QUESNEL MINERAL BELT: SUMMARY OF THE GEOLOGY OF THE BEAVER CREEK – HORSEFLY RIVER MAP AREA*

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KEYWORDS: Regional geology, Quesnel terrane, Horsefly, Quesnel Lake, volcanic arc, placer gold, porphyry copper-gold, propylitic alteration, Tertiary basins.

INTRODUCTION

The Quesnel project, a regional mapping program at 1:50 000 scale, was begun in 1986, funded by the Canada/British Columbia Mineral Development Agreement. It is primarily intended to study the geological setting and economic potential for gold and copper-gold deposits in the Triassic-Jurassic Quesnel island arc volcanic rocks and their flanking and underlying clastic rocks. The map area is within the southern part of the Quesnel terrane (Tipper *et al.*, *1981*) in the region previously known as the Quesnel trough (Figure 1-18-1). The regional geology has been described by Campbell (1978) and Struik (1986). Results of recent Ministry mapping and other work are summarized by Panteleyev (1987, 1988), Bloodgood (1987, 1988), and Bailey (1988).

This report summarizes mapping in the Beaver Creek (93A/5) and Horsefly River (93A/6) map-areas (*see* Figure 1-18-2) and concludes three seasons of fieldwork. A 1:50 000 Open File geology map is in preparation and will be followed by a publication in the Ministry's Paper series. Other project-generated discussions of nearby map-areas are those of Bailey and Lu (1989, this volume) and Bloodgood (1989, in preparation).

Outcrop in the map area is relatively scarce. Bedrock is exposed mainly where the generally shallow overburden has been disrupted by industrial activity, most commonly logging and road building. Frequently outcrop can be found along ridge crests, and less commonly, in some of the more deeply incised creek gulleys and at the southeast end (the up-ice or stoss side) of some glacial ridges.

Geological interpretation of the sparse outcrop data is difficult due to the similarity of the predominantly pyroxene-phyric lithologies and abundant block faulting. However, a few distinctive breccia units and flows containing analcite phenocrysts or feldspar laths provide readily identifiable marker units. Considerable assistance in map interpretation is provided by federal/provincial 1:63 360 (1 inch to 1 mile) aeromagnetic maps 5239G (93A/6) and 1532G (93A/5).

LITHOLOGIC MAP UNITS

Mafic volcanic rocks of calcalkaline to alkaline affinity are the dominant rock type. The stratigraphic succession consists mainly of pyroxene-phyric basaltic flows, flow breccia, debris flow or lahar deposits and locally derived epiclastic rocks. Within this sequence there are at least two basalt units containing relict olivine and/or analcite crystals. These mafic rocks overly and interfinger with a basal sequence of basaltic-source sandstone and siltstone and are overlain, in turn, by more felsic polylithic alkalic volcanic-clast breccia and the upper unit of amygdaloidal analcite-bearing olivine basalt flows. Locally, remnants of Tertiary lacustrine deposits, crystal ash flows and subaerial flows of intermediate composition overlie the mafic rocks. Miocene plateau basalts overlap the southwestern and southern parts of the map area along Beaver Creek and Horsefly River. The western boundary of the volcanic belt is a fault contact with calcareous and graphitic sediments of the Paleozoic Cache Creek Group.

The map units used are compatible with subdivisions first established by Bailey (1976, 1978) and used in more recent reports by Bailey and Panteleyev. The stratigraphy outlined by Morton (1976) in the central and eastern parts of the map area has been completely revised.

The following map units represent a sequence that is approximately 5 kilometres thick as shown in Figure 1-18-2.

