GEOLOGY OF THE CENTRAL QUESNEL BELT, SWIFT RIVER, SOUTH-CENTRAL BRITISH COLUMBIA (93B/16, 93A/12, 93G/1)

By D.G. Bailey
Bailey Geological Consultants (Canada) Ltd.

KEYWORDS: Regional geology, economic geology, Barkerville terrane, Swift River, stratigraphy, Upper Triassic, Lower Jurassic, alkalic plutons, porphyry copper.

INTRODUCTION

In 1988 regional mapping of the central Quesnel belt (the Quesnel Project; Panteleyev, 1987, 1988; Bailey, 1988; Bloodgood, 1988) continued in the Horsefly area (Panteleyev and Hancock, 1989, this volume) and in the Swift River area, north of the Quesnel River (Figure 1-19-1). In the latter area the Mesozoic stratigraphy was mapped to north of the Quesnel-Barkerville Highway (Figure 1-19-2) where the volcanic element of the stratigraphy lenses out. Upper Triassic pelitic and psammitic sedimentary rocks, equivalent to Bloodgood's (1988) Units 5 to 7 which underlie the Mesozoic volcanic rocks, continue to the north.

The area described in this report includes most of map sheet 93B/16, the northern part of 93A/12 and the southeastern part of 93G/1 and extends northward from the Hydraulic area mapped in 1987 (Bailey, 1988). The west-central part of the map area is partly compiled from detailed mapping in the Cantin Creek area by Lu (1989, this volume).

In the Swift River area Mesozoic outcrop is extremely sparse and geological interpretation relies to a large extent on the stratigraphic relationships determined in the Hydraulic area to the south and the aeromagnetic patterns of the various rock units. Nevertheless, the pattern of outcrop distribution is consistent with the geology of both the Hydraulic (Bailey, 1988) and Horsefly (Panteleyev, 1988) areas; volcanic rocks exhibit a regional synformal structure with local modifications. Intermediate to felsic volcanic rocks occupy the central part of the synform and mafic rocks are exposed on the limbs. The basal sedimentary rocks are more asymmetrically distributed with finer grained varieties more common to the east ("phyllites" of Struik, 1983, and Bloodgood, 1988) than in the west where psammite rather than pelite predominates. No attempt has been made to subdivide the basal sedimentary rocks (Unit 1) in the Swift River map area.

Mapping was carried out by pace-and-compass traversing, at intervals determined by the nature of the terrain and the relative abundance of outcrop interpreted from aerial photographs. Several all-weather roads and numerous logging roads and trails provide good access to most parts of the area.

STRATIGRAPHY

SEDIMENTARY AND VOLCANIC ROCKS

In general the stratigraphic succession in the Swift River area is the same as in the Hydraulic area. The lowermost rocks comprise Upper Triassic sandstone, siltstone and minor claystone with intercalated beds of mafic tuff and breccia. These volcanic beds occur throughout the sedimentary succession but become more common towards the top. Overlying the sedimentary rocks are basaltic volcanic rocks, also of Late Triassic age (probably Norian); the top of the volcanic suite is marked by a thin discontinuous limestone unit, the uppermost Triassic unit in the Mesozoic sedimentary-volcanic succession.

The Triassic stratigraphy is overlain by volcanic tuffs and breccias characterized by varying abundances of felsic material. These Lower Jurassic rocks are confined to the central volcanic axis of the belt. Middle Jurassic strata mapped in the Hydraulic area are interpreted to extend into the Swift River area, east of Maud Lake (Figure 1-19-2).

Tertiary rocks in the Swift River area are represented by Miocene plateau basalt, and sedimentary and volcanic rocks of possible Eocene age. A veneer of Pleistocene glacial and glaciofluvial deposits covers much of the area and, although probably thin, effectively masks underlying rocks.

