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By Don G. MacIntyre

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GEOLOGY AND MINERAL DEPOSITS OF THE TAHTSA LAKE DISTRICT, WEST-CENTRAL BRITISH COLUMBIA

By Don G. MacIntyre

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SUMMARY

This bulletin describes the geology and mineral deposits in the vicinity of Tahtsa Lake, West Central British Columbia. The study area covers approximately 1 000 square kilometres and extends from latitude 53 degrees 30 minutes north to 53 degrees 52 minutes north and from longitude 127 degrees west to 127 degrees 30 minutes west. The study area is part of the Whitesail Lake map sheet (NTS 93E).

Within the map-area deformed andesitic volcanic and sedimentary rocks of the Early to Middle Jurassic Hazelton Group and successor basin deposits of the Late Jurassic and Early Cretaceous Bowser and Skeena Groups are unconformably overlain by continental volcanic rocks of Late Cretaceous age. These rocks constitute the Kasalka Group as defined in this study.

Kasalka Group rocks are preserved in a fault-bounded structural depression that is interpreted to be a cauldron subsidence complex of Late Cretaceous age. Within the area of subsidence, the Kasalka Group is over 1 000 metres thick and includes a lower felsic fragmental unit that is overlain by units of porphyritic andesite, lahar, and columnar jointed basalt. These units thin rapidly away from the area of subsidence and are succeeded to the north by younger rhyodacite flows.

Several small porphyritic andesite, microdiorite, dacite porphyry and rhyolite porphyry dykes, sills, plugs, and laccoliths are peripheral to and within the area of subsidence; these intrusions are interpreted to be comagmatic with the volcanism. Potassium argon isotopic age dating indicates that rocks of the Kasalka Group range in age from 105 to 87 Ma. Granitic intrusions are divisible into two age groups — 83 to 75 Ma and 58 to 49 Ma. All rocks are cut by late northwest-trending dyke swarms.

Granitic intrusions of Late Cretaceous and Tertiary age are unroofed outside the area of subsidence. Porphyry copper and molybdenum deposits are associated with porphyritic phases of these intrusions. Veins containing lead, zinc, and silver are also present. Berg, Huckleberry, and Ox Lake are the most economically significant deposits discovered to date.

This study suggests that emplacement of granitic intrusions and hydrothermal activity post-dated cauldron subsidence by several million years. However, ring and radial fractures generated during the early stages of subsidence may have controlled the location of later intrusive centres and their associated hydrothermal systems.

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INTRODUCTION

LOCATION AND ACCESS

The Tahtsa Lake porphyry copper district is in west-central British Columbia between latitudes 53 degrees 30 minutes and 53 degrees 32 minutes north, and longitudes 127 degrees and 127 degrees 30 minutes west (Fig. 1); it is part of the Whitesail Lake map-area (93E/11, 14). Tahtsa Lake is at the geographic centre of this area and is accessible via

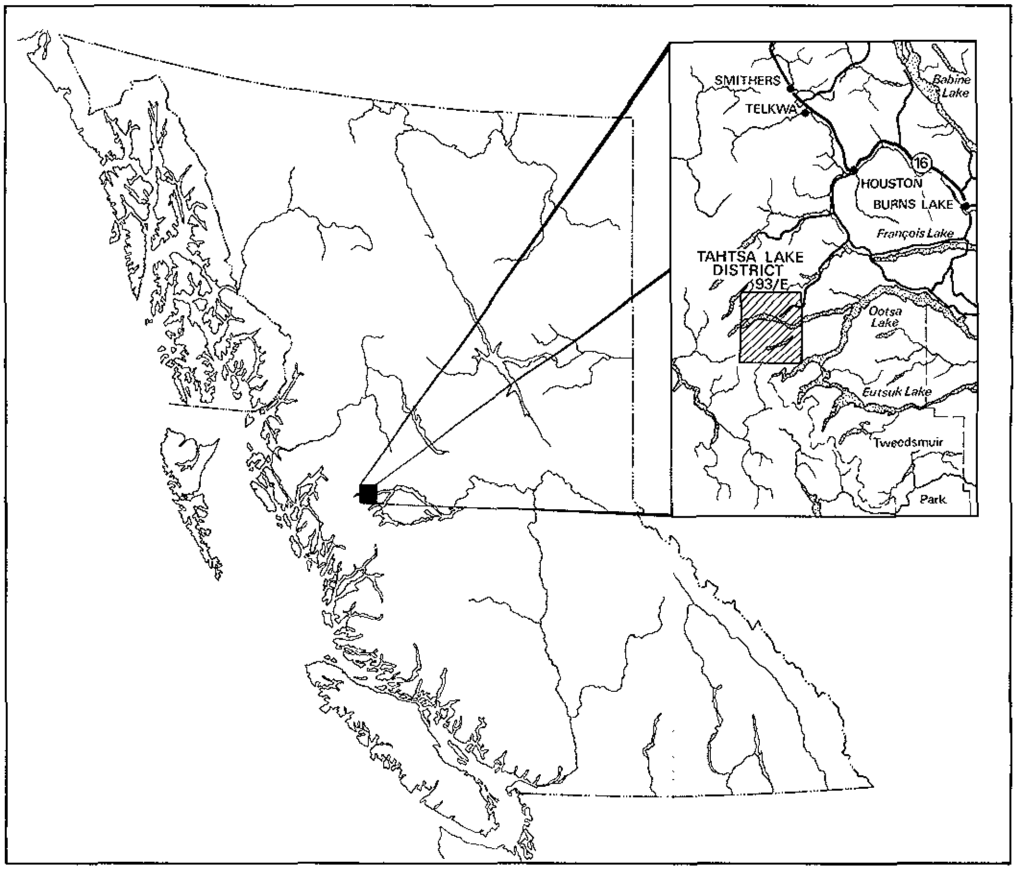

Figure 1. Tahtsa Lake district location map.

forestry access roads from the town of Houston, a distance of 85 kilometres. Terrane south of Tahtsa Lake can only be reached by helicopter, or by boat across the lake and then on foot.

