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Geological setting of the eastern Bella Coola map area, west-central British Columbia[1]

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Abstract: Jurassic and Cretaceous magmatic-arc volcanic and sedimentary strata are widely distributed across the eastern Bella Coola map area (NTS 93 D) in two northwest-trending outcrop belts. (?)Lower to Middle Jurassic arc rocks, found in the east, are correlative with the youngest part of the Hazelton Group, distributed widely to the north. Lower Cretaceous volcano-sedimentary strata are found west of the principal Jurassic arc rocks and correlate with the Monarch volcanic deposits, widespread to the south. Plutonic suites of (?) Middle Jurassic, Cretaceous, and Tertiary (Paleogene) ages increase volumetrically westward across the map area. Cretaceous plutonic rocks of ca. 122–119 Ma age may be comagmatic with the Monarch assemblage. East-west extension appears to have characterized both Hazelton Group and Monarch magmatism. Northwest-trending, steeply-dipping ductile shear zones in the central and western parts of the study area involve (?)Jurassic and (?)Cretaceous plutons but are cut by intrusions of Tertiary age.

Résumé : Dans la partie est de la région cartographique de Bella Coola (SNRC 93 D), des strates sédimentaires et des roches volcaniques d'arc magmatique du Jurassique et du Crétacé sont largement représentées au sein de deux bandes d'affleurements de direction nord-ouest. Les roches d'arc du Jurassique inférieur(?) et moyen présentes à l'est sont mises en corrélation avec la partie la plus récente du Groupe de Hazelton, une unité largement représentée au nord. Des strates volcanosédimentaires du Crétacé inférieur sont présentes à l'ouest des principales roches d'arc du Jurassique et elles sont mises en corrélation avec les dépôts volcaniques de Monarch, lesquels sont répandus au sud. Le volume des suites plutoniques du Jurassique moyen(?), du Crétacé et du Tertiaire (Paléogène) augmente vers l'ouest à l'intérieur de la région cartographique. Des roches plutoniques du Crétacé (env. 122-119 Ma) sont peut-être comagmatiques des roches volcaniques de l'assemblage de Monarch. Une distension est-ouest semble avoir caractérisé à la fois la mise en place du Groupe de Hazelton et l'activité magmatique de Monarch. Dans les parties centrale et occidentale de la région à l'étude, des zones de cisaillement ductile fortement inclinées de direction nord-ouest traversent des plutons du Jurassique(?) et du Crétacé(?), mais sont recoupées par des intrusions du Tertiaire.

[1] Contribution to the Targeted Geoscience Initiative (TGI) 2000–2003.

INTRODUCTION

The eastern Bella Coola map area (NTS 93 D), in west-central British Columbia, is a rugged region that forms part of the Coast Mountains (Fig. 1) and includes the topographic divide and transition zone between the Coast and Intermontane morphogeological belts. The principal objectives of the Bella Coola Targeted Geoscience Initiative (TGI) are to assess little-known Mesozoic volcanic assemblages in the eastern Bella Coola map area for their massive sulfide (VMS) potential and to improve understanding of the geological evolution of this part of the central coast region. A significant component of the TGI project is a bedrock mapping study, undertaken during 2001–2002, which covers an area greater than 5000 km^2 between the Dean Channel and South Bentinck Arm to the west and the western boundary of Tweedsmuir Provincial Park to the east. This program has been conducted jointly by the Geological Survey of Canada and the British Columbia Geological Survey, in conjunction with the University of Wisconsin-Eau Claire and the University of British Columbia.

This report briefly describes the geology of the eastern Bella Coola map area, based on two years of detailed mapping which concluded in 2002 with completion of the mapping of regions south of the Bella Coola River (93 D/1, 2, 7, 8) and north of the Dean River (93 D/15). Geological results from the first season were presented in a series of reports, including Diakow et al. (2002), Hrudey et al. (2002), Israel and Kennedy (2002), Mahoney et al. (2002), Sparks and Struik (2002), and Struik et al. (2002). Nomenclature presented in this report, particularly in relation to the plutonic rocks, supercedes that utilized in those reports.

GENERAL GEOLOGY

The eastern Bella Coola map area marks the transition from the Coast Plutonic Complex into the Intermontane Belt (Fig. 1). In general, the geology of the study area is dominated by two northwest-trending and parallel belts of volcanic and sedimentary rocks representing Jurassic and Cretaceous island arcs (Fig. 2), elements of the Stikine tectono-stratigraphic terrane of the Intermontane belt. These rocks are intruded by westward-increasing volumes of plutonic rocks, some considered comagmatic with Mesozoic arc assemblages and others forming part of the Coast Plutonic Complex. The Coast Plutonic Complex is cut by the Coast shear zone, a major transpressional structure that may have accommodated significant early Tertiary displacement (Andronicos et al., 1999).

