QUESNEL MINERAL BELT–THE CENTRAL VOLCANIC AXIS BETWEEN HORSEFLY AND QUESNEL LAKES* (93A/05E, 06W)

By Andre Panteleyev

KEYWORDS: Regional mapping, Quesnel terrane, Horsefly, Quesnel Lake, volcanic arc, placer gold, porphyry copper-gold deposits, propylitic alteration.

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 (*see* Figure 1-11-1). Results of ministry mapping in 1986 and previous work are summarized in Geological Fieldwork, 1986, by Panteleyev (1987) and Bloodgood (1987).

In 1987 enhanced provincial funding enabled an expanded project to be undertaken, with field mapping in four areas. The individual field studies are summarized in this report and by Bailey and Bloodgood elsewhere in this volume. Bailey's area adjoins this study to the northwest; Bloodgood's mapping is to the northeast. In addition, J. Lu conducted studies in the Cantin Creek area along Quesnel River in NTS area 93B/16. His study will be summarized in the ministry publication, Exploration in British Columbia, 1987.

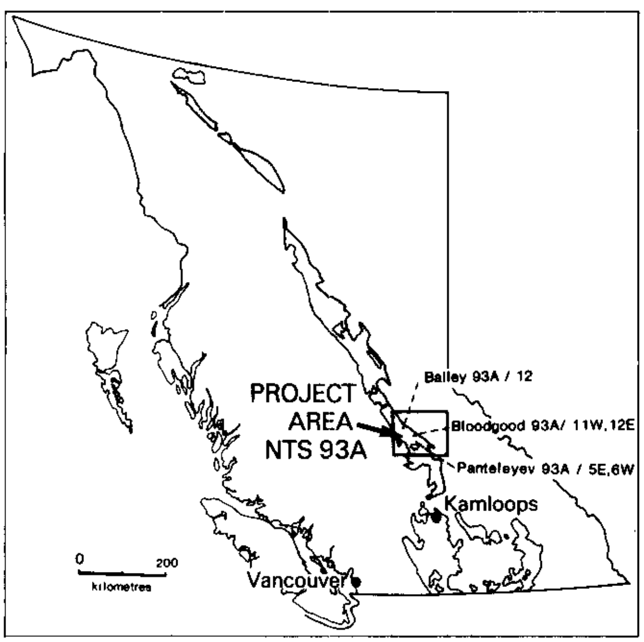

Figure 1-11-1. Location of mapping studies described in this volume. The Quesnel mineral belt project area within the Quesnel Terrane (shaded area) is shown.

This report outlines results of 1:20 000-scale mapping in a 480-square-kilometre area between Horsefly and Quesnel lakes, mainly to the west of the Horsefly River. Outcrop is scarce, it occurs in approximately 0.01 per cent of the map area. Bedrock is exposed mainly where the generally shallow overburden has been disrupted by industrial activity, most commonly logging and road building. Less frequently outcrop can be found in a few 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 made even more difficult by the similarity of the predominantly pyroxene-phyric lithologies and abundant block faulting. However, a few breccia units and flows containing analcite phenocrysts and feldspar laths provide distinctive, readily identifiable map units. Considerable assistance in map interpretation is provided by federal/provincial 1:63 360 (1 inch to 1 mile) aeromagnetic maps 5239G (93A/06) and 1532G (93A/05).

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 olivine and/or analcite phenocrysts. These mafic rocks overlie a basal sequence of basaltic-source sandstone and siltstone and are overlain, in turn, by more felsic polylithic alkalic volcanic-clast breccia and an upper unit of amygdaloidal analcite-bearing olivine basalt flows. Locally, remnants of Tertiary subaerial flows and ash flows of intermediate composition overlie the mafic rocks. Miocene or younger plateau basalts overlap the southwestern part of the map area and the south-central portion along the Horsefly River (*see* Figures 1-11-2, 1-11-3).