PHYSIOGRAPHY, OUTCROP DISTRIBUTION, AND GLACIATION

The Tahtsa Lake district is part of a transitional zone between the Coast Mountains to the west and the Interior Plateau to the east. This area is characterized by ridges and peaks rising to 2 400 metres above an average base elevation of 900 metres. In spite of pronounced relief, outcrops are generally restricted to the steeper slopes and peaks, and to downcutting stream valleys. Broad, U-shaped valleys between the ranges are filled with fluvioglacial debris and generally lack outcrop. The best and most easily accessible outcrops are on the shorelines of Tahtsa and Troitsa Lakes.

The Tahtsa Lake area has had several episodes of continental and alpine glaciation. Remnant icefields and small alpine glaciers are common, particularly in cirque valleys surrounding the higher peaks. Remnants of a once continuous upland surface are preserved above 1 800 metres in the Sibola Range (Church, 1971) suggesting that this area may have been part of a plateau prior to glaciation.

PREVIOUS WORK

The northern half of the Tahtsa Lake area was first mapped by M. S. Hedley of the Geological Survey of Canada in 1935, at a scale of 1:250 000. From 1947 to 1952, S. Duffell mapped the remainder of the area as part of the Whitesail Lake (NTS 93E) map sheet. In 1961 the Berg porphyry copper deposit was discovered by Kennco Explorations, (Canada) Limited, generating considerable interest in the economic potential of the area. In the following years, six more porphyry copper occurrences were discovered. Geologic information on these occurrences has been published by the British Columbia Ministry of Energy, Mines and Petroleum Resources (Sutherland Brown, 1966, 1969; Carter, 1970, 1974; Church, 1971). Several thesis studies (Cawthorn, 1973; MacIntyre, 1974; Richards,1974; Panteleyev, 1976) have also been completed on individual deposits. Detailed assessment reports summarizing exploration work on major properties have also provided valuable information (for example, Cann, 1981; Goldsmith and Kallock, 1981).

PROJECT SUMMARY

The Tahtsa Lake porphyry copper district, an area of approximately 1 000 square kilometres, was mapped at a scale of 1:50 000 in the summers of 1973 and 1974. The results of this work are presented on Figure 2 (in pocket). A total of 525 rock samples were collected from this area; from these, 186 thin sections were prepared and studied in detail. In addition, the whole rock chemical compositions of 42 samples of Upper Cretaceous volcanic and plutonic rocks were determined by the author using X-ray fluorescence spectroscopy. The K/Ar isotopic ages of three whole rock samples were determined by Teledyne Isotopes Inc.

ACKNOWLEDGMENTS

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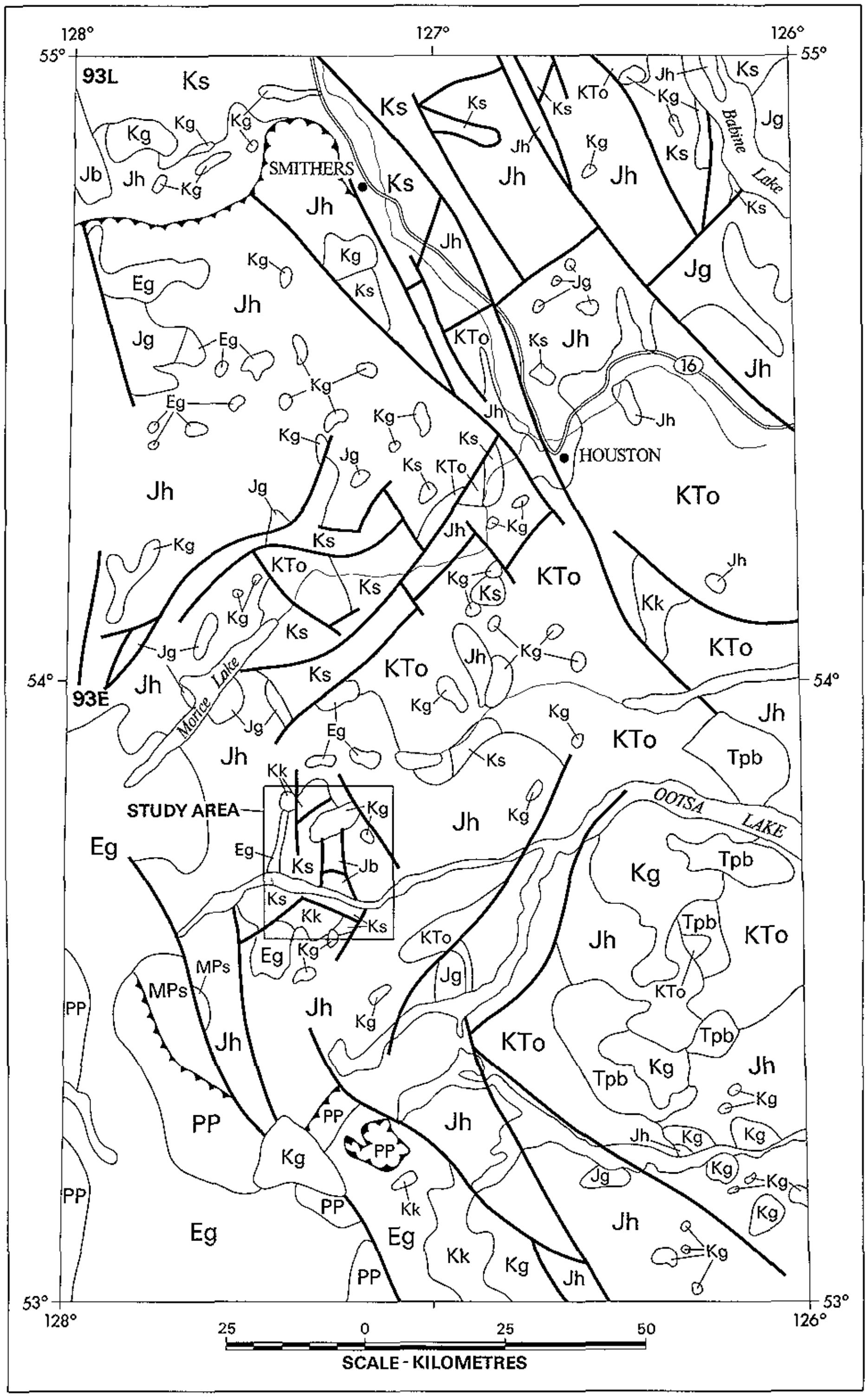