The eastern Bella Coola map area is dominated by three lithostratigraphic successions, including, from east to west: the Jurassic Hazelton Group (Baer, 1965; Diakow et al., 2002); the Lower Cretaceous, informally named, Monarch volcanic rocks (van der Heyden, 1990, 1991; Rusmore et al., 2000; Struik et al., 2002), herein referred to as the Monarch assemblage; and contrasting suites of (?) Middle Jurassic, Early Cretaceous, and Tertiary plutons (Baer, 1973; Hrudey et al., 2002). Additional, (?)areally-restricted volcanic arc rocks of (?)Late Jurassic age may also be present locally within the region. The plutonic rocks are subdivided into a number of plutonic suites, based on textural and compositional characteristics, crosscutting relations, xenoliths, degree of alteration, and weathering character.

(?)Lower and Middle Jurassic Hazelton Group

The oldest known rocks in the eastern Bella Coola region consist of (?)Lower to Middle Jurassic sedimentary and volcanic rocks that correlate regionally with the youngest part of the Hazelton Group. These rocks expand the known distribution of the Early to Middle Jurassic magmatic arc sequence exposed extensively to the north in central Stikine terrane, south-southeast from Whitesail Lake map area (93 E) into northeastern Bella Coola map area. North of the Bella Coola River, exposures of these rocks outcrop intermittently east of the broad belt of Lower Cretaceous (Valanginian, in part) volcano-sedimentary rocks, within a northwest-trending corridor that coincides roughly with the western boundary of Tweedsmuir Provincial Park. Also within this corridor, an unconformable contact between Middle Jurassic and Lower Cretaceous strata, not necessarily as old as the Valanginian stratigraphy farther west, is suspected from consistent field relationships; however, this relationship requires verification from isotopic dating in progress.

Along the northern margin of the Bella Coola map area, centred on Jumble Mountain, nearly continuous Jurassic stratigraphy forms a superbly layered, east-dipping homocline more than 4 km thick. The lower part of this succession is dominated by maroon and green, massively bedded basalt and basaltic andesite flows intercalated with crudely stratified fragmental rocks. Tuff and tuff breccia, which range from dacite to quartz-phyric rhyolite, form volumetrically significant deposits locally near Sakumtha Crag and immediately west of East Sakumtha River. Felsic rocks at these localities have been sampled for uranium-lead zircon geochronology in order to ascertain the age of deposits statigraphically low in the homocline. We speculate that the lower part of this stratigraphic succession passes well down into the Lower Jurassic, possibly into the Pliensbachian.

Upsection of the mafic to intermediate volcanic sequence that forms the distinctly layered western slopes of Jumble Mountain is a thick sedimentary succession, composed of coarse-grained volcanic lithic arenite, arkosic sandstone, and conglomerate. Rhyolitic tuff forms distinctive, light-coloured, weathered interbeds readily evident from a distance. Sedimentary structures within lithic arenite include crude parallel laminae, graded bedding, and rare trough cross-stratification. Minor, medium- to thick-bedded, calcareous sandstone and sandy limestone are locally rich in fossils, containing a diverse assemblage of gastropods, bivalves, and ammonites. The earliest Aalenian ammonite *Troitsaia westermanni* Poulton & Tipper, and the accompanying bivalve assemblage in the middle part of the homoclinal succession, resemble those found at Troitsa Peak, Whitesail Lake area. Farther east, near Sigutlat Lake, stratigraphically higher sedimentary beds contain Early Bajocian stephanoceratid ammonites and the type specimens of *Myophorella dawsoni* (Whiteaves), characteristic of the Smithers Formation in the Whitesail Lake area.

Younger Middle Jurassic volcanic rocks

A unique and comparatively young Middle Jurassic ((?)Bathonian or (?)Callovian) sequence, composed of volcanic and volcaniclastic-epiclastic rocks, outcrops between the Dean and Bella Coola rivers, and is exposed mainly in a small area between Stack Peak, Mount Collins, and Tzeetsaytsul Peak. These rocks are significant for two reasons. Firstly, stratabound-massive- sulphide lenses of volcanogenic origin are associated with silica-bimodal volcanic rocks of this succession at the Nifty property; hence, they are a prospective stratigraphic unit for mineral exploration. Secondly, volcanic rocks of Bathonian-Callovian age are not known anywhere else in Stikinia. They record an eruptive pulse that may either