Mapping conventions for the Triassic and Jurassic units in the Swift River area are the same for the Hydraulic area to the south, thus pyroxene basalt of Subunit 2A in the Hydraulic area is equivalent to Subunit 2A in this study. However, due

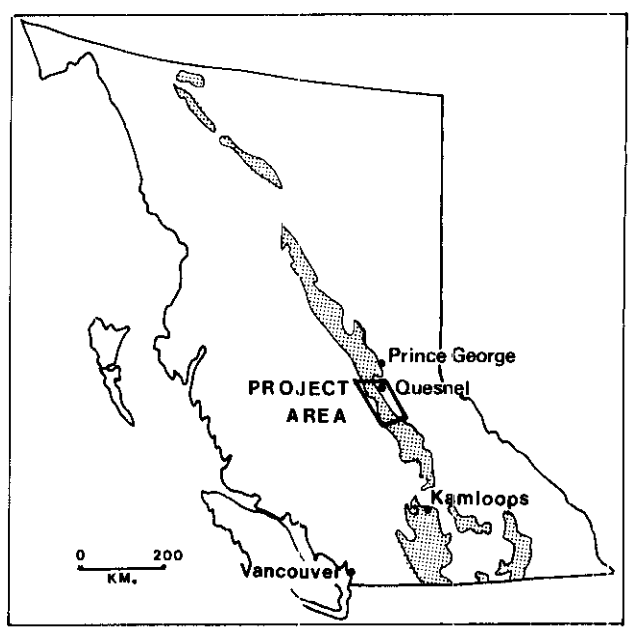

Figure 1-19-1. Location map, Swift River area. Quesnel belt and related Mesozoic volcano-sedimentary rocks shown stippled.

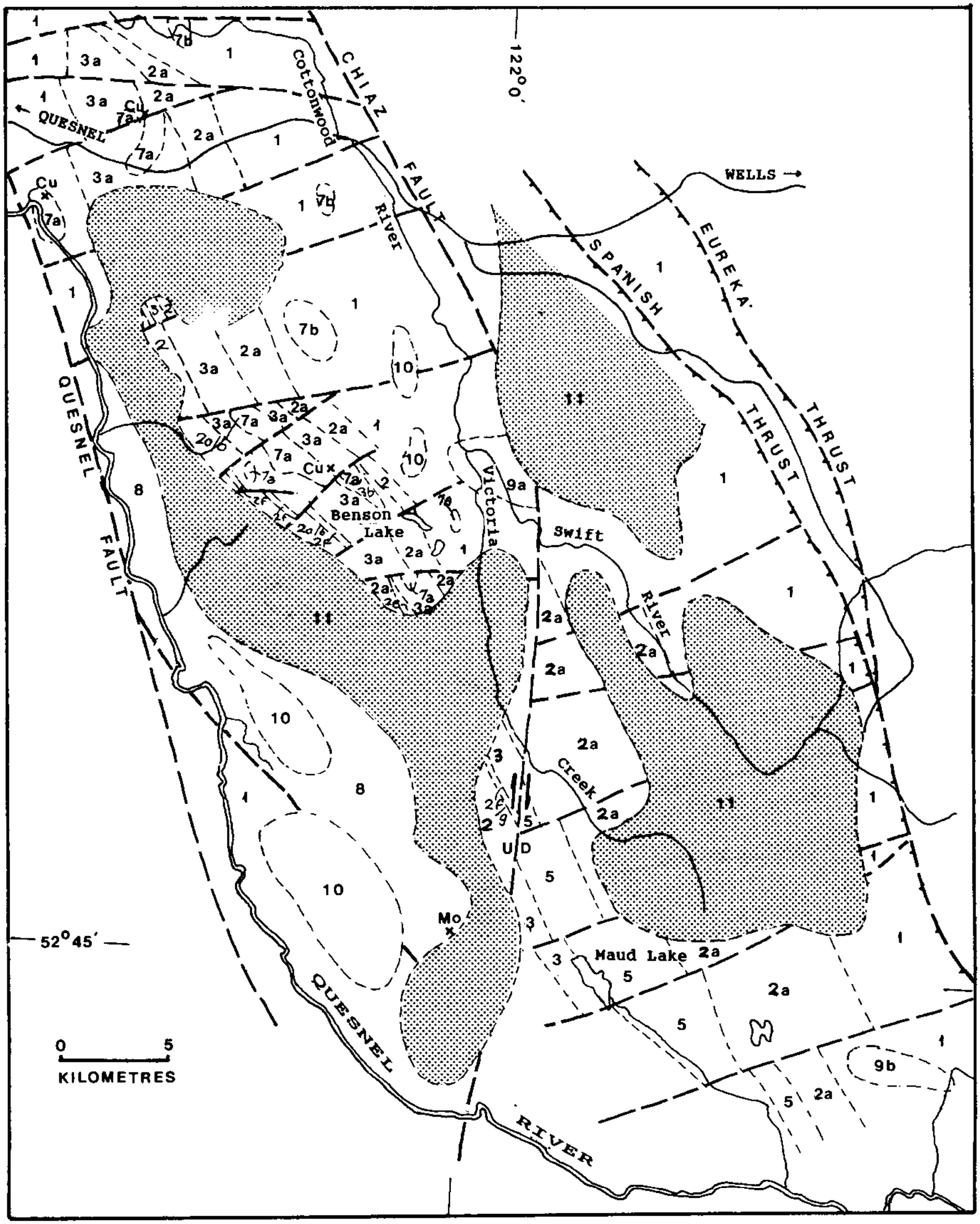

Figure 1-19-2. Geology of the Swift River area.