Unit 1: Dark brown and grey mafic volcaniclastic sandstone and siltstone, minor cherty beds and rare calcareous siltstone. Generally a thinly bedded sequence containing turbidite units; locally contains moderately thick beds or

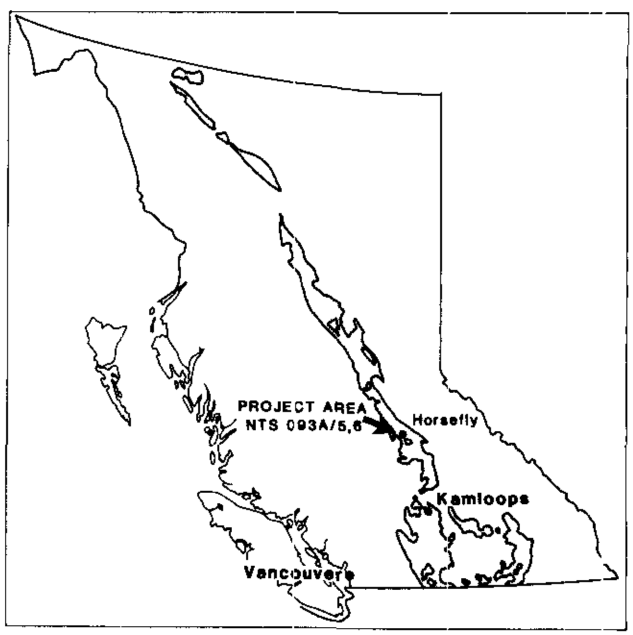

Figure 1-18-1. Location of Quesnel mineral belt project area within the Quesnel terrane.

* This project is a contribution to the Canada/British Columbia Mineral Development Agreement.

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1988, Paper 1989-1.