Figure 3. General geology of west-central British Columbia.

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GENERAL GEOLOGY

REGIONAL SETTING

The Tahtsa Lake district is near the centre of the Pacific Orogen (Wheeler, *et al.*, 1972), just east of the boundary between the Coast Crystalline and Intermontane Tectonic Belts (Fig. 1). The Coast Crystalline Belt is essentially an uplifted terrane of Permian to Tertiary granitic and metamorphic rocks bounded by northwest-trending transverse faults; the Intermontane Belt is composed mainly of folded eugeosynclinal rocks of Early to Middle Mesozoic age. In west-central British Columbia the Intermontane Belt includes successor basin deposits of the Bowser basin and Late Mesozoic to Early Cenozoic continental sedimentary, volcanic, and plutonic rocks.

The distribution of major geologic formations in west-central British Columbia is shown on Figure 3. The most areally extensive of these is the Hazelton Group (Leach, 1910; Hanson, 1935; Armstrong, 1944; Tipper, 1955, 1971; Tipper and Richards, 1976) which is basement for most of the area. The Hazelton Group consists mainly of folded andesitic volcanic and sedimentary rocks that probably represent remnants of ancient volcanic island arcs. The Hazelton Group is unconformably overlain by successor basin deposits of the Late Jurassic Bowser Lake and Early Cretaceous (Albian) Skeena Groups. East of Babine Lake, Late Cretaceous continental sedimentary rocks occur in the Sustut basin. Continental volcanic rocks of Late Cretaceous to Tertiary age crop out in the vicinity of Francois and Ootsa Lakes where they constitute the Tiptop Hill and Ootsa Lake volcanic rocks respectively. A younger (Eocene) sequence of volcanic rocks, known as the Endako and Goosly Lake Groups, occurs in the Houston area. The eastern half of the Interior Plateau is largely covered by late Tertiary plateau basalts.

The Intermontane Belt has been the site of major episodes of plutonic activity from Late Triassic until Tertiary time. Carter (1974) has shown that these intrusive rocks form groups with distinctive isotopic ages, chemical compositions, associated metal concentrations, and spatial distribution. Although most of the intrusions are Late Cretaceous or Tertiary in age, a few are older. These are the Topley, Omineca, Francois Lake, and Kitsault intrusions which range from Triassic to Late Jurassic in age. The distribution of the Late Cretaceous Bulkley intrusions defines a north-trending belt which includes the Tahtsa Lake area (Fig. 3). The Alice Arm and Nanika intrusions, which are Eocene in age, occur in a belt parallel to the eastern margin of the Coast Crystalline Belt; several of these intrusions occur in the Tahtsa Lake area. The Babine intrusions are also Eocene in age but are restricted to the Babine Lake area.