LEGEND

	SEDIMENTARY AND VOLCANIC ROCKS	INTRUSIVE ROCKS
PLEISTOCENE	**11** Glacial, fluvioglacial gravel and sand	
MIOCENE	**10** Alkali olivine plateau basalt	
EOCENE	**9b** Light grey latite tuff, tuff-breccia and autobreccia	
	9a Light grey sandstone and mudstone	
CRETACEOUS		**8** Medium to coarse - grained granodiorite and quartz monzonite
JURASSIC		
PLIENSBACHIAN		**7b** Pink and grey megacrystic syenite; minor hornblende gabbro and diorite
		7a Pink and grey, medium to fine-grained syenite, monzonite and diorite
	5 Dark to medium grey interbedded sandstone and siltstone	
SINEMURIAN	**3b** Reddish grey to maroon monolithic latite tuff and breccia	
	3a Maroon polylithic breccia with feldspathic clasts	
TRIASSIC		
NORIAN	**2g** Massive grey limestone and calcareous sandstone	
	2f Interbedded mafic siltstone and sandstone	
	2e Analcite-bearing maroon and grey basalt	
	2b Maroon alkali basalt breccia	
	2a Green and grey alkali and alkali olivine basalt	
CARNIAN	**1** Dark grey and green siltstone, sandstone, mafic tuff; minor conglomerate	

SYMBOLS

- - - -	Geological contact (inferred)
— —	Fault (inferred)
×	Mineral occurrence
Cu	Copper
Mo	Molybdenum

to the lack of Mesozoic exposures, the same degree of rock-type definition has not been achieved in the Swift River area and some distinct subunits such as 2C and 2D of Hydraulic have therefore been included within Subunit 2A.

UNIT 1

This unit consists mainly of sedimentary rocks which, on the basis of conodonts collected from limestones to the southeast (Bloodgood, 1988) and macrofossils identified in the western part of the Hydraulic area (Bailey, 1988), is mainly of Upper Triassic age with perhaps some Middle Triassic (Anisian) strata at the base. The unit is dominated by dark grey to medium grey pelite with grey to green-grey interbeds of psammite. Graded bedding, scour-and-fill structures and trough crossbedding are commonly seen in areas of abundant outcrop such as along the banks of the Swift and Cottonwood rivers and, with few exceptions, indicate the unit is right way up.

Psammitic beds with a large basaltic tuff component, generally recognized by a green coloration, are common in the almost continuous outcrop along the Swift River gorge in the central part of the map area. Conglomerate beds in this area also contain volcanic debris in the form of pyroxene basalt clasts and tuffaceous partings in the matrix. Basaltic breccia deposits occur elsewhere within the sedimentary rocks of Unit 1. With two exceptions these deposits are too limited in extent to represent on a 1:50 000-scale map although they do appear to occur throughout the sedimentary sequence.

Light grey and orange rhyolite sills or dykes also outcrop in the Swift River gorge, cutting the sedimentary bedding at very shallow angles. Triassic-Jurassic rocks containing modal quartz are rare within the central Quesnel belt although rhyolite dykes have been recognized in outcrops along the Quesnel River to the west of the Hydraulic area and siliceous tuffs occur within Unit 1 sediments on Spanish Mountain (Bloodgood, 1988). The significance of these dykes and tuffs with respect to the evolution of the central Quesnel belt is not yet fully understood.

In places finer grained sediments of Unit 1 are calcareous, occurring as impure silty limestone and micritic siltstone. Limestones, such as those described by Bloodgood (1988) to the southeast, have not been recognized within Unit 1 in the Swift River area.