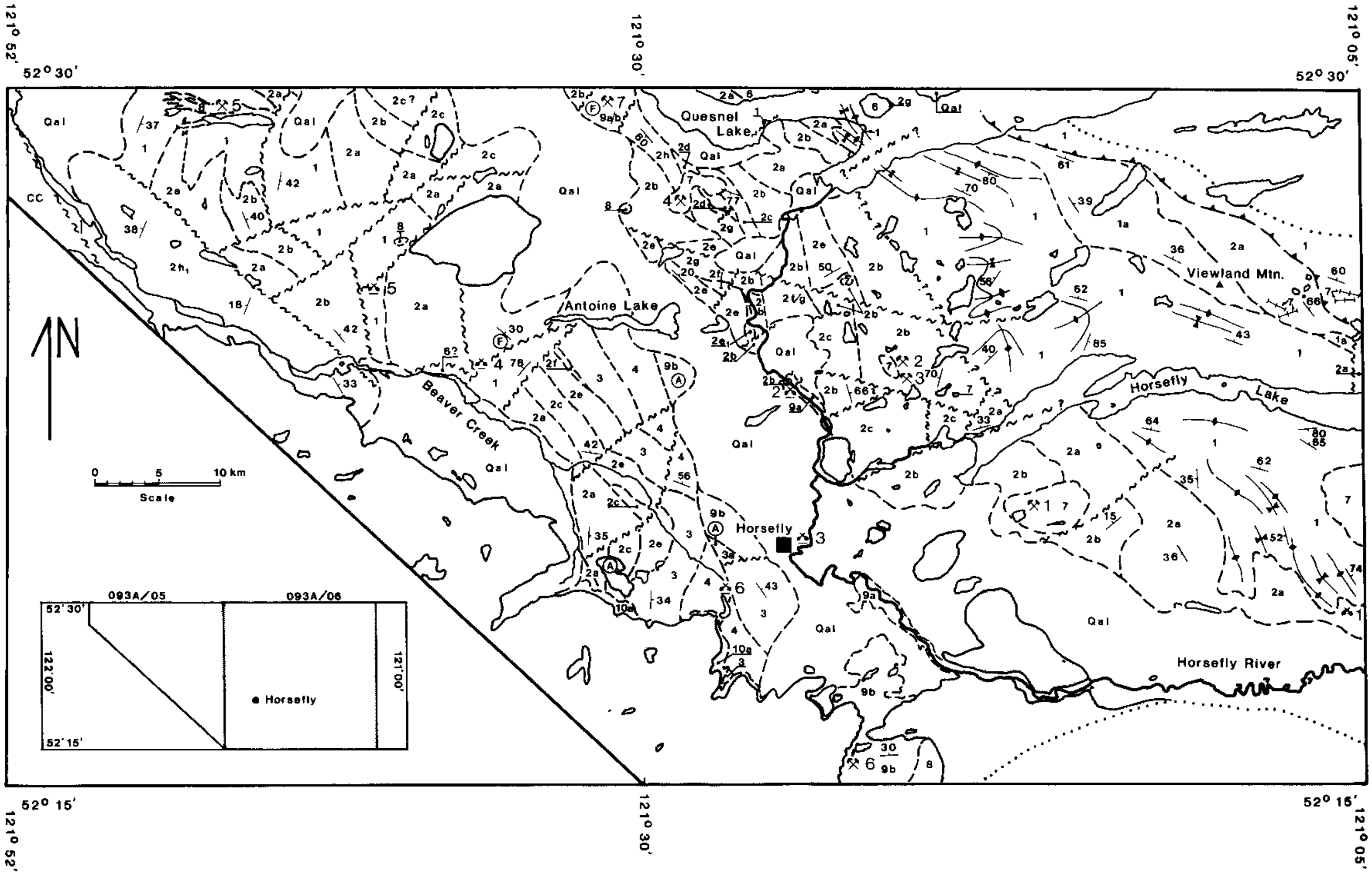

Figure 1-18-2. Geology of the central Quesnel terrane in the Horsefly area.

LEGEND

QUATERNARY

PLEISTOCENE AND RECENT

Qal Glacial and fluvial deposits; alluvium

TERTIARY

MIOCENE

10 Grey to black plateau basalt (alkali olivine basalt); 10A - basal white-quartz cobble conglomerate and gravel, fluvial channel deposits

EOCENE

9b Grey, pale mauve, buff plagioclase crystal ash tuff; pale grey, flaggy, biotite latite and andesite

9a Grey, cream to buff, pale yellow lacustrine sandstone, siltstone, minor conglomerate

JURASSIC

LATE JURASSIC (?) POSSIBLY CRETACEOUS

6 Polylithic cobble conglomerate, shale, sandstone; in part red beds

SINEMURIAN

4 Maroon and grey vesicular, zeolitized, amygdaloidal alkali olivine pyroxene-phyric basalt, contains analcite

3 Maroon and grey polylithic breccias; clasts of mafic and intermediate composition including latite, monzonite and other feldspathic rocks; locally feldspathic sandstone, limestone lenses and limestone matrix breccia

TRIASSIC

NORIAN (?) OR YOUNGER

2h Sandstone, siltstone, calcareous siltstone - flaggy thinly bedded. $2H_1$ - also contains sandstone, limestone, some tuffaceous beds, conglomerate with abundant chert and limestone clasts and pyroxene hornblende basalt breccia

NORIAN

2g Feldspar-lath, pyroxene-phyric basalt; locally breccia with limestone matrix; locally felsic breccia

2f Dark grey to brown, fetid mafic sandstone and siltstone, calcareous siltstone, limestone breccia

2e Analcite-bearing purple, dark brown and green-grey alkali basalt, locally feldspathic; minor crystal lithic ash tuff; $2E_1$ - sparse pyroxene-phyric to aphanitic basalt - intrusive plug ?

2d Pyroxene basalt breccia, tuff; pyroxene-rich wacke

2c Polylithic, grey-green and purple mafic breccia, debris flow or lahar, minor volcanic-source conglomerate, pyroxene-rich greywacke, minor feldspathic clasts

2b Dark green, maroon and grey pyroxene-phyric basalt breccia, lithic lapilli and ash tuff, mafic wacke. Includes some flows and pyroxene-phyric plagioclase microlite-bearing basalt

2a Green and dark grey pyroxene-phyric alkali olivine basalt and alkali basalt flows, pillow lava and pillow breccia; locally breccia and vesicular amygdaloidal flows with lenses of mafic wacke, limestone or limestone clast-bearing basalt breccia

CARNIAN AND (?) YOUNGER

1 Grey to dark brown siltstone and sandstone, volcaniclastic towards top of unit, rare thin chert beds and limestone lenses. Locally interfingers with unit 2A. 1A - conglomerate, sandstone, minor pyroxene basalt breccia. Locally contains hornblende monzonite and latite clasts in breccia