TABLE 1. TABLE OF FORMATIONS, TAHTSA LAKE DISTRICT

PERIOD	EPOCH	FORMATION	MAP SYMBOLS	LITHOLOGY
QUATERNARY	Pleistocene and Recent		Qal	Till, alluvium, colluvium
TERTIARY	Eocene and younger (may include Cretaceous)	Late dykes, sills, and plugs		Basalt, rhyolite, andesite, lamprophyre, feldspar porphyry, aplite
	Intrusive Contact			
	Eocene	Nanika Intrusions	Tpqm	Porphyritic biotite-quartz monzonite
		Intrusive Contact		
		Coast Intrusions	Tqd	Biotite-hornblende quartz diorite
		Not in Contact		
		Mount Bolom Intrusion	Tpgr	Porphyritic hornblende-biotite granophyre
Not in Contact				
CRETACEOUS	Late Cretaceous	Bulkley Intrusions	uKpqm uKpgd uKgd uKqd	Porphyritic hornblende-biotite quartz monzonite and granodiorite, biotite-hornblende granodiorite, and quartz diorite
		Intrusive Contact		
		Rhyolitic Intrusions	uKqp	Quartz porphyry, dacite porphyry, breccia
	Not in Contact			
	Early to Late Cretaceous (in part Tertiary ?)	Kasalka Intrusions	uKdr	Porphyritic andesite and diorite
		Intrusive Contact		
		Kasalka Group	uKTb	BASALT UNIT: Basalt, andesite
			uKr	RHYOLITE UNIT: Rhyolite
			uKl	LAHAR UNIT: Lahar, slump breccia, volcanic sandstone, minor andesite flows
			uKp	PORPHYRITIC ANDESITE UNIT: porphyritic augite-hornblende andesite
			luKf	FELSIC FRAGMENTAL UNIT: welded and non-welded ash, crystal, and lapilli tuff, volcanic breccia and agglomerate, minor andesite and dacite flows
			luKc	BASAL PEBBLE CONGLOMERATE UNIT: Pebble conglomerate, sandstone
	Angular Unconformity			
	Early Cretaceous (Albian)	Skeena Group	lKs	MARINE SEDIMENTARY UNIT: Micaceous wacke, argillite, minor conglomerate
			lKv	AMYGDALOIDAL BASALT UNIT: Spilitized amygdaloidal basalt
Unconformity				
JURASSIC	Middle Jurassic (Upper Bathonian — Lower Callovian)	Bowser Lake Group (Ashman Formation)	mJs	MARINE SEDIMENTARY UNIT: Lithic and feldspathic wacke, conglomerate, argillite, tuff (may include Smithers Formation)
	Unconformity			
	Lower to Middle Jurassic (Sinemurian to Middle Bajocian)	Hazelton Group (Whitesail/Smithers Formations)	lmJc	FELSIC VOLCANIC AND CHERT UNIT: Chert, rhyolite, ash flow, welded tuff, argillite, volcanic wacke
		Hazelton Group (Telkwa Formation)	lJf	ANDESITIC FRAGMENTAL UNIT: Red and green ash, crystal, and lapilli tuff, agglomerate, volcanic breccia, minor tuffaceous sandstone, porphyritic andesite flows

GEOLOGY OF THE TAHTSA LAKE DISTRICT

Jurassic and Early Cretaceous volcanic and sedimentary rocks underlie most of the Tahtsa Lake map-area (Fig. 2, in pocket). These rocks have been folded and faulted; they are unconformably overlain by relatively flat-lying Late Cretaceous volcanic rocks. The entire sequence is cut by plutons of Late Cretaceous to Early Tertiary age — several have spatially associated porphyry copper deposits. The major map units recognized in the Tahtsa Lake district are summarized in Table 1. Stratigraphic and intrusive relationships are illustrated on Figure 4. Figure 5 shows the general geology of the district.

HAZELTON GROUP

The oldest rocks in the Tahtsa Lake area are Early Jurassic in age and belong to the Hazelton Group. These rocks, which crop out in the eastern half of the map-area, form a terrane of glacially rounded hills and ridges (Fig. 5). Good exposures of these rocks also occur on the western slope of the Tahtsa Range and on the shores of Tahtsa and Troitsa Lakes.

ANDESITIC FRAGMENTAL UNIT (TELKWA FORMATION; lJf)

In the Tahtsa Lake area andesitic fragmental rocks of the Hazelton Group are assigned to the Telkwa Formation as defined by Tipper and Richards (1976). These rocks are predominantly fragmental in nature, and are characteristically red and green in colour due to hematitic and chloritic alteration. Individual beds range from several centimetres (Plate I) to as much as 100 metres in thickness. Lapilli tuff, lithic tuff, crystal tuff, and tuff breccia predominate; there are minor intercalations of porphyritic augite andesite, dacite, tuffaceous siliceous argillite, and pebble conglomerate. The fragmental rocks are poorly sorted and contain mainly angular clasts of andesite and tuff with lesser amounts of chert and rhyolite (Plate II). The matrix is largely composed of quartz and plagioclase crystal fragments cemented by sericite and microcrystalline silica.

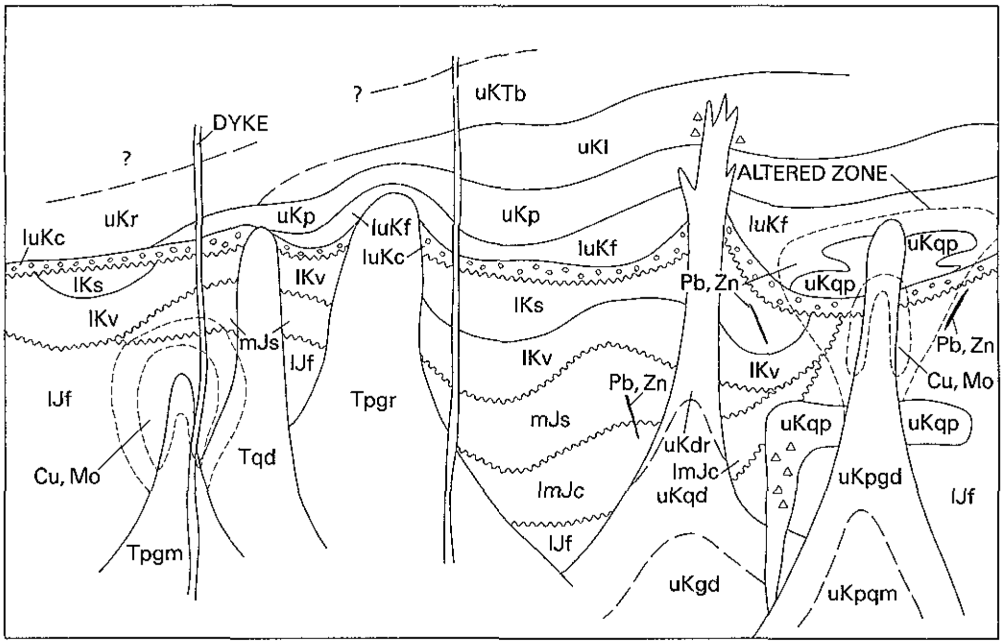


Figure 4. Schematic diagram of stratigraphic and intrusive relationships, Tahtsa Lake district (*see* Table 1 for explanation of symbols).