UNIT 2

This unit represents the lowermost wholly volcanic unit in the Swift River area and is equivalent to Unit 2 in the Hydraulic (Bailey, 1988) and Horsefly (Panteleyev, 1988) areas. It consists of green and grey pyroxene basalt, pyroxene hornblende basalt and pyroxene olivine basalt (2A), usually in the form of monolithologic tuff breccias, pillow lavas, pillow breccias and autobrecciated flows. Overlying these rocks are maroon basaltic breccias of both polylithologic and monolithologic compositions (2B) representing shallow water or subaerial equivalents of the underlying green and grey basalt. Towards the top of the basaltic sequence is porphyritic analcite-bearing pyroxene basalt (2E), equivalent to that described by Bailey (1978) near Mount Polley in the Hydraulic area.

Thin maroon sandstone beds occur discontinuously at or near the top of the maroon basaltic breccia, along the strike of the volcanic belt in the Swift River area. Although included in Subunit 2F of Bailey (1988) because of its stratigraphic position, this unit may not have the same composition as Subunit 2F in the Hydraulic area. The top of the basaltic section is marked by a thin, light grey limestone unit (2G) which, however, only appears to occur on the western contact with overlying rocks of Unit 3.

Unit 2 is considered to be entirely of Late Triassic age (Norian) on the basis of fossil evidence in the Hydraulic area (Bailey, 1988). No fossils have been identified in these rocks in the Swift River area.

UNIT 3

Whereas Unit 2 is mainly basaltic in composition, Unit 3 is characterized by felsic rocks as well as basaltic debris derived from the underlying unit. In the Swift River area Unit 3 comprises polylithologic breccias (3A) and minor amounts of monolithologic breccia of Subunit 3B.

Subunit 3B represents the direct products of felsic volcanism while the much more voluminous Subunit 3A is considered to have resulted from laharic activity along the flanks of volcanic edifices. Subunit 3A contains material from all underlying rock types together with clasts of syenite, monzonite, monzodiorite and diorite, and extrusive equivalents of these rock types. Without exception, Unit 3 is distributed along the axis of the Swift River area volcanic belt.

Based on paleontological evidence in the Hydraulic area (Bailey, 1988) the age of Unit 3 is probably Sinemurian (Early Jurassic), indicating a possible depositional hiatus of several million years between Unit 2 and Unit 3.

UNIT 5

Unit 5 has a similar composition to Unit 1 consisting of dark to medium grey, commonly pyritic, psammite and pelite. Although unfossiliferous, the outcrop distribution suggests these rocks are equivalent to similar sedimentary rocks which outcrop to the southeast, along the Quesnel River near Likely. The contact of Unit 5 with underlying rocks of Unit 2 is either an unconformity or a fault.

The presence of *Arieticeras* sp. collected from Unit 5 in the Likely area (R.B. Campbell, personal communication, 1976) indicates these rocks are of Pliensbachian age. Unit 4, a maroon analcite-bearing basaltic unit stratigraphically lower than Unit 5 in the Hydraulic area, is absent in the Swift River area.

UNIT 9

A sequence of light grey mudstones and sandstones (9A), which Struik (1987) considered to be of Eocene age, crops out along part of the Swift River and Victoria Creek. Lithologically these rocks are similar to sedimentary rocks exposed along the Horsefly River (Panteleyev, 1988) from which Middle Eocene fish fossils have been obtained (Wilson, 1977a, 1977b). Along Victoria Creek these strata dip gently east, in contrast to the steeply dipping underlying Mesozoic sedimentary rocks.

A succession of latite tuff, polylithologic and monolithologic breccias mainly of latitic composition, and minor autobrecciated latite flows (9B) is exposed near Kangaroo Creek in the southeastern part of the map area. These rocks overlie sedimentary rocks of Unit 1 and are spatially unrelated to felsic volcanic rocks of Unit 3. Although it is conceivable they represent a separate Sinemurian (Unit 3) volcanic centre, the writer considers it more likely they are equivalent to biotite-bearing Eocene volcanic rocks described by Panteleyev (1988) in the Horsefly area. However, biotite is absent in volcanic rocks in the Kangaroo Creek area; in this respect they are more similar to latitic rocks of Unit 3.

Unit 10

This unit consists of olivine basalt flows, remnants of plateau basalt which covered much of the Quesnel region during Miocene time. In the Swift River area flow-top breccias and columnar jointing are well developed in Unit 10 which provides a subhorizontal capping to hills in the central and southwestern parts of the area.