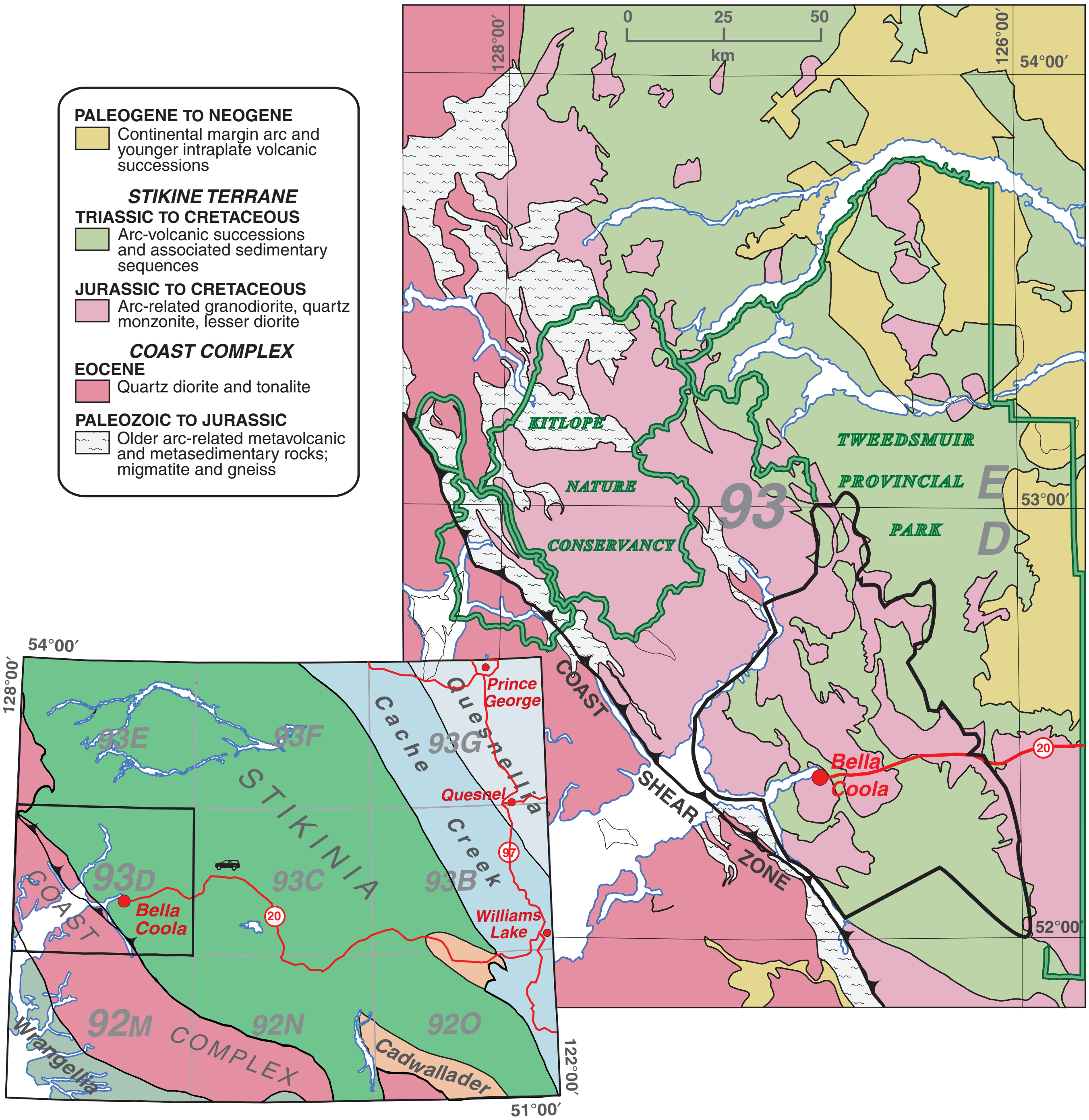

Figure 1. *Location map of the Bella Coola region (NTS 93 D), British Columbia. The black-bordered area within eastern 93 D delimits the region mapped in 2001 and 2002.*