The area shown on Figure 1-11-2 is underlain by eleven major lithological units. These map units are identical to those of Bailey (this volume) and based on his earlier studies (Bailey, 1976, 1978), except for Unit 9 and the map units numbered with subscripts (for example, $2B_1$, $2D_2$, etc.) which are unique to this area. They simplify the 17 stratigraphic subdivisions described previously (Panteleyev,

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

British Columbia Ministry of Energy, Mines and Petroleum Resources, Geological Fieldwork, 1987, Paper 1988-1.

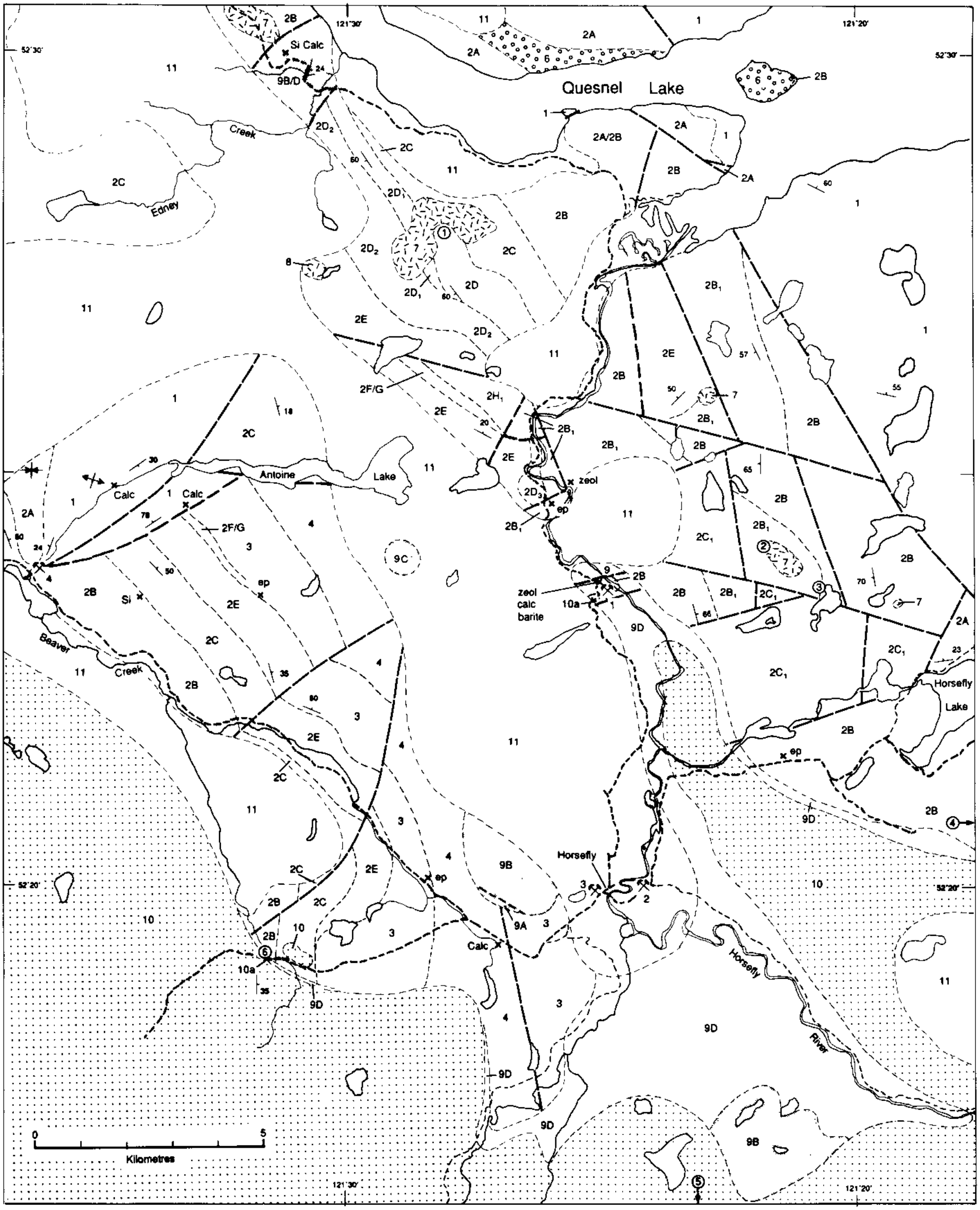

Figure 1-11-2. Geology of the central Quesnel terrane between Horsefly and Quesnel lakes.