PALEOZOIC

CC Cache Creek Group - flaggy, fetid limestone, graphitic argillite and siltstone

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8 Grey, medium-grained hornblende quartz diorite and granodiorite, locally leucocratic

7 Grey and pink fine to medium-grained diorite, monzodiorite, syenodiorite, monzonite and syenite, hornblende porphyry dykes; locally pyroxenite, hornblendite

SYMBOLS

Map unit contact
Fault-mapped and inferred
-thrust
Fold axis
Bedding attitude
Dykes of granitic rocks
Limit of mapping
Potassium-Argon sample site
Fossil sample site

Mineral prospects

Lemon Lake	Cu,Au	1
Kwun Lake	Cu,Au	2
Beekeeper	Au,Hg,Cu	3
Shiko Lake	Cu,Au	4
Gavin Lake	Cu,Mo	5
Megabuck	Cu,Au	6
Vuggy quartz-calcite veinlet epithermal occurrence	Au	7

Historic placer workings

Black Creek (active)	1
Hobson's Hydraulic mine	2
Ward's Horsefly mine	3
Antoine Creek	4
Choate (west) Creek	5
China Cabin Creek	6

lenses of pebble-bearing wacke and conglomerate derived predominantly from pyroxene basalt and containing limestone and shale chips.

Unit 1A: A subunit restricted to an eruptive centre and coarse clastic wedge in the Viewland Mountain area. Conglomerate and sandstone in the northwest, pyroclastic breccia and autobrecciated flows and/or small intrusions in the southeast, forming Viewland Mountain. The unit forms a northward-thickening coarse clastic wedge or slope-base debris flow/fanglomerate deposit. Predominantly pyroxene basalt clasts, but polylithic with some feldspathic rocks and hornblende-bearing latite or monzonite debris. This unit represents the first, more evolved and differentiated alkalic eruptive cycle in the overall basaltic succession.

Unit 2A: Dark green olivine-bearing, pyroxene-phyric basalt flows, flow breccia, pillow lava and pillow breccia. Locally extensively chloritized with abundant calcite veinlets. Some flows contain granular aggregates and skeletal cumulophyric grains of analcite. In the upper part of the unit flows are commonly vesicular and extensively zeolitized. Zeolites present are laumontite, thompsonite and scolecite. Rocks of this unit are present as members in the uppermost part of Units 1 and 1A where they commonly form pillow basalt flows or domes and pillow breccia units. In some places, especially in the northwest to the north of Beaver Creek, there is extensive interfingering of Units 1 and 2A. Locally the unit contains abundant small lenses of mafic wacke containing limestone clasts.

Unit 2B: Dark green and purple, medium to coarse pyroxene-phyric basalt breccia and flows. Lithic lapilli ash tuffs and mafic wacke are commonly interbedded with flow units and breccias. Some members contain fine to medium-grained plagioclase laths.

Unit 2C: Grey, grey-green, purple to maroon polylithic mafic breccia; in large part derived from lahar or debris flow deposits. Contains some feldspathic, monzonitic clasts. Reworked conglomeratic deposits occur locally.

Unit 2D: Pyroxene basalt, breccia, tuff; pyroxene-rich wacke.

Unit 2E: Grey-green and dark purple to purplish brown analcite-bearing pyroxene-phyric basalt flows and flow breccia. This unit is characterized by fine to very coarse-grained, white, buff or salmon-pink euhedral analcite phenocrysts and coarse-grained pyroxene. Locally, plagioclase laths are also present; elsewhere pyroxene dominates and analcite is rare or absent. Some basal units contain analcite crystal ash and lapilli tuffs. **$2E_1$**: Dark green to grey-green, aphanitic to very fine-grained basalt, with sparse pyroxene phenocrysts forms a small body unique to the map area, possibly an intrusive plug or neck.

Unit 2F: Dark grey to brown sandstone and siltstone derived from mafic volcanics. Silty limestones or calcareous siltstones are common. The rocks are fetid and contain fine sulphide grains. A benthonic bivalve assemblage is relatively common.

