma (Journeay and Friedman, 1993; Umhoefer and Miller, 1996).

High-temperature sinistral shearing is best developed on Mount Pootlass in metasedimentary layers (Fig 12) and many felsic stringers in plutonic rocks. The high intensity of non-coaxial strain on Mount Pootlass may be related to magmatism during deformation that promoted strain softening (*i.e.*, strain localization) in the rocks and led to more intense shearing. The presence of L-tectonite in this area suggests that the rocks were very weak during deformation, which is likely a result of syntectonic magmatism.

High-temperature sinistral shear was also noted in metasedimentary rocks at Falls Camp, whereas the Snootli Peak area shows F_{1-2} and F_3 folds with no structures recording non-coaxial strain. The Snootli Peak area is interpreted as recording pre-shearing structures with no strike-slip overprint and attests to the along-strike variation in the PHSZ.

Sinistral shear in the Taseko Lakes has also been documented by Israel *et al*. (2006), who report brittle and ductile sinistral structures in several fault zones in the Tchaikazan River area. Israel *et al*. (2006) suggest that the major Tchaikazan fault was the locus of significant sinistral displacement prior to its reactivation as part of a Late Cretaceous to Eocene dextral fault system.

Low-temperature, foliation-parallel brittle faults are observed in all three areas and cut through all rock types. Several of these late brittle faults show dextral strike-slip movement. These faults are likely to have formed during a Cretaceous to Eocene dextral strike-slip event that affected the entire southeastern Coast Belt (McLaren, 1990; Schiarizza *et al*., 1997; Andronicos *et al*., 1999). At the east end of the eastern ridge on Mount Pootlass, these faults may represent a dextral brittle reactivation of an earlier localization of sinistral ductile deformation.

FUTURE RESEARCH

In order to constrain the ages of contraction and transpression, Ar-Ar and U-Pb dating will be conducted on folded and sheared felsic and mafic interlayers in the plutonic and metasedimentary rocks. Thin sections will be used for a petrographic analysis of microstructures that may further identify the kinematic sense of shearing. Fieldwork is scheduled for the summer of 2007 that will focus on other along-strike locations of the high-strain zone and involve a more regional component to put the PHSZ into a regional context.

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