LEGEND (also see Bailey, this volume)

QUATERNARY

PLEISTOCENE AND RECENT

11 Glacial and fluvial deposits; alluvium

TERTIARY

MIOCENE

10 Grey to black plateau basalt (alkali olivine basalt); 10a – basal white quartz-cobble conglomerate and gravel

EOCENE

9D Grey, pale mauve, olive and tan flows, sandstone and conglomerate. Includes 9A – hornblende andesite, 9B

9A/B/C – plagioclase crystal ash tuff, 9C – biotite latite, 9D – lacustrine siltstone, sandstone and conglomerate (see Figure 1-11-3)

JURASSIC

PLIENSBACHIAN?

6 Cobble conglomerate: clasts of chert, quartzite, limestone, sandstone; carbonaceous shale and sandstone

SINEMURIAN

4 Maroon and grey vesicular, zeolitized, amygdaloidal alkali olivine basalt, may contain analcite

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

TRIASSIC

NORIAN

$2H_1$ Feldspar-lath, pyroxene-phyric basalt; locally breccia with limestone matrix

2F/G Dark grey to brown, fetid mafic sandstone and siltstone, calcareous siltstone, limestone breccia

2E Analcite-bearing maroon and green-grey alkali basalt, locally feldspathic; minor crystal lithic ash tuff

2D Plagioclase and pyroxene-phyrix basalt, in part autobrecciated. Contains alkalic and intermediate composition clast breccia. Includes $2D_1$ – fine-grained sandstone, siltstone; $2D_2$ – pyroxene-phyric basalt flows and breccia, mafic polylithic breccia; $2D_3$ – sparse pyroxene-phyric aphanitic basalt

2C Polylithic grey, grey-green and purple mafic breccia, pyroxene-rich greywacke, minor feldspathic clasts. Includes $2C_1$ – monzonite and latite clast-bearing breccia, possibly equivalent to Unit 3

2B Dark green and maroon pyroxene-phyric alkali basalt, commonly vesicular-amygdaloidal; locally breccia, pillow breccia with limestone lenses and mafic wacke. Includes $2B_1$ – plagioclase microlite-bearing basalt

2A Green and dark grey pyroxene-phyric alkali olivine basalt and alkali basalt, flows, pillow lava and pillow breccia

CARNIAN AND (?) YOUNGER

1 Grey to dark brown silstone and sandstone, volcaniclastic towards top of unit, rare thin chert beds and limestone lenses

8 Grey hornblende quartz diorite and granodiorite

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

SYMBOLS

Map unit contact ....

Fault – mapped and inferred ...

Major road ....

Bedding attitude 60

Fold axis ....

Historic placer workings ....

Hobsons hydraulic mine 1

Wards Horsefly mine 2

Miocene shaft 3

Antoine Creek 4

Mineral prospects .... O

Shiko L.	Au, Cu	 1
Kwun L.	Au, Cu	 2
Beekeeper	Au, Hg	 3
Lemon L.	Au, Cu	 4
Megabuck	Au, Cu	 5
Old adit	Au, Cu, Ag	 6

Alteration zones sampled .... ×

Propylitic-epidote, calcite, ... Ep chlorite, garnet, pyrite, chalcopyrite, tremolite

Zeolite and calcite .... Zeol

Calcite and quartz .... Calc

Silicification .... Si

1987) in the eastern part of the map area and completely revise the stratigraphy described in the same area by Morton (1976).

The following map units represent a sequence that is approximately 5 kilometres thick shown on Figure 1-11-2.