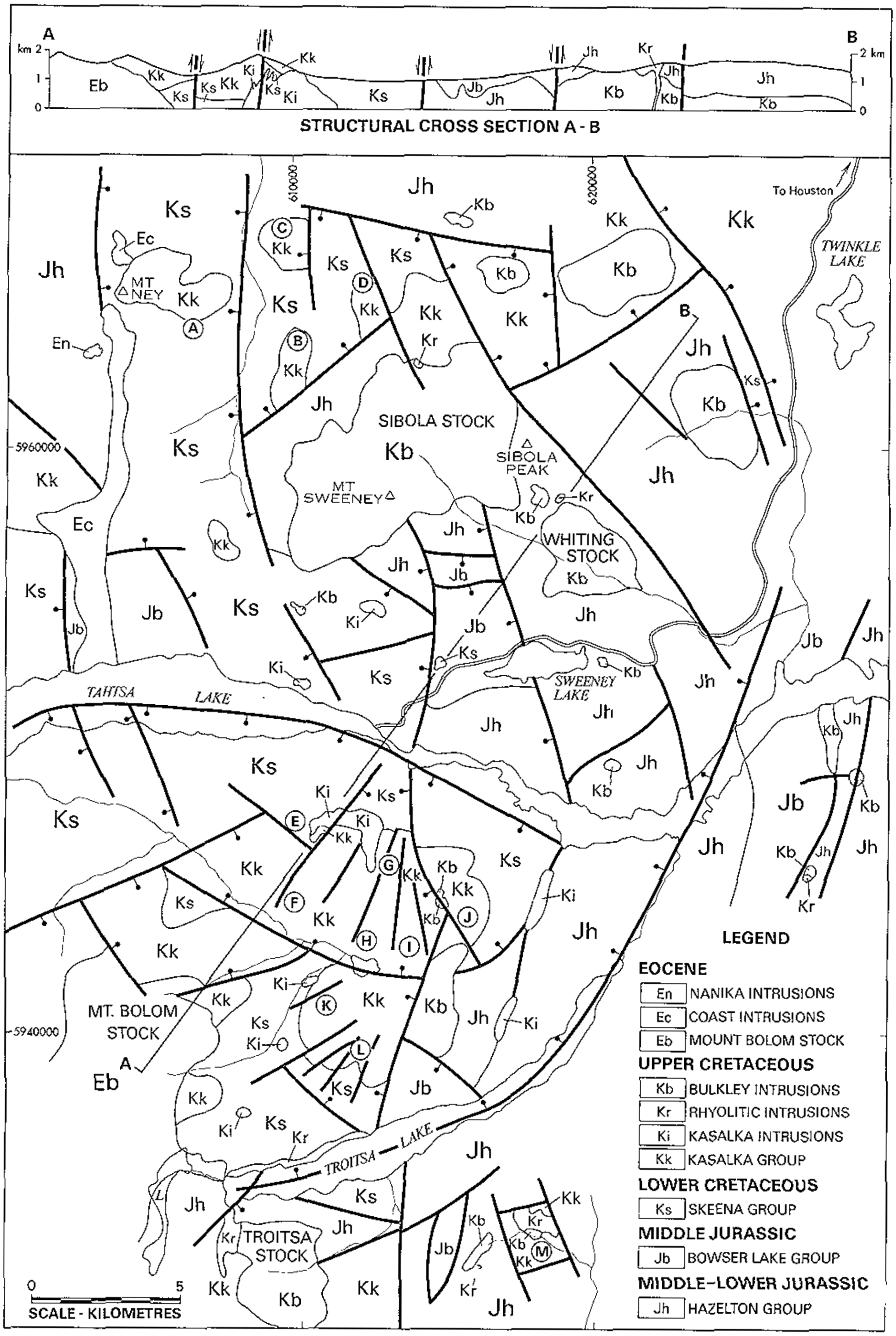


Figure 5. General geology, Tahtsa Lake district; structural cross-section A-B.

FELSIC VOLCANIC — CHERT UNIT [SMITHERS AND/OR WHITESAIL FORMATION (?); lmJc]

Siliceous light grey, greenish grey, and dark grey volcanic rocks conformably overlie, and are, in part, interbedded with red and green volcanic units of the Telkwa Formation. These rocks are typically thin bedded, and in places are finely laminated. The predominant rock types are welded lapilli tuff (Plate III), mottled cherty tuff, and banded or massive dacite and rhyodacite. Eutaxitic textures are common in the more siliceous fragmental rocks. These felsic volcanic rocks grade upward into alternating beds of mottled and banded grey chert, siliceous argillite, and siltstone which may be part of the Smithers Formation. Stratabound lenses of pyrite and pyrrhotite, up to several centimetres thick, are common in this part of the section.