Unit 11

This unit comprises the unconsolidated deposits of Pleistocene glacial and fluvioglacial processes and covers much of the map area. Although commonly consisting of a thin veneer of till, these deposits have attained thicknesses of greater than 150 metres in incised river valleys such as that of the Quesnel River. Direction of transport of these deposits was commonly between about 300 and 310 degrees.

INTRUSIVE ROCKS

Unit 7

Unit 7, comprising stocks of syenite, monzonite and diorite, is subdivided into two subunits. Subunit 7A consists of generally fine-grained, nonporphyritic grey monzonite, diorite and pink syenite which have intruded the Triassic-Jurassic volcanic stratigraphy. Almost all of these stocks have associated pyrite-chalcopyrite mineralization with attendant propylitic alteration halos. Subunit 7B consists mainly of stocks of a distinctive grey porphyritic syenite with very large (up to 10 centimetres in length) feldspar phenocrysts; these rocks are only seen intruding sedimentary rocks of Unit 1.

A stock of Subunit 7B, in which porphyritic syenite has been intruded by diorite and later by coarse-grained hornblende pyroxene gabbro, outcrops along the Cottonwood River. In places the mafic rocks are intensely chloritized although the syenite has remained relatively unaltered.

The age of Subunit 7A is considered to range from late Early Jurassic to Middle Jurassic on the basis of stratigraphic evidence and radiometric dates from similar plutons to the south. However, whether Subunit 7B is the same age is not known at this time. Hornblende from gabbro of the Cottonwood River stock has been collected for radiometric dating but results are not yet available.

Unit 8

A large granodiorite and quartz monzonite pluton extends along the southwestern corner of the Swift River area and into the Hydraulic map area (Bailey, 1988). It is similar in composition to Cretaceous plutons elsewhere in the region and is also assumed to be Cretaceous.

STRUCTURE AND METAMORPHISM

The structural geology of the Swift River area is similar to that of the Hydraulic area to the south (Bailey, 1988) and is related to collision of Quesnellia with the Omineca crystalline belt to the east and to a later period of crustal extension. The accretion of Quesnellia onto the Mesozoic North American margin is only recorded in the easternmost rocks of Unit 1 in the Swift River area. Here northwest-striking folds (F_1), with an accompanying well-developed axial planar fabric, have been refolded about northeast-striking axes (F_2). Although F_2 folding does not appear to have been accompanied by penetrative deformation, an S_2 crenulation cleavage is commonly associated with F_2 folds. This style of deformation is similar to that described by Bloodgood (1988) in the Spanish Lake area.

Deformation of the easternmost rocks of Unit 1 has resulted in the formation of phyllite in fine-grained carbonaceous sediments. The occasional development of chlorite along foliation planes suggests greenschist facies of regional metamorphism has been attained in this area.

The contact of Unit 1 sedimentary rocks with the older crystalline rocks of the Omineca Belt is marked by the Eureka thrust (Struik, 1983). Rocks in the footwall of the thrust comprise metasedimentary rocks of the Barkerville terrane.

Struik has mapped a second thrust fault, the Spanish thrust, within Unit 1 metasedimentary rocks. The location of these thrusts, compiled from Struik (1987), is shown in Figure 1-19-2.

Northeasterly striking faults are inferred throughout the Swift River area, cutting the Mesozoic stratigraphy. Although none of these faults has been directly observed, their presence is suggested by aeromagnetic patterns and outcrop distribution. It is not clear whether they cut the thrust faults which bound the eastern part of the central Quesnel belt. Bloodgood (1988) has mapped northeasterly striking faults within the Barkerville terrane of the Spanish Lake area but there is little evidence for offset of the Eureka thrust itself.

Northeasterly striking faults are interpreted to cut late Lower Jurassic to Middle Jurassic rocks but not rocks interpreted to be Cretaceous and younger. In contrast, northerly to northwesterly striking faults in the Swift River area, named here the Quesnel and Chiaz faults, have cut rocks assumed to be of Cretaceous age but not Miocene plateau basalt. The Chiaz fault cuts obliquely through the volcanic axis of the central Quesnel belt in the Swift River area with minimum dextral displacement of about 4 kilometres. The distribution of outcrops of Triassic basalt on either side of the fault suggests 5 kilometres of relative uplift on the west side of the fault. The trace of the Chiaz fault zone, which is exposed in the Swift River valley, is well displayed on the regional aeromagnetic map.