UNIT 1: Dark brown and grey mafic volcanic-source sandstone and siltstone, minor chert and rare thin limestone lenses. A thinly bedded sequence containing turbidite units; beds near the top of the succession contain abundant pyroxene grains and limestone clasts.

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.

UNIT 2B: Dark green and maroon pyroxene-phyric alkalic basalt flows and flow breccia, locally pillow breccia. Mafic wacke interbeds are common; limestone forms small lenses and breccia matrix. Many flows are amygdaloidal and zeolitized. **$2B_1$** — Flow units contain fine to medium-grained plagioclase laths.

UNIT 2C: Breccia, grey, grey-green and purple polylithic mafic breccia derived from lahar or debris flow deposits. **$2C_1$** — Contains some feldspathic monzonitic clasts and is possibly equivalent to Unit 3.

UNIT 2D: Porphyritic plagioclase pyroxene basalt with interbedded alkalic breccia and sedimentary units. Mainly grey and grey-green coarse plagioclase lath and pyroxene-phyric basalt flows and autobrecciated flows. Includes thick lenses or wedges of grey, pink-weathering, epidotized polylithic breccia with abundant monzodiorite clasts. Minor mafic wacke beds. **$2D_1$** — Fine-grained sandstone and siltstone; contains carbonaceous wood debris and fragments of ammonites, bivalves, corals and gastropods. **$2D_2$** — Pyroxene-phyric basalt flows and breccia, mafic wacke. **$2D_3$** — Dark grey microcrystalline basalt with sparse fine to medium-grained pyroxene, possibly intrusive.

UNIT 2E: Grey-green and maroon 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.

UNIT 2F/G: Dark grey to brown sandstone and siltstone derived from mafic volcanics. Silty limestone or calcareous siltstone are common; limestone-clast breccia occurs locally. The rocks are fetid and contain fine sulphide grains. A benthonic bivalve faunal assemblage is relatively common.

UNIT 2H: Grey feldspar and 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. Flow rocks resemble feldspar-phyric rocks of Unit 2D.

UNIT 3: Breccia; maroon, lavender, purple 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.

UNIT 4: Dark grey, grey-green to maroon pyroxene-phyric basalt, generally zeolitized and amygdaloidal. Fine-grained analcite is present in some flows, which distinguishes this map unit from Unit 2B.

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. Note Bailey's Unit 5 has not been recognized in this map area.

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.

UNIT 8: Grey fine-grained quartz diorite; weathers granular, rusty coloured. This unit is equivalent to Bailey's Cretaceous(?) Unit 9.

UNIT 9: Tertiary volcanic flow remnants and sedimentary basin deposits. **9A** — Grey to olive hornblende porphyry. **9B** — Grey to pale violet plagioclase crystal ash tuff; ash flows with chloritized, hematite-altered mafic minerals. **9C** — Grey, platy biotite-phyric latite. **9D** — Pale grey to buff and yellow, thin-bedded and varved lacustrine siltstone and sandstones with floral debris and rare fish imprints. Contains polymictic cobble conglomerate containing Unit 9B and C detritus and rare granitic clasts. The unit contains some tuffaceous interbeds.

UNIT 10: Plateau basalt; dark grey to black alkali-olivine basalt. **10A** — River channel gravel deposits with distinctive abundant white quartz detritus; locally calcite-cemented conglomerate above basal contact.

UNIT 11: Quaternary glacial and fluvioglacial deposits and alluvium. Thick valley fill in the upper reaches of the Horsefly River, between Horsefly River and Antoine Lake, and to the northwest of Antoine Lake. Elsewhere a relatively thin but persistent veneer on gently rolling hills. 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 (1978; 1988, this volume) gives faunal evidence for a Norian age for rocks of Unit 2; a Sinemurian age for Unit 3 and a Pleinsbachian age for Units 5 and 6 (*see* Bailey, Figure 1-11-4). The few fossils collected by this writer and examined by the Geological Survey of Canada have yielded equivocal information. The ammonites in map Subunit 2D cannot be positively identified and the taxonomy and biostratigraphy of the bivalves including *Lima* sp. in Subunit F/G have not been resolved (T.P. Poulton, personal communication, 1987). At best, a Late Triassic to possibly Late Hettangian range is indicated (H.W. Tipper, personal communication, 1987).