BOWSER LAKE GROUP

MARINE SEDIMENTARY UNIT (ASHMAN FORMATION; mJs)

Marine sedimentary rocks of the Bowser Lake Group occur in a fault-bounded block northwest of Sweeney Lake (Woodsworth, personal communication). Up to 800 metres of interbedded dark grey pebble conglomerate (Plate IV), sandstone, siltstone, shale, and minor tuff are exposed along the old Emerald Glacier mine road. Shelly fauna, particularly large coiled ammonites (Plate V), occur in the clastic sedimentary units; they indicate a Late Bathonian age (Woodsworth, personal communication; Appendix A). On the basis of this age, these rocks can be correlated with the Ashman Formation of the Bowser Lake Group.

SKEENA GROUP

The Early Cretaceous succession is comprised of distal turbidites; such rocks are typical of the successor basin deposits of the Skeena Group. In the Tahtsa Lake area Skeena Group rocks are well exposed on the south shore of Tahtsa Lake, in the core of the Tahtsa Range, and on Swing Peak ridge.

Duffell (1959) first recognized sedimentary rocks of Early Cretaceous age in the Tahtsa Lake area; he suggested a twofold division into a lower sedimentary unit and an upper volcanic unit. However, the contact between these units is an angular unconformity that represents a major depositional hiatus. Duffell's upper volcanic unit is, in fact, the Late Cretaceous Kasalka Group as defined in this study.

In several localities throughout the map-area, Early Cretaceous sedimentary rocks conformably overlie amygdaloidal basalt flows. These flows unconformably overlie Hazelton Group strata and therefore are included with the Skeena Group. The combined thickness of the Skeena Group is estimated to be at least 1 500 metres.

BASAL CONGLOMERATE UNIT (lKc)

The base of the Skeena Group is not well exposed; contacts with older rocks are generally faults. However, a relatively flat-lying boulder conglomerate (Plate VI) exposed on the east bank of Rhine Creek, approximately 700 metres upstream from the access road bridge, appears to conformably underlie nearby columnar-jointed, amygdaloidal basalt flows. This conglomerate may be the basal member of the Skeena Group.

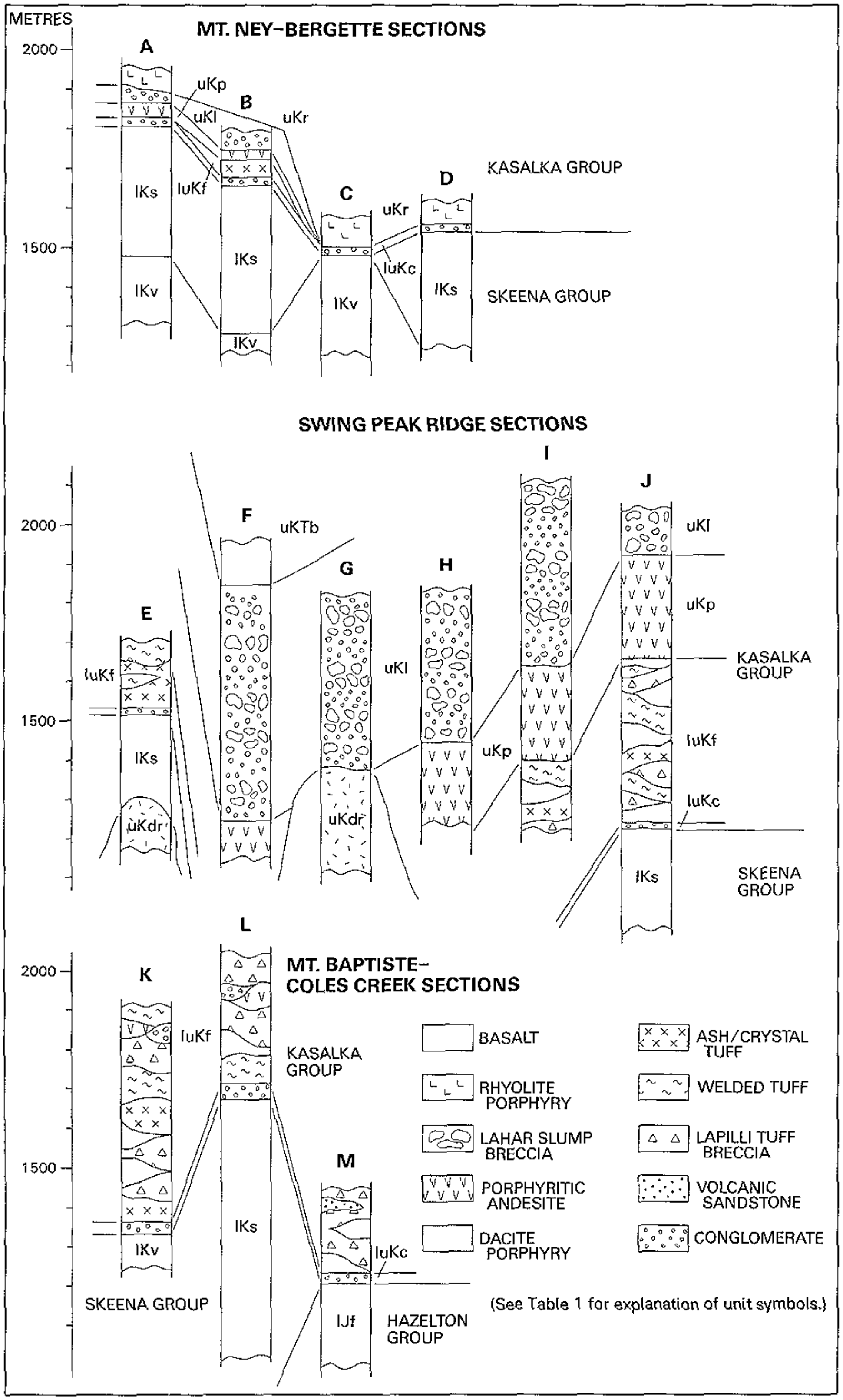


Figure 6. Stratigraphic columns for the Kasalka Group (for locations *see* Fig. 5).