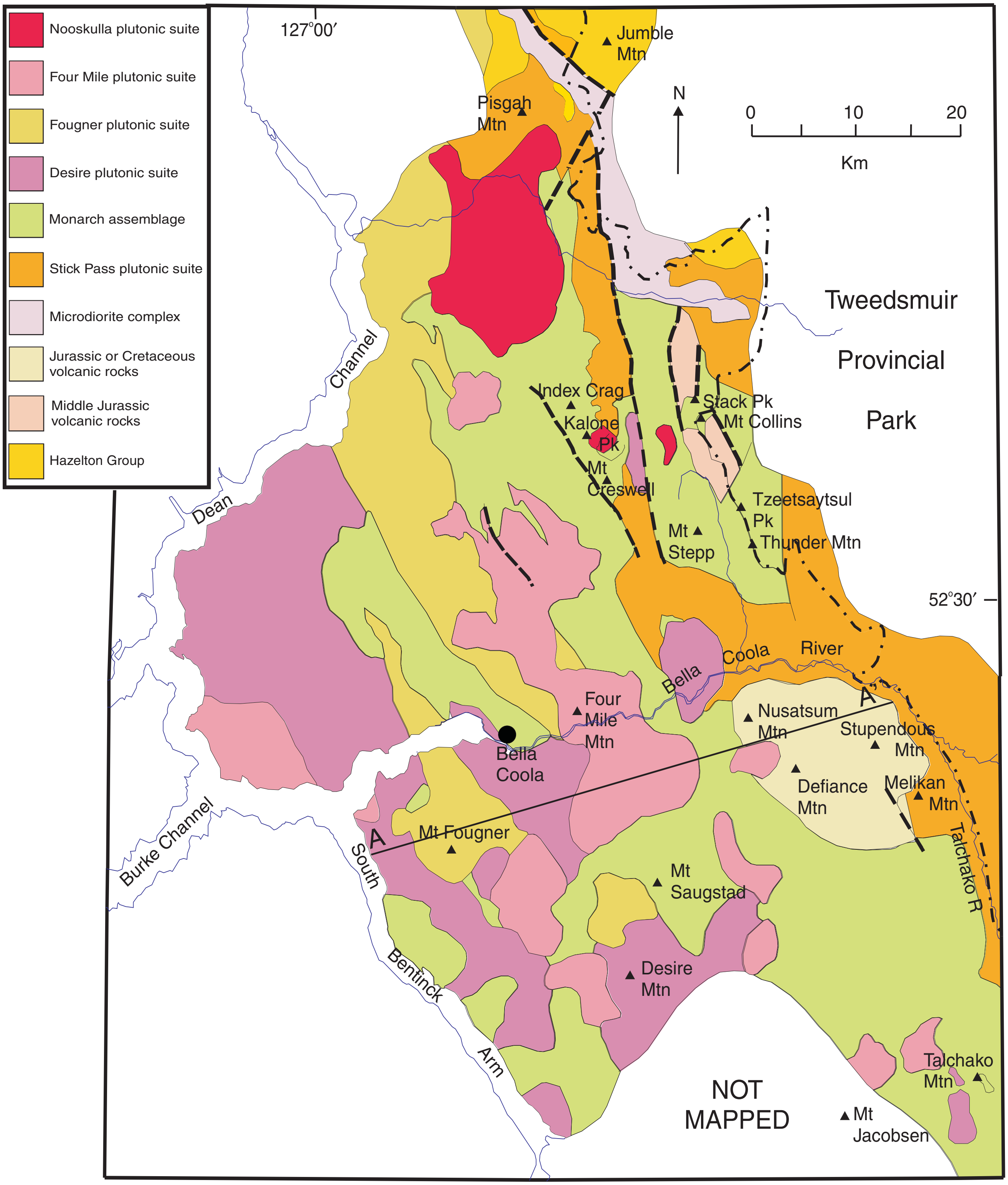

***Figure 2a**. Schematic geological map of the study area.*

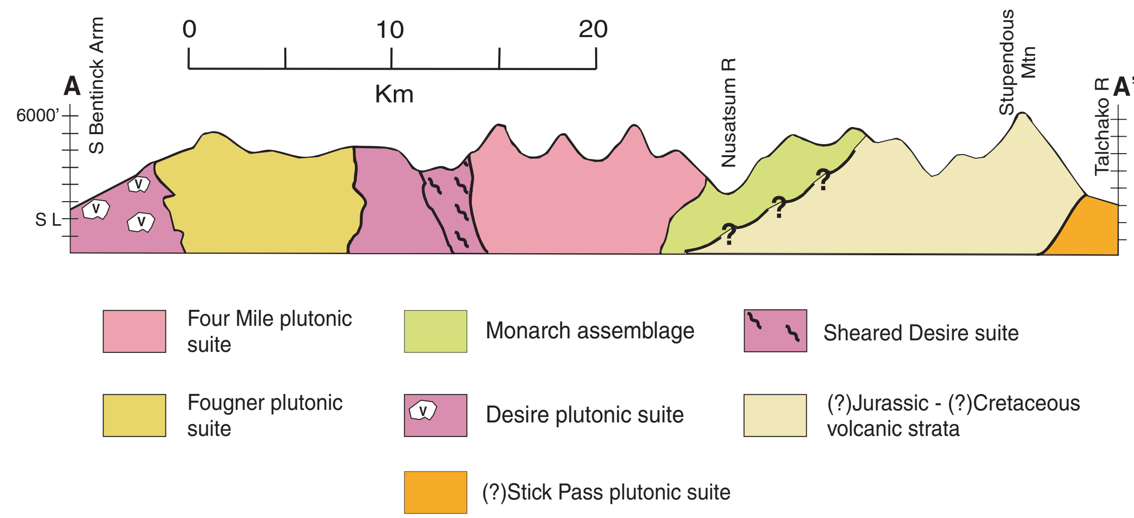

Figure 2b. *Geological cross-section across the study area (*see *location in Fig. 2a). Elevation ticks in 1000' increments; S L = sea level.*

represent the last "gasp" of the Hazelton magmatic arc, or vestiges of a more extensive, but previously unrecognized, volcanic event marking terminal arc magmatism in Stikinia, prior to widespread basinal sedimentation.