Radiometric data from diorite-monzonite plutons intruding Unit 2 basaltic rocks range from 192 to 201 Ma (Panteleyev, 1987). A new potassium-argon date of 185 Ma was obtained from the Kwun Lake stock (*see* Table 1-11-1). This

1-11-1). This somewhat younger date corresponds to the 184 Ma radiometric age of the mineralized Cariboo-Bell stock (Hodgson *et al.*, 1976).

TABLE 1-11-1
POTASSIUM-ARGON DATA, KWUN LAKE STOCK

Sample Number	Location (UTM)	Lithology	Material Analysed	%K	Ar^{40*} 10^{-40} (moles/gm)	Ar^{40*} Total Ar^{40}	Apparent Age (Ma)
86AP-20/6-64	611250E, 5806000N	Kwun stock	Biotite	5.00	16.932	89.8	185 ± 6

Rocks of Unit 9 are considered to be Tertiary, probably Early and Middle Eocene. The lacustrine varved sediments and interbedded tuffs of Subunit 9D contain Middle Eocene fossil fish, which were found in 1898 and studied by the National Museum of Canada (Wilson, 1976, 1977). Two samples from the Horsefly River near the old Hobson minesite were submitted to Glenn E. Rouse, The University of British Columbia, for palynological examination. The samples yielded a large number of palynomorphs that confirm a Middle Eocene age of between 48 and 52 Ma for the basal beds of this lacustrine unit. The samples contained 17 species of angiosperm pollen, 7 species of conifer pollen, 5 species of fungal spores and fern glochidia. The most diagnostic palynomorphs are *Pistillipollenites mcgregorii*, *Sabal granopollenites*, *Ailanthipites berryi*, *Granatisporites cotalus*, *Pluricellaesporites psilatus*, *Multicellaesporites* -6, *Tetracellaesporites* sp., *Diporisporites* sp., and glochidia of the water fern *Azolla*.

Rocks of Subunits 9A to C are assumed to be Early to Middle Eocene or older, because they form isolated erosion remnants of volcanic deposits that appear to unconformably overlie basaltic rocks. Rocks of Subunit 9C provide coarse detritus for the basal conglomerate in Subunit 9D immediately downstream from the old Hobson hydraulic mine. Similarly, clasts of Subunit 9B are found in conglomerate overlying lacustrine beds of Subunit 9D near Quesnel Lake. Plateau basalt of Unit 10 is Miocene or Pliocene (Campbell, 1978). It locally overlies Miocene(?) river channel deposits of white quartz-cobble gravel (Subunit 10A) that rest on lacustrine sediments of Subunit 9D or the Triassic-Jurassic basaltic rocks.

STRUCTURE

The region is folded into a broad, northwesterly trending, extensively block-faulted syncline. In the northwestern part the fractured but unfoliated, poorly stratified volcanic flows and flow breccia form rotated panels that dip steeply to the southwest; in the southwest, moderate to shallow-dipping flows and debris flow or laharic breccia face northeasterly. The basal sedimentary rocks of Unit 1 crop out in the extreme east and west parts of the map area and, together with the intervening 15 to 20-kilometre-wide volcanic-arc deposits, define a broad structural depression, truly a "Quesnel trough".

The structural style is identical to that further along the volcanic belt to the northwest as described by Bailey (this volume). Notable differences are: (1) stratigraphic units in the southern part of the map area trend north to north-northeast rather than northwesterly; (2) the Early Jurassic plutons (Lemon Lake, Kwun Lake, Shiko Lake and two smaller unnamed stocks) intrude the older basaltic rocks of Unit 2 along the northeastern limb of the syncline rather than the younger, more felsic volcanic units in the core of the volcanic arc; and (3) the area is generally more fragmented by block faulting and has less stratigraphic continuity.