AMYGDALOIDAL BASALT UNIT (lKv)

Massive volcanic flows at the base of the Skeena Group (map unit lKv) range from dark green to light grey in colour and are characteristically amygdaloidal (Plate VII). Discontinuous lenses of flow breccia are common at the top of individual flows. Petrographically, the flows are typical basalts with euhedral andesine and labradorite phenocrysts set in a matrix of divergent microlites of albite and interstitial chlorite, clay, calcite, and magnetite. Primary pyroxenes are pseudomorphed by chlorite and/or epidote. Amygdules are filled with concentric layers of calcite, chlorite, epidote, and chalcedony, occasionally surrounding a core of pyrite and pyrrhotite grains.

MARINE SEDIMENTARY UNIT (lKs)

The amygdaloidal basalt is overlain by at least 1 000 metres of interbedded wacke and shale. These rocks weather fawn grey to black and range from thin to thick bedded. The predominant rock type is fine-grained, flaggy lithic wacke; it locally contains iron-rich concretions and carbonaceous plant fragments. Intercalations of shale are common, particularly near the base of the sedimentary division; these rocks locally contain poorly preserved shelly marine fauna of Albian age (Duffell, 1959). Locally, the wacke is flaser (Plate VIII) or crossbedded.

Early Cretaceous wackes can be distinguished from their Middle Jurassic equivalents because they are better sorted and have greater amounts of microcline, muscovite, and metamorphic rock fragments.

KASALKA GROUP

Prior to the present study, no volcanic or sedimentary rocks younger than Early Cretaceous (Albian) were known to be present in the Tahtsa Lake area. However, the Skeena and Hazelton Groups are unconformably overlain by a sequence of volcanic rocks that are cut by Late Cretaceous intrusions; these rocks constitute the Kasalka Group (MacIntyre, 1976).

The Kasalka Group is well exposed in the Kasalka Range, particularly on Swing Peak ridge and Mount Baptiste; to the north, similar rocks are found capping peaks in the Tahtsa Range. Stratigraphic sections for the Kasalka Group are shown on Figure 6 and type sections are given in Appendix B. Figure 2 shows the distribution of the major units of the Kasalka Group in the Tahtsa Lake district.

The contact between the Kasalka Group and older rocks is an angular unconformity. Faulted contacts are also common, particularly on the north and northwest perimeter of the Kasalka Range.

BASAL CONGLOMERATE UNIT (luKc)

A thin unit of red to reddish brown pebble conglomerate is the basal member of the Kasalka Group. This unit is well exposed on the south side of Mount Baptiste, at the eastern end of Swing Peak ridge, on ridge crests in the vicinity of Mount Ney, and near the Bergette porphyry copper prospect.

The basal pebble conglomerate unit of the Kasalka Group is strikingly red in colour and provides an easily recognizable marker horizon. Individual beds, which are of variable thickness, are conformable with overlying volcanic rocks. The conglomerate unit is generally between 5 to 10 metres thick, although it thickens to as much as 50 metres where it fills channels in the underlying erosion surface. Lenses of red sandstone are locally interfingered with the conglomerate. The pebble conglomerate is a poorly sorted rock, containing rounded to subangular clasts of oxidized Hazelton and Skeena Group rock types set in a fine-grained sandy matrix (Plate IX); the cementing media are iron oxide and silica.

FELSIC FRAGMENTAL UNIT (luKf)

On Mount Baptiste the basal pebble conglomerate is overlain by grey to cream-coloured, variably welded, siliceous pyroclastic rocks. Individual layers range from a few metres to as much as 100 metres in thickness; lithologic changes up section are frequent. Locally, large blocks and bombs disrupt stratification. The predominant rock type of the felsic fragmental unit is a partly welded to nonwelded lithic lapilli tuff (Plate X). Fragments in these rocks are generally angular, somewhat compressed, and mainly rhyolitic to dacitic in composition. Dark grey clasts of Hazelton Group andesite are also common. The groundmass of the lapilli tuffs is predominantly microcrystalline quartz, muscovite, and feldspar; in places it contains minute, devitrified glass shards.

Interbedded with the lapilli tuffs are massive flows of fragmental and porphyritic rhyodacite, dacite, and andesite, as well as partly welded crystal ash flow tuff (Plate XI), tuff breccia, and minor amounts of volcanic sandstone. The porphyritic flows contain euhedral, oscillatory-zoned andesine, brown biotite, with or without augite, green hornblende, and, in the more siliceous rocks, embayed quartz phenocrysts. The phenocrysts are set in a microcrystalline to cryptocrystalline groundmass of quartz, K-feldspar, and minor plagioclase. Apatite, angular quartz and feldspar crystal fragments, and rhyolitic rock fragments are common in these rocks. By contrast, aphanitic rhyodacite flows are comprised of quartz, K-feldspar, and plagioclase-rich bands with few or no rock or crystal fragments. Alteration of plagioclase to epidote and chloritization of mafic minerals is widespread.