The nature of the contact separating Lower Bajocian from (?)Bathonian rocks is unknown in the study area. Aphanitic rhyolitic flows and associated quartz-phyric dykes, as well as basaltic to andesitic volcanic rocks, occupy topographically low terrain east of the headwaters of the Noosgulch River. Felsic country rocks near the Nifty VMS prospect were dated as part of this project, yielding a U-Pb age similar to that previously obtained for a crosscutting dyke (164.2 +1.2/-0.9 Ma; Ray et al., 1998). Farther north, toward Mount Collins, aphanitic rhyolitic volcanic rocks are succeeded upsection by several hundred metres of felsic, volcanic-derived turbidite and volumetrically minor interspersed pyroclastic flows. Welded rhyolites from this sequence yielded a U-Pb zircon date of 164.7 ± 2.0 Ma, indicating rapid aggradation of submarine fan deposits proximal to a contemporaneous subaerial rhyolite volcanic centre. Locally, near Mount Collins, more than 500 m of massive, parallel-bedded, dark grey to black siltstone, sandstone and subordinate grit beds represent a deeper water, more distal sedimentary facies. Still farther north, near Stack Peak and between Stack Peak and the Dean River, laminated black mudstone and siltstone, alternating with distinctive white ash-tuff layers and sparse arkosic sandstone interbeds, dominate a moderately deep-water, in part possibly turbiditic, facies. Belemnoids occur throughout all sedimentary facies, but are particularly abundant in darker, more organic-rich siltstone beds, in places accompanied in sparse limy beds and lenses by rare bivalves and ammonites. Rare and poorly preserved ammonite fragments from a limestone lens in black siltstone (GSC Loc. C-306159) are not positively identified, but resemble Middle Bathonian to Middle Callovian *Cadoceras* or *Lilloetia*. In its probable age, general lithology, and abundance of belemnites, this unit resembles the southernmost lower Bowser Lake Group facies of central Whitesail Lake map area.

(?) Middle-Upper Jurassic or (?) Lower Cretaceous volcanic rocks

The (?)Bathonian strata are unconformably overlain by a massive volcanic sequence dominated by basaltic lava flows, associated primary and reworked autoclastic breccia, and fragmental deposits. Basaltic flows are dark green to purplish and locally amygdaloidal, and include aphanitic as well as medium-grained plagioclase-phyric varieties. Rounded to irregular amygdales are filled with quartz and chlorite. Rhyolite tuff and less abundant flows occupy widely separated intervals tens of metres thick within the mafic sequence. This succession forms the distinctive 'crudely layered' precipitous topography at Stack Peak, Mount Collins, and the Tzeetsaytsul-Thunder massif and, south of the Bella Coola valley, in the rugged peaks of Nusatsum, Defiance and Stupendous. It is estimated to be in excess of 1300 m thick south of the Bella Coola River valley, thinning gradually northward to its apparent terminus immediately south of the Dean River valley.

The unconformity with underlying (?)Bathonian strata is marked by either volcanic boulder conglomerate, such as is exposed in the headwall of a southeast-facing cirque at Mount Collins, or a sequence of pyroxene-bearing sandstone found nearby to the south-southwest. The conglomerate is composed of oxidized reddish basaltic clasts, characterized by a 'crowded' porphyritic texture imparted by 1 to 3 mm plagioclase crystals, with or without pyroxene. It is monomictic and clast-supported, composed of well rounded clasts as much as 2 m in diameter. Locally, volcanic sandstone, siltstone and red mudstone within the conglomerate form variegated red and green, parallel-bedded intervals up to 50 m thick. These fine-grained clastic rocks commonly contain angular pyroxene and plagioclase grains, presumably derived locally from basaltic tuff or flow units related to the overlying basaltic sequence.

On the north flank of Tzeetsaytsul Peak, the basaltic sequence rests on monomictic volcanic boulder conglomerate, which in turn unconformably overlies a dacite flow dome. A Middle Jurassic U-Pb zircon date of 171.6 ± 2.3 Ma from this dome (R.M Friedman, unpub. data, 2002) provides a maximum age for the basaltic sequence. Another U-Pb date, on zircons from welded rhyolite collected high in the basaltic succession exposed at Tzeetsaytsul Peak, provided an inconclusive 113 Ma minimum age (R.M Friedman, unpub. data, 2002). However, rhyolitic rocks, composed of lapilli tuff and some quartz-phyric flows, and interlayered with volcanic conglomerate typically found in the lowermost part of this unit elsewhere, also outcrop along a ridge trending north from Mount Stepp, approximately 5 km west of Tzeetsaytsul Peak. Quartz- rhyolite lava flows from this section have been sampled for U-Pb zircon geochronology. If an Early Cretaceous age is reproduced, broadly in agreement with that derived from the Tzeetsaytsul Peak section, this bimodal volcanic sequence could then be correlated with the informal Monarch assemblage. However, the sequence is lithologically distinct from, and perhaps somewhat younger than, Monarch stratigraphy of known Valanginian age which outcrops farther to the west. Alternatively, this succession could conceivably be Middle to Late Jurassic in age, part of the little-known and poorly exposed (?)Bathonian stratigraphy documented during this project, or correlative perhaps with the Oxfordian Hotnarko volcanics recognized by van der Heyden (1991) in the Anahim Lake map area (93 C).