Three main sets of faults are recognized. The earliest faults are major north to northwesterly trending structural breaks. These are cut by northeast-trending faults. The youngest northerly trending faults, and possibly some reactivated northeasterly trending structures, control the distribution of the inliers of Tertiary flows and ash flows of Unit 9 (Figure 1-11-3). They outline a north to northwesterly trending broad, shallow graben along the Horsefly River–Edney Creek axis. This zone remained as a depression during the Middle Eocene and was the site of sedimentation and tuff deposition in a broad, shallow lake. The area now occupied by the Horsefly River valley east of Horsefly village remained as a (fault-bounded ?) depression into the Late Tertiary when it was flooded by Miocene to Pliocene plateau 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 and 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 production was achieved from underground and hydraulic workings at the Hobson and Ward's Horsefly mines and from the Miocene shaft in the village of Horsefly (*see* Figure 1-11-2). Placer activity has also been recorded on a number of other creeks including Antoine, Beaver Lake, China Cabin and Moffat creeks. Placer gold from the Big Bar Creek, about 9 kilometres west of the map area, is noted to have a fineness of 980 parts per thousand, the highest of any placer gold in the province (Holland, 1950).

Bedrock sources of the placer gold remain unknown. Much of the Horsefly River gold is derived from Miocene (?) river channels containing white quartz gravels of Subunit 10A. 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 area to the southeast (93A/07) or even further east. A metasedimentary source would be consistent with the two samples of pan concentrate taken from these gravels. They are notably lacking in black sand and contain considerable garnet; the light fraction contains abundant white micas. Other placer deposits, such as those on Antoine and Beaver Lake creeks, probably have a more proximal source in basaltic volcanic rocks or alkalic intrusions. These placers are reported in a number of Minister of Mines Annual Reports (for example, 1927, pages C181, C182) to contain abundant black sand and some platinum.

Exploration for lode gold and copper-gold deposits has concentrated on intrusion-related alteration zones within and peripheral to the Early Jurassic alkalic intrusions. Exploration targets are auriferous porphyry copper mineralization such as at the Cariboo-Bell deposit (Hodgson *et al.*, 1976) and gold in propylite alteration zones in basalts such as at the

QR deposit (Fox *et al.*, 1987; Melling, this volume). The Lemon, Shiko and Kwun Lake stocks are being examined for these types of deposits. In addition, cinnabar has been noted in quartz-carbonate veinlets associated with hornblende porphyry dykes near Kwun Lake (Bill Morton, personal communication, 1986). Similar but probably younger auriferous porphyry copper mineralization is associated with quartz-bearing intrusions (part of the Takomkane stock ?) in suspected Tertiary rocks at the Megabuck prospect, 8 to 12 kilometres to the southeast of Horsefly.