Unit 2G: Grey, feldspar-pyroxene-phyric basalt flows and flow breccia. Autobrecciated flow tops and margins have a crystalline limestone matrix. Limestone lenses commonly contain volcanic clasts and pyroxene grains as well as crinoid columns, coral and fragments of bivalves. At the Shiko Lake prospect this unit contains two lenses of felsic to intermediate polylithic breccia that might be in part intrusive or are extrusive precursors of the Shiko stock.

Unit 2H: Fine-grained sandstone, siltstone, and calcareous siltstone; contains carbonaceous wood debris and fragments of ammonites, bivalves, corals and gastropods. **$2H_1$**: Thinly bedded, fine-grained sediments. The unit contains limestone, tuffaceous beds, conglomerate with chert and limestone clasts and locally polymictic breccia and flow breccia of pyroxene hornblende basalt.

Unit 3: Breccia; maroon, purple, lavender and grey polylithic breccias containing mafic and felsic clasts. Felsic clasts are alkali-feldspathic latite or monzonite species. Locally slumping has produced reworked breccia and lithic tuff beds, some with calcareous matrix or limestone matrix breccia. **3A**: Hornblende-phyric andesite flows; platey and moderately zeolitized.

Unit 4: Dark grey, grey-green to maroon pyroxene-phyric basalt flows and flow breccia. Locally contains fine-grained analcite; generally zeolitized and amygdaloidal.

Unit 5: This unit is not recognized in the map area. It occurs further to the north along the Quesnel River where it has been described by Bailey (1988).

Unit 6: Conglomerate with clast-supported cobbles of chert, limestone, siltstone, sandstone and rare greenstone. The sandy matrix contains ferruginous carbonate cement that commonly weathers rusty orange. Conglomerate and sandstone of similar composition, but strongly oxidized to form red beds, occurs along Beaver Creek and is shown on Figure 1-18-2 as Unit 6?

Unit 7: Diorite and monzonite intrusions; plutons, stocks and dykes. Grey to pink, medium-grained equigranular to porphyritic rocks; coarse-grained hornblende porphyry and very coarse poikilitic syenite occur as dykes and small plugs. Locally mafic phases of pyroxenite and hornblendite are developed within stocks or along their contacts.

Unit 8: Grey fine-grained quartz diorite to medium-grained granodiorite; dykes may be leucocratic. Commonly weathers rusty coloured.

Unit 9: Pale grey to buff and yellow, thin-bedded and varved lacustrine siltstone and sandstone with floral debris and rare fish imprints. The unit contains some tuffaceous beds and locally has a basal polymictic cobble conglomerate.

Unit 9B: Grey to pale violet plagioclase crystal ash tuff. Breccia is present in the north; platey, strongly epidotized, massive to thin-bedded, dust and ash tuff or epiclastic deposits in the south. A weak compaction or flow foliation is evident in ash flows as well as a pervasive deuteric alteration that produces chloritization and hematite alteration of mafic minerals.

Unit 10: Plateau basalt. Dark grey to black alkali olivine basalt flows approximately 80 metres in thickness. The base of the flows occurs at an approximate elevation of 880 metres.

Unit 10A: River channel gravel deposits underlying plateau basalt flows. The gravels contain abundant white quartz detritus; locally calcite-cemented conglomerate marks the basal contact.

TABLE 1-18-1
POTASSIUM-ARGON DATA, BEAVER CREEK – HORSEFLY RIVER

Sample Number	Location (UTM)	Lithology	Material Analysed	% K	Ar^{40*} 10^{-10} (moles/gm)	Ar^{40*} Total Ar^{40}	Apparent Age (Ma)
87AP-3/1-4	603440E, 5799080N	Unit 9B	biotite	7.250 ± 0.020	6.662	93.2	52.2 ± 1.8
87AP-6/3-16	605670E, 5799080N	Unit 3A	hornblende	0.642 ± 0.240	2.181	97.2	186 ± 0.5
87AP-18/8-44	601710E, 5797170N	Unit 10	whole rock	0.722 ± 0.008	0.1838	33.4	14.6 ± 0.5