Microdiorite-basalt intrusive-extrusive complex

A belt of undivided mafic rocks mapped primarily as microdiorite is situated in the easternmost part of the study area, between Sea Lion Peak and the eastern Dean River area. It is difficult to establish an intrusive hypabyssal versus extrusive origin for these rocks, due to their characteristic fine-grained, felty appearance, as well as to the absence of significant textural variations and associated bedded rocks. Exposures are typically dark green and massive, and most commonly exhibit minute plagioclase laths and anhedral intercrystalline mafic grains. Medium-grained hornblende diorite, cut by a north-south set of basaltic dykes forming Sakumtha Crag, extends to the northwest across the East Sakumtha River and is also included within this unit. Similar, smaller bodies of medium-grained diorite occur elsewhere in (?)gradational contact with more widespread microdiorite. Near Mount Bernhardt, microdiorite is cut locally by prominent northwest-trending dykes of white-weathered aphanitic felsite and chloritized hornblende-biotite granodiorite. The granodiorite dykes closely resemble the rocks composing the Stick Pass plutonic suite.

Immediately north of Sea Lion Peak, a rare and distinctive white quartz-phyric rhyolite underlies a thick sequence of aphanitic mafic rocks, interpreted as basaltic flows. Within this sequence, about 25 m of massive rhyolite, containing potassium feldspar megacrysts and abundant phenocrysts of quartz and biotite, is directly overlain by block-lapilli tuff that contains fragments of the underlying rhyolite. The quartz-rich rhyolite flow has been collected for isotopic dating to provide a maximum age for the mafic rocks. A Late Jurassic age is possible for the succession, assuming that crosscutting granodiorite dykes are in fact part of the Early Cretaceous Stick Pass suite.

Stick Pass plutonic suite

Microdiorite and volcanogenic strata, probably of Jurassic age, are intruded by a suite of medium-grained equigranular biotite±hornblende granodiorite to diorite, referred to as the Stick Pass suite after exposures on Stick Pass Mountain. The suite appears restricted to the eastern portion of the map area, between Pisgah Mountain and Melikan Mountain. It is characterized by extensively chloritized biotite and hornblende, saussuritized plagioclase, and dark pink, interstitial and phenocrystic potassium feldspar. The mineralogy and characteristic alteration result in a mottled green and pink coloration, with distinctly green-tinted plagioclase, mottled green mafic minerals and dark pink potassium feldspar. Quartz and epidote veining are common. The suite contains abundant xenoliths of microdiorite, and is cut by numerous basaltic and microdiorite dykes. North of the Bella Coola valley and east of Noosgulch River, a swarm of north-trending microdiorite dykes cutting older granodiorite accounts for up to 70 percent of exposure. The mafic dykes exhibit chilled margins, grading inward into porphyritic to sparsely amygdaloidal textures.

The Stick Pass suite intrudes microdiorite and associated rocks of probable Jurassic age, and is nonconformably overlain by basal conglomerate of the Lower Cretaceous Monarch assemblage. The Stick Pass suite includes the Firvale pluton of van der Heyden (1991), which yielded a U-Pb age of ca. 134 Ma.

Monarch volcano-sedimentary assemblage

A thick succession of andesitic flows, fragmental rocks, volcaniclastic sandstone, tuff, and argillite forms a northwest-trending panel between Noosgulch River/Kalone Creek and Christenson Creek/Jump Across Creek (Struik et al., 2002). This succession is herein referred to as the Monarch assemblage. It is dominated by olive-green flows ranging from amygdaloidal dacite to basaltic andesite, as well as by associated breccia and tuff breccia, and contains intercalated argillite, siltstone and volcanic lithic sandstone that form locally continuous stratigraphic sections up to 2.5 km thick. Stratigraphy within this sequence is complex, a result of abrupt lateral facies changes complicated by structural deformation. The Monarch assemblage nonconformably overlies the Stick Pass suite, and appears to overlie Jurassic volcanic and volcaniclastic strata, although the contact is locally sheared or faulted. The basal contact is exposed in several areas, including, from north to south:

1. South of Stick Pass Mountain. The base of the section here consists of polymictic boulder conglomerate nonconformably overlying granodiorite of the Stick Pass suite. The conglomerate contains boulder-sized clasts of altered biotite granodiorite identical to the underlying pluton, and is overlain by a succession of sandy limestone, lapilli tuff, tuff breccia, volcanogenic sandstone, and thick amygdaloidal flows.
2. Necleetsconnay headwaters. At this locale, a thick succession of highly cleaved argillite overlies a leucocratic granodiorite that yielded a U-Pb age indicating Early Cretaceous intrusion. The granodiorite and overlying argillite are intruded by numerous (?)basaltic dykes. The contact is interpreted as a sheared nonconformity.
3. North of Salloomt Peak. Polymictic plutonic and volcanic conglomerate overlies a quartz diorite pluton which yielded a 134 ± 0.3 Ma U-Pb zircon age (van der Heyden, 1991). Plutonic debris is identical to the subjacent pluton, and is overlain by thin- to medium-bedded feldspathic sandstone and argillite, which in turn are overlain by a thick succession of amygdaloidal andesite flows.
4. East of Mount Ratcliff. Boulder conglomerate at this locality, just southeast of the map area, nonconformably overlies an altered granodiorite pluton that yielded a U-Pb age of ca. 155 Ma (P. van der Heyden, pers. comm., 2002), and contains clasts lithologically identical to the subjacent pluton. The conglomerate is overlain by a very thick succession (>3 km) of massive, featureless basalt flows and minor interbedded volcaniclastic sedimentary rocks.

A section of the Monarch assemblage exposed near Mount Creswell (93 D/10) was identified in 2001 and described by Sparks and Struik (2002). This section consists of approximately 1000 m of aphanitic andesite and crystal tuff, with interstratified argillite in its uppermost part. The section lacks fossil control but is correlated with fossiliferous rocks of the Monarch assemblage based on lithologic content and structural relationships.

A second section of Monarch assemblage strata was identified in 2002, west of Kalone Peak and Index Crag and approximately 8 km northwest of the Mount Creswell section. There, a continuous, eastward-dipping section of Monarch assemblage strata aggregates approximately 2500 m in total thickness. The lower half of this section consists almost exclusively of fine-grained basaltic andesite flow rocks, with very rare sedimentary intercalations. In contrast, the upper half includes similar andesite flow rocks, but with substantial amounts of interstratified fine- to coarse-grained volcaniclithic sandstone, rich in feldspar. The uppermost 500 m of the section consist almost entirely of this sandstone, which shows grading, convolute laminations, shale rip-up clasts, flame structures, and fossilized wood and plant fragments. The sandstone likely represents proximal facies in a fan-delta system adjacent to the active arc.

Black argillite beds up to 15 m thick are interstratified with sandstone in the upper part of the section west of Kalone Peak; several thicker beds are found at the base of the upper half of the section, and at least 10 distinct argillite units were identified interstratified with the sandstone at the top of the section. The stratigraphically highest argillite is succeeded by approximately 100 m of amygdaloidal pillow basalt.

Regionally, the Monarch assemblage is interpreted to be Valanginian in age, partly on the basis of sparse ammonite collections made in 2001 from several localities (Struik et al., 2002). One argillite bed near the top of the section west of Kalone Peak, studied in 2002, also yielded Valanginian fossils. These biostratigraphic data are the only firm age control at present for the Monarch assemblage, which is distributed over a wide region. If the volcanic strata on Tzeetsaytsul Peak are also included within the Monarch assemblage (see discussion above), the preliminary U-Pb date from that succession suggests that the Monarch assemblage may contain strata possibly as young as Aptian.

Desire plutonic suite

Metavolcanic rocks interpreted to belong to the Monarch assemblage are intruded in several localities by a heterogeneous, diorite to granodiorite intrusive complex referred to as the Desire suite, from exposures on the eastern flank of Desire Mountain. The suite is extensively exposed south and east of Desire Mountain and west of Clayton Falls Creek from Howe Lake to the southern end of the map area. It is texturally and compositionally diverse, ranging from a fine- to medium-grained hornblende diorite/quartz diorite to a medium- to coarse-grained biotite hornblende granodiorite. The suite is characterized by an abundance of elongate metavolcanic panels and pendants and mafic, commonly amphibolitic, xenoliths. Magmatic and tectonic foliation is common. Internal crosscutting relationships within the suite are complex: metavolcanic pendants are intruded by hornblende diorite cut by hornblende quartz diorite, which is cut by dykes of hornblende granodiorite to tonalite, in turn cut by quartz-eye rhyolite. Rocks assigned to the Desire suite have previously yielded a U-Pb age of 119 ± 2 Ma (Gehrels and Boghossian, 2000). The close association between the Monarch assemblage and the Desire suite suggests that the Desire suite may represent the comagmatic roots of the Monarch assemblage.