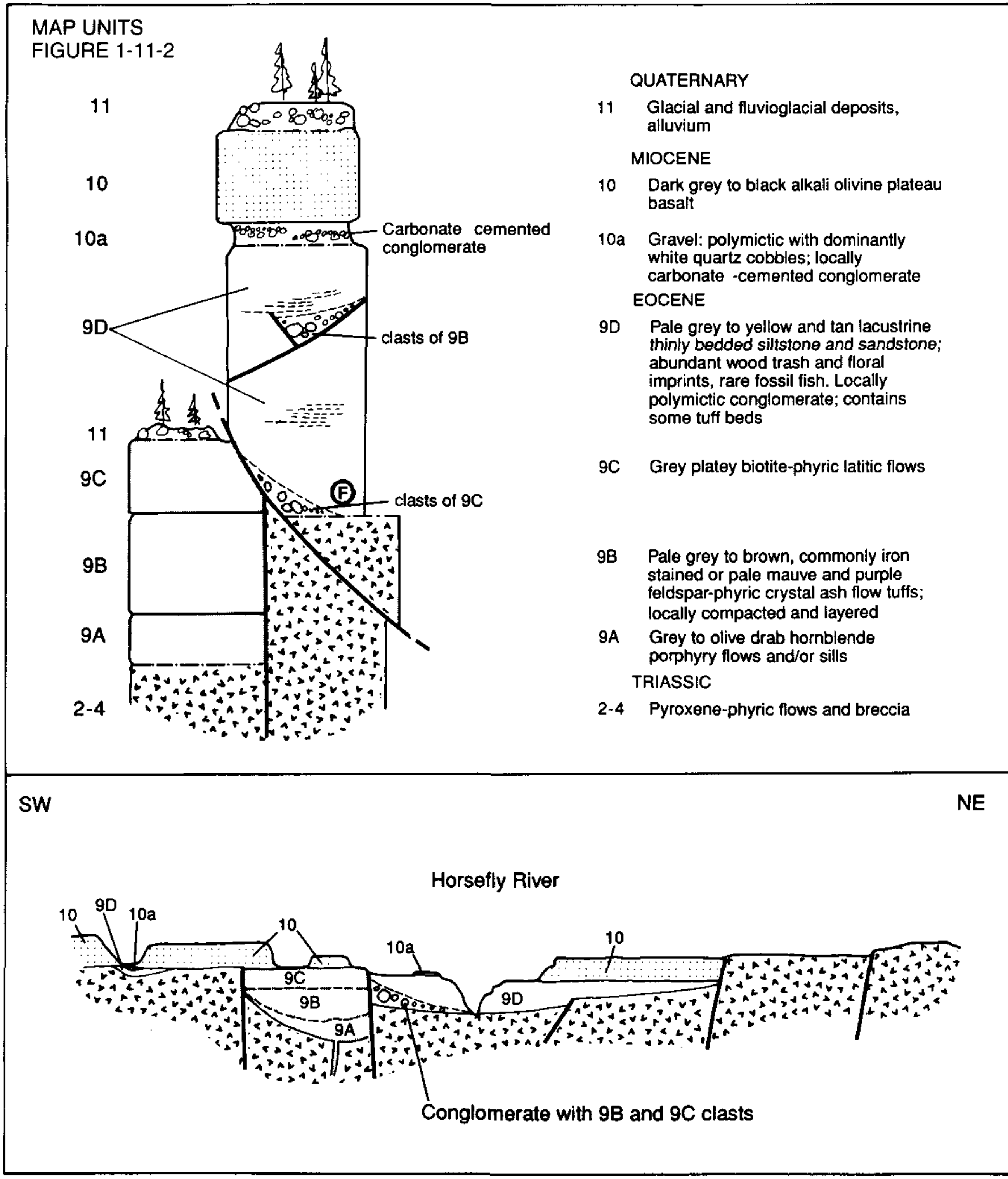

Figure 1-11-3. Schematic stratigraphic column of Tertiary map units and southwest-northeast cross-section from Beaver Creek to Horsefly Lake depicting Tertiary volcanic and sedimentary deposits infilling the northwesterly trending graben.

Elsewhere in the map area there are widespread indications of low-temperature fracture-controlled and fault-zone-related hydrothermal activity. Most commonly the fractured rocks contain zeolite and calcite veinlets and fracture coatings. Locally vein systems with calcite and calcite-quartz veinlets are developed. Propylitic alteration is evident with disseminated epidote, tremolite-actinolite, chlorite, rare garnet, pyrite and calcite veinlets in a few pervasive alteration zones in basaltic rocks. The extensively zeolitized window of basaltic rocks on the Horsefly River near the Hobson mine also contains a number of calcite-quartz veinlets, some with barite and pyrite and/or marcasite. Two areas with silicification were noted. One occurs as a pervasive to vuggy and banded pale grey chalcedonic quartz and dolomitic carbonate zone along the apparent contact of Subunits 2B and 2C about 1 to 2 kilometres north of Beaver Creek. The other is near the mouth of Edney Creek near Quesnel Lake, where chalcedonic epithermal-type vuggy quartz and calcite veins and breccia matrix are noted in the fault-bounded block of Subunit 9B/D rocks.