The units described above comprise the Quesnel belt. They are in fault contact with Unit CC, Cache Creek graphitic shales and calcareous siltstone. All bedrock units are covered extensively by glacial and fluvioglacial deposits and alluvium (Qal). Thick valley fill in the upper reaches of the Horsefly River, between Horsefly village and Antoine Creek and to the northwest, and along Beaver Creek, mark the main Pleistocene meltwater channelways. Elsewhere a relatively thin but persistant veneer of glacial deposits and alluvium covers the gently rolling terrain. The most common ice-movement direction is 305 degrees.

AGE OF MAP UNITS

The age of the volcanic arc rocks and underlying sediments ranges from Middle Triassic to Early Jurassic (Campbell, 1978; Struik, 1986). Bailey (1988) and Panteleyev (1988) have summarized faunal evidence for a Norian to possibly Late Hettangian age for Unit 2. Conodonts have been described by Dr. Michael Orchard, Geological Survey of Canada, from one of the 15 samples collected from the map area by the writer. The sample from Unit 1, 1.5 kilometres to the west-southwest of Antoine Lake, contains the conodont taxa *Epigondonella* cf. *E. abneptis* Huckriede and *Neogondonella* species. This confirms a Late Triassic, probably early Norian age for the limestone clasts in this conglomerate member.

Radiometric data from diorite-monzonite plutons intruding Unit 2 rocks range from 186 to 201 Ma (Panteleyev, 1987 and 1988). A new potassium-argon date of 186 Ma (Table 1-18-1) confirms the Early Jurassic age of Unit 3A volcanic rocks, but suggests that they may be younger than the "probably Sinemurian" age considered by Bailey (1988) for Units 3 and 4.

Tertiary rocks have been dated both radiometrically and by palynomorphs. Bedded lacustrine sediments of Unit 9A/B along Hazeltine Creek near Quesnel Lake have been shown by palynomorphs to be equivalent to the Middle Eocene rocks (Panteleyev, 1987) of Unit 9A. Dr. Glen Rouse of The University of British Columbia has identified diagnostic 48 to 52 Ma palynomorphs from Unit 9A/B as shown in Table 1-18-2. The crystal ash tuffs and conglomerates of Unit 9B overlie these Middle Eocene sediments. The biotite latite platey lavas of Unit 9B have been dated to be Middle Eocene, 52.2 ± 1.8 Ma (Table 1-18-1). Debris of this unit is contained in the basal conglomerate of Unit 9A.

A whole-rock radiometric sample of alkali olivine basalt of Unit 10 gives a Middle Miocene date of 14.6 ± 0.5 Ma. (Table 1-18-1). These flows overly the extensive white-quartz-cobble-bearing gravel channels of Unit 10A. The channels are developed within and follow the distribution of the Middle Eocene lacustrine sediments of Unit 9A. This dating confirms the wisdom of the ancient placer miners who regarded the white-quartz channels to be Miocene and considered them to be the sources of some of the younger reworked placers of glacial and postglacial origin.

STRUCTURE

The major regional structures in the area are a northwesterly trending, extensively block-faulted syncline in the volcanic axis of the Quesnel belt and a broad anticlinal structure in sedimentary rocks of Unit 1 in the northeast corner of the map area. The basal sedimentary rocks of Unit 1 crop out in the eastern and western parts of the area mapped and, together with the intervening 15 to 20-kilometre-wide volcanic arc deposits of Units 2 to 4, define a broad structural depression, truly a "Quesnel Trough". Superimposed on the northwesterly trending Triassic-Jurassic volcanic belt is a north-northwesterly trending depression, probably a series of connected grabens, filled by Middle Eocene sediments, subaerial volcanics and isolated remnants of a once-continuous thin cover of Miocene plateau basalts. The Middle to Late Tertiary depression is now extensively infilled by glacial and fluvioglacial deposits.