Fougner plutonic suite

The Fougner suite is a distinctive, homogeneous hornblende biotite tonalite to granodiorite that is extensively exposed throughout the western portion of the map area, west of Thorsen Creek and the Necleetsconnay River. The suite is named for excellent exposures on Mount Fougner, at the head of Clayton Falls Creek. The Fougner suite is characterized by very fresh, medium- to coarse-grained, equigranular 'salt and pepper' hornblende-biotite tonalite to granodiorite that contains minor (1–2%) yet conspicuous honey-brown sphene. Xenoliths are rare, although mafic enclaves are found near pluton margins. Massive exposures display prominent exfoliation joint sets.

The Fougner suite is locally cut by high-angle ductile shear zones. Apparent flattening within the shear zones is moderate to intense, evidenced by locally abundant protomylonite and mylonite. Shear fabric is defined by rare attenuated mafic enclaves, by fractured, elongate to rotated plagioclase, and by flattened to smeared biotite and quartz. Shear fabric within tonalite is commonly gradational from shear zone margins into the undeformed pluton. Tonalitic dykes assigned to the Fougner suite also cut shear zones and, near Clayton Falls Creek, the main Mount Fougner pluton clearly plugs a major high-angle shear zone. The Fougner suite is thus believed to be syn- to postkinematic with respect to these high-angle ductile shear zones.

The age of the Fougner suite is presently unconstrained. Hrudey et al. (2002) inferred that quartz diorite along the south side of the Bella Coola estuary, dated at 119 ± 2 Ma (Gehrels and Boghossian, 2000), was part of the Fougner suite, but we can demonstrate that it belongs to the Desire suite. The Fougner suite intrudes the Desire suite, which is believed to be >119 Ma, and is itself cut by the Four Mile suite, which is <73 Ma. The syn- to postkinematic nature of the intrusion suggests a Paleocene age (Rusmore et al., 2001; Mahoney et al., 2002).

Four Mile plutonic suite

Coarse-grained biotite±muscovite granite that forms spectacular massifs on both sides of the Bella Coola Valley is assigned to the Four Mile suite, named for excellent exposures on Four Mile Mountain, north and east of Bella Coola (Hrudey et al., 2002). Granite of the Four Mile suite underlies large areas between Mount Creswell and Big Snow Mountain. These plutons are typified by well developed, steeply dipping joints that lend a sheeted appearance.

The suite consists of homogeneous, coarse-grained, and equigranular biotite granite to granodiorite, characterized by large, fresh books of biotite up to 5–7 mm across. Muscovite is diagnostic, but ranges from 0 to 8%. Rare scattered maroon to red, semi-opaque garnet (0.3–1.5 mm in diameter) is a diagnostic minor component. The suite is locally inequigranular, containing potassium feldspar phenocrysts. Aplite dykes with pegmatitic segregations containing garnet, muscovite and tourmaline are associated with the suite.

The Four Mile suite intrudes the Monarch assemblage, the Desire and Fougner suites, and the northwest-trending high angle shear zones that are pervasive in the region. Preliminary U-Pb ages range from ca. 51 to 73 Ma. Additional isotopic dating is in progress.

Nooskulla plutonic suite

The Nooskulla suite is named for homogeneous, fine- to medium-grained hornblende-biotite tonalite characteristically exposed on Nooskulla Peak, south of the Dean River. The suite differs from tonalite of the compositionally similar Fougner suite in that it is finer grained, does not contain conspicuous sphene, and is entirely postkinematic with respect to the high-angle shear zones. The tonalite weathers to a light grey, and has a sheeted appearance due to well developed subhorizontal joints. The suite is cut by numerous thin (2–20 cm), randomly oriented aplite dykes and by less abundant basaltic dykes. Near the margins of the pluton, the tonalite grades to an inequigranular biotite granodiorite with coarse-grained potassium-feldspar phenocrysts.

The Nooskulla suite has yielded a biotite K-Ar age of ca. 47 Ma (Baer, 1973). Additional isotopic dating is in progress.

STRUCTURAL GEOLOGY

The structural evolution of the eastern Bella Coola map area can be subdivided into several distinct episodes. The earliest deformational event was possibly east-west extension associated with extrusion of the Lower to Middle Jurassic Hazelton Group. A similar extensional event, indicated by the presence of polymict volcanic-plutonic conglomerates and north-trending dyke swarms, may have accompanied accumulation of the Lower Cretaceous Monarch assemblage. The contact between the Hazelton Group and Monarch assemblage strata has not yet been recognized; it is inferred to be a sheared/faulted unconformity, on the basis of the identification of nonconformities between the Monarch assemblage and the Stick Pass suite, which is interpreted to intrude the Hazelton Group.

Inferred Late Cretaceous contraction formed a system of northwest-trending, northeast-vergent folds and subordinate thrust faults. This system is best displayed in the interbedded volcanic flows and sedimentary rocks of the Monarch assemblage; it is much less evident in Hazelton strata. The contractional event was superseded by the development of kilometre-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 in addition to the Monarch assemblage, and is cut by plutons of probable Tertiary age. The shear zones record extensive contraction and multidirectional flow.

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