Metamorphism of Mesozoic rocks in the Swift River area is typical of the zeolite facies of regional metamorphism. Contact metamorphic effects have occurred around several plutons, with the development of biotite hornfels where stocks have intruded sedimentary rocks of Unit 1. Where stocks have intruded volcanic rocks contact metamorphic effects are not obvious, perhaps because these rocks were less reactive or because contact metamorphic effects have been obliterated by later metasomatic overprinting.

MINERALIZATION

The porphyry copper potential of the central Quesnel belt has long been realized and most of the larger Jurassic alkaline stocks have been explored. The Cariboo Bell deposits in the Polley stock of the Hydraulic area (Bailey, 1988) are by far the largest porphyry copper deposits discovered to date, but almost all stocks within felsic rocks of Unit 3 have associated copper mineralization.

In the Swift River area copper mineralization is known in stocks south of Benson Lake, at Cantin Creek and at Mouse Mountain in the northern part of the map area (Figure 1-19-2). Copper is invariably chalcopyrite with minor bornite and occasional chalcocite. Pyrite is always present, both with chalcopyrite and as a pyritic-propylitic halo around zones of copper mineralization. Magnetite is also ubiquitous and magnetic patterns are important indicators of the presence of stocks in overburden-covered areas.

Copper deposits associated with alkaline felsic stocks are commonly enriched in gold relative to porphyry deposits in calcalkaline intrusions. The QR deposit in the Hydraulic area (Bailey, 1988) comprises gold-bearing pyrite mineralization with associated chalcopyrite within a zone of intensely propylitized basaltic breccia marginal to an alkaline felsic stock. The reactive nature of the rocks was probably caused by the presence of abundant carbonate in marine sediments in which the basaltic breccias were deposited, and also by post-depositional carbonate metasomatism. Given the very poor exposure in the Swift River area and the fact that most drilling has been within the felsic stocks themselves, there is potential for new discoveries similar to the QR deposits which are more related to exoskarns than to porphyry systems.

In addition to copper mineralization associated with alkaline felsic stocks intruding felsic volcanic terrain, minor pyrite-chalcopyrite mineralization occurs in a small stock which has intruded sedimentary rocks east of Benson Lake. The general lack of sulphide mineralization around stocks of Subunit 7B may perhaps be attributed to depth of intrusion, a factor in the formation of hydrothermal systems. The lack of suitable source rocks may also be a contributing factor.

Minor molybdenite mineralization was discovered in granodiorite of Unit 8 during exploration of this stock in the early 1970s.

ACKNOWLEDGMENTS

Giovanni Pagliuso is thanked for his enthusiastic and uncomplaining assistance during the mapping program. Maps supplied by Dr. Peter Fox of Fox Geological Consultants Ltd. were of great help in locating outcrops in heavily wooded and till-covered terrain and were much appreciated.

REFERENCES

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

——— (1988): Geology of the Central Quesnel Belt, Hydraulic, South-central British Columbia (93A/12), *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1987, Paper 1988-1, pages 147-153.

Bloodgood, M.A. (1988): Geology of the Quesnel Terrane in the Spanish Lake Area, Central British Columbia, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1987, Paper 1988-1, pages 139-145.

Lu, J. (1989): Geology of the Cantin Creek Area, Quesnel River (93B/16), *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1988, This Volume.

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.

——— (1988): Quesnel Mineral Belt–the Central Volcanic Axis between Horsefly and Quesnel Lakes (93A/05E, 06W), *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork, 1987, Paper 1988-1, pages 131-137.

Panteleyev, A. and Hancock, K.D. (1989): Quesnel Mineral Belt–Summary of the Geology of the Beaver Creek–Horsefly River Map Area, *B.C. Ministry of Energy, Mines and Petroleum Resources*, Geological Fieldwork 1988, This Volume.

Struik, L.C. (1983): Bedrock Geology of Spanish Lake (93A/11) and Parts of Adjoining Map Areas, Central British Columbia, *Geological Survey of Canada*, Open File Map 920.

——— (1987): Bedrock Geology, Swift River, *Geological Survey of Canada*, Open File Map 858.

Wilson, M.V.H. (1977a): Paleoecology of Eocene Lacustrine Varves at Horsefly, British Columbia, *Canadian Journal of Earth Sciences*, Volume 14, pages 953-962.

——— (1977b): Middle Eocene Freshwater Fishes from British Columbia, *Royal Ontario Museum*, Life Sciences Contributions, Volume 113, pages 1-61.