Folding is most evident in sedimentary units, especially at deeper structural levels, as described by Bloodgood (1987). The sedimentary rocks of Unit 1 north and south of Horsefly Lake display open, upright asymmetrical folds with steep

TABLE 1-18-2
LIST OF PALYNOMORPHS FROM SAMPLE 87AP 32/4-99

angiosperm pollen
- *Rhoipites retipillatus*
- *Pistillipollenites mcgregori*
- *Carpinpites ancipites*
- *Quercus shiabensis*
- *Araliaceoipollenites granulatus*

conifer pollen
- *pinus haploxylon* type
- *P. diploxylon* type
- *Picea grandivescipites*
- *Tsuga phyllites*
- *Keteleeria* sp.

fungal spores
- *Granatisporites cotalus*
- *Rhizophagites cerasiformis*
- Fungal hypha – type C of Norris

algal cyst
- *Lejeunia hyalina*

southwest limbs and moderately dipping northeast limbs. In the more thinly bedded successions, folds may be tight to isoclinal. There is no widespread penetrative deformation evident; in places an axial planar spaced cleavage is developed. A second phase of broad, open folding or large-scale warping about northeasterly-trending axes is superimposed on the major folds. It modifies the overall northwesterly trending fold pattern. The overlying volcanic rocks display little or no folding. They form thick, poorly stratified panels that are tilted and rotated by numerous block faults.

Faults dissect the area mapped along two dominant trends – northwesterly and northeasterly. The former are the older set, probably Middle to Late Jurassic in age and related to the first period of major compressive, subduction-related deformation. Many have been reactivated, possibly during the second phase of northeasterly faulting. It is likely that many of the map unit boundaries shown in Figure 1-18-2 as lithologic contacts are faulted. The only thrust fault or steepened reverse fault noted is between Horsefly and Quesnel Lakes to the north of Viewland Mountain. There the folds in Unit 1 verge southwesterly and the rocks are thrust onto rocks of Units 1A and 2A.

A long-lived, reactivated fault zone along Beaver Creek forms the southwestern and western map boundary. It marks the contact between Mesozoic volcanic and Cache Creek rocks along what is most probably a right-lateral fault of major regional extent. Later reactivation, probably related to Tertiary extentional tectonism, emplaced younger volcanic units ($2H_1$ and 6?) into the resulting graben – now marked by the Beaver Valley. This structural zone was again reactivated in the Late Tertiary with uplift of the north side. This uplift formed a highland buttress against which the Miocene plateau basalt was deposited. The basalt now forms a "rim rock" wall along almost the entire length of lower Beaver Creek.

The youngest faults also trend northwesterly and northeasterly, and are possibly reactivated older structures. They control the distribution of the inliers of Teriary flows and ash flows of Unit 9B (Figure 1-18-2). The distribution of Middle Eocene rocks outlines a north to northwesterly trending, broad, shallow basin or series of interconnected basins along the upper Horsefly River – Antoine Creek axis. This zone remained a depression during much of the Tertiary and was the site of sedimentation in a shallow lake followed by deposition of volcanic rocks in locally developed grabens. The area remained as a (fault-bounded?) depression into the Late Tertiary when it was flooded by Miocene basalt flows.

MINERALIZATION

No lode metal deposits have been worked in the area nor are economic reserves known to be present in any of the gold or copper-gold prospects. However, in 1859 the Horsefly area was the scene of some of the first placer gold mining in the Cariboo (Holland, 1950). Significant gold (over 465 kilograms recorded) was won from underground and hydraulic workings at the Hobson's Horsefly and Ward's mines near the village of Horsefly (Figure 1-18-2). Placer activity has been recorded in a number of other areas including Antoine, Beaver (Lake), Black, China Cabin and Moffat creeks. In addition, some small-scale, unrecorded mining has been done by local residents on Parminter and 'West' (Choate-Teasdale) creeks, both tributaries to Beaver Creek. Black Creek is the only active placer mine in the area.