The association of broad propylitic alteration zones in the overall zeolite facies, subgreenschist-grade basaltic rocks, and the widespread fracture and fault-related zeolite-calcite-quartz vein systems, occasional sulphide-bearing quartz-carbonate, vuggy quartz veins and rare quartz-carbonate veins with barite or cinnabar, imply that large, low-temperature hydrothermal fluid systems were established in the map area. Veinlets and alteration are evident in almost all the Triassic and Jurassic rocks as well as some of the Eocene volcanic rocks. Thus, hydrothermal activity took place in the Tertiary as well as during the Jurassic following emplacement of the alkalic stocks. These indications are compatible with low-temperature gold deposits or peripheral zones of mesothermal gold mineralization and, therefore, provide some encouragement for further exploration.

ACKNOWLEDGMENTS

Kirk Hancock provided capable and enthusiastic mapping assistance during fieldwork. Charlie Greig provided a tour of the Megabuck prospect and succinctly outlined a number of regional geological problems that needed to be addressed. Belatedly, I thank Rudi Durfeld and Bill Morton for their valuable advice and discussions based on their long-time involvement and expertise in the map area.

REFERENCES

Bailey, D.G. (1976): Geology of the Morehead Lake Area, Central British Columbia, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Map with Notes, Preliminary Map 20.

——— (1978): The Geology of the Morehead Lake Area, South Central British Columbia, Unpublished Ph.D. Thesis, *Queen's University*, 198 pages.

——— (1988): Geology of Eastern Quesnel Belt (93A/12), *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1987, Paper 1988-1, This Volume.

Bloodgood, M.A. (1987): Geology of the Triassic Black Phyllite in the Eureka Peak Area, Central British Columbia, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1986, Paper 1987-1, pages 135-142.

Campbell, R.B. (1978): Quesnel Lake 93A Map-area, *Geological Survey of Canada*, Open File Map 574.

Fox, P.E., Cameron, R.S. and Hoffman, S.J. (1987): Geology and Soil Geochemistry of the Quesnel River Gold Deposit, British Columbia, *in* GEOEXPO '86, Proceedings, *Association of Exploration Geochemists*, Vancouver, May, 1986, pages 61-71.

Hodgson, C.J., Bailes, R.J. and Verzosa, R.S. (1976): Cariboo-Bell, *in* Porphyry Deposits of the Canadian Cordillera, *Canadian Institute of Mining and Metallurgy*, Special Volume 15, pages 388-396.

Holland, Stuart S. (1950): Placer Gold Production of British Columbia, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Bulletin 28, 89 pages.

Melling, D.R. and Watkinson, D.H. (1988): Alteration of Fragmental Basaltic Rocks: The Quesnel River Gold Deposit, Central British Columbia (93A/12W), *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1987, Paper 1988-1, This Volume.

Morton, R.L. (1976): Alkalic Volcanism and Copper Deposits of the Horsefly Area, Central British Columbia, Unpublished Ph.D. Thesis, *Carelton University*, 196 pages.

Panteleyev, A. (1987): Quesnel Gold Belt — Alkalic Volcanic Terrane Between Horsefly and Quesnel Lakes, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1986, Paper 1987-1, pages 126-133.

Struik, L.C. (1986): Imbricated Terranes of the Cariboo Gold Belt with Correlations and Implications for Tectonics in Southeastern British Columbia, *Canadian Journal of Earth Science*, Volume 23, Number 8, pages 1047-1061.

Tipper, H.W., Woodsworth, G.J. and Gabrielse, H. (1981): Tectonic Assemblage Map of the Canadian Cordillera, *Geological Survey of Canada*, Map 1505A.

Wilson, M.V.H. (1976): Paleoecology of Eocene Lacustrine Varves at Horsefly, British Columbia, *Canadian Journal of Earth Science*, Volume 14, pages 953-962.

——— (1977): Middle Eocene Freshwater Fishes from British Columbia, Life Science Contributions, *Royal Ontario Museum*, Number 13.