Lode sources of the placer gold remain unknown. Much, possibly all, of the gold was originally transported within the Miocene white-quartz channelways of Unit 10A. Most deposits, such as Black and Antoine creeks, represent reworked placers in which gold is reconcentrated in Pleistocene fluvioglacial channelways which have cut into or through the Miocene gravels. These placers are similar in age to other deposits in the Cariboo district. They are related to pre or post-Wisconsin glacial gravels, generally 59 000 Y.B.P. in age or younger (Eyles and Kocsis, 1988; Clague, 1987). In contrast, gold at the Hobson mine and possibly some other Horsefly River deposits was recovered directly from the calcite-cemented basal part of the Miocene gravels.

The source of the white quartz pebbles and cobbles and the associated gold has long been speculated to be metamorphic terranes, possibly in the Eureka Peak – Crooked Lake – Horsefly River headwaters to the southeast (93A/7) or even further east. A metasedimentary, high-grade metamorphic source is consistent with samples of panned or sluiced concentrates taken from most of the placer creeks and two road cuts in the Miocene gravels. The samples are remarkably consistent. The heavy concentrates are notably lacking in black sand but contain abundant ruby-red garnet and kyanite as well as rare zircon, scheelite and pseudobrookite in addition to relatively common epidote, pyroxene, hornblende and biotite. The light fraction contains abundant white mica as well as quartz and feldspar. Contrary to the suggestions in Geological Fieldwork, 1987 (Panteleyev, 1988) based on older Ministry reports, Antoine and Beaver Creek samples are similar to the other placer pan-samples and do not appear to be derived from a different source.

Exploration for lode gold and copper-gold deposits has concentrated on intrusion-related alteration zones within and peripheral to the Early Jurassic alkalic intrusions at Lemon, Shiko and Kwun lakes. Exploration targets are auriferous porphyry copper mineralization similar to the Cariboo-Bell deposit (Hodgson *et al.*, 1976) and gold in propylitic alteration zones in basalts such as at the QR deposit (Fox *et al.*, 1987; Melling and Watkinson, 1988).

Younger porphyry-style mineralization is found in the Cretaceous(?) copper-molybdenum-bearing Gavin Lake granodiorite stock and in Eocene rocks at the Megabuck prospect, 8 kilometres south of Horsefly. At Megabuck, a quartz stockwork zone contains chalcopyrite, pyrite, magnetite and epidote. Elsewhere on the property the extensively epidotized rocks are sericitized and cut by veinlets and small breccia bodies with quartz, black tourmaline and pyrite. The Eocene age of the Megabuck host rocks is established by geologic mapping and lithologic correlation with identical, dated rocks of Unit 9B to the north. The mineralization cannot be related to the nearby Early Jurassic Takomkane batholith nor Cretaceous quartz monzonites like those of the Boss Mountain stock to the south (Soregaroli and Nelson, 1976). Similar quartz-carbonate veinlets and stockworks occur in Eocene rocks of Unit 9A/B along Hazeltine and Edney creeks near the northern edge of the map area (Occurrence 7, Figure 1-18-2).

Elsewhere in the area mapped, there are widespread indications of hydrothermal activity in fault and fracture zones. However, the presence of olivine as remnant, partially replaced grains in basalts and the pristine, unaltered nature of pyroxene and analcite crystals in many of the volcanic units, attests to the lack of pervasive alteration in most of the volcanic succession. Similarily, the conodont alteration index (CAI) of 2 to 3 (M. Orchard, personal communication, 1988) indicates the relatively low thermal maturation conditions in sedimentary rocks of Unit 1 near Antoine Lake. Also, palynomorphs from the vicinity of quartz-carbonate veinlets in lacustrine sediments of Unit 9A (Occurrence 7, Figure 1-18-2) have an estimated maximum temperature of about 200°C based on thermal maturation (G. Rouse, personal communication, 1988).

The evidence therefore, based on geological mapping, petrography and alteration assemblages suggests that thermal conditions capable of supporting any significant hydrothermal activity are restricted to the Jurassic and Cretaceous(?) intrusive centres and Eocene grabens containing volcanic deposits. Elsewhere alteration, mainly zeolite, calcite, quartz, chlorite and epidote in fracture zones, faults and some of the permeable pyroclastic units, indicates some potential for low-temperature gold and possibly mercury deposits.

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