PORPHYRITIC ANDESITE UNIT (uKp)

On Swing Peak felsic fragmental rocks are overlain by massive, greenish grey to dark green, fine-grained flows or sills of porphyritic andesite (Plate XII) to dacite (Fig. 6). Columnar jointing is typically well developed. The texture of the flows varies from sparse coarse-grained to crowded fine-grained porphyritic. Plagioclase (An_{35-50}), hornblende, and augite phenocrysts are set in a microgranular or pilotaxitic groundmass of plagioclase with interstitial K-feldspar and minor quartz. Moderate to intense alteration of plagioclase to clay, with or without epidote, and alteration of mafic minerals to fine-grained mixtures of chlorite, microcrystalline quartz, and iron oxide is ubiquitous. Following the classification scheme of Streckeisen (1967), flows on Swing Peak classify as latite-andesites or dacites; generally they contain too much K-feldspar to be true andesites.

LAHAR UNIT (uKl)

Andesitic flows at the base of Swing Peak are conformably overlain by a chaotic assemblage of volcanic debris that is up to 600 metres thick. These rocks are crudely stratified (Plate XIII) with alternating coarse and fine-grained beds; they are interpreted to be lahars and mass flow or scarp slump deposits. Clasts are generally rounded to subangular and range from a few centimetres up to several metres (Plate XIV) in diameter. Most are porphyritic andesite, identical to underlying flows and sills. The clasts are suspended in a fine-grained muddy matrix which contains abundant angular plagioclase and quartz crystal fragments (Plate XV). A few thin, discontinuous lenses of crystal tuff, volcanic sandstone, tuff breccia, and andesite occur in the lahar unit.

RHYOLITE UNIT (uKr)

Light grey to cream-coloured rhyolite flows and fine-grained siliceous tuffs cap peaks to the north and northwest of the Bergette porphyry copper prospect, where they unconformably overlie either porphyritic andesite or basal pebble conglomerate (Plates XVI and XVII). Outcrops of rhyolite are highly fractured and covered by talus. The rhyolitic flows are essentially microcrystalline aggregates of quartz, K-feldspar, muscovite, and albite, very similar to flows in the felsic fragmental unit exposed on Mount Baptiste. According to the modal classification scheme of Streckeisen (1967) these flows are rhyodacites.

BASALT UNIT (uKTb)

Columnar-jointed basalt flows cap Swing Peak ridge. These flows apparently conformably overlie the lahar unit of the Kasalka Group as indicated by the well-exposed, relatively flat-lying contact on the south face of Swing Peak ridge (Plate XVIII). Basalt dykes that cut the Kasalka Group may have been feeders for these flows. As far as is known, the basalt flows on Swing Peak are the youngest extrusive rocks in the Tahtsa Lake area. The age of these flows is not certain; they are included with the Kasalka Group in this study but may be significantly younger.

AGE AND CORRELATION

The Kasalka Group volcanic rocks are believed to be mainly of Late Cretaceous age because they unconformably overlie sedimentary rocks containing latest Early Cretaceous (Albian) fauna (Duffell, 1959). In addition, a whole rock K/Ar isotopic age of 105 ± 5 Ma was determined for a dacitic lapilli tuff near the base of the Kasalka Group. At Coles Creek, a porphyritic granodiorite stock dated at 83.8 ± 2.8 Ma cuts the base of the Kasalka Group suggesting the felsic fragmental unit there is no younger than Late Cretaceous. On Swing Peak ridge a porphyritic andesite laccolith dated at 87 ± 4 Ma intrudes lahar of the Kasalka Group, again implying most of the group is latest Early or earliest Late Cretaceous in age.

Volcanic rocks of similar age and lithology to the Kasalka Group are not widespread in other parts of west-central British Columbia. Possible correlatives to the Kasalka Group are the Tip Top Hill volcanic rocks of the Parrott Lake area (Church, 1970) and the Brian Boru Formation of the Hazelton area (Sutherland Brown, 1960). Tip Top Hill rocks are described as porphyritic andesite, dacite, and rhyolite flows which have yielded a K/Ar date of 77 Ma (Carter, 1981). Brian Boru flows are also very similar to those of the Kasalka Group and may be of a similar age. On the basis of apparent age and lithology, the Kasalka Group may correlate with the Mount Nansen and Hutshi Group's in Yukon Territory and with the Kingsvale Group in southern British Columbia.

PLUTONIC ROCKS

Volcanic and sedimentary rocks of Jurassic to earliest Late Cretaceous age are intruded by a wide variety of plutonic rock types. Mapping and petrographic studies suggest that these rocks can be subdivided on the basis of modal composition, isotopically determined age, and mode of occurrence (Table 2). Group names conform to those used by Carter (1974) where noted.

TABLE 2. MODAL ANALYSES, PLUTONIC ROCKS

MAP UNIT	uKqd		uKgd					uKqgd			uKpqm		Tgr	Tqd	Tpqm			fp
No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
QZ	27.5	26.2	15.2	20.9	24.0	26.9	21.0	24.0	19.0	20.0	29.8	26.2	25.0	5.3	26.1	25.8	26.7	20.2
KF	5.8	4.8	11.3	20.3	19.2	23.1	20.3	18.8	20.3	15.3	21.3	17.1	21.0	12.6	27.1	26.7	15.1	10.4
PL	53.2	48.8	56.6	47.7	47.6	43.6	46.4	40.8	44.2	57.0	36.9	40.0	45.0	61.2	35.6	32.2	41.4	43.0
BT	12.5	16.8	7.1	3.3	3.3	2.4	3.3	9.0	8.7	3.4	4.8	6.2	—	—	—	—	—	—
HB	—	—	6.8	7.0	4.7	2.4	7.1	1.0	6.0	—	6.2	—	—	—	—	—	—	—
OP	1.0	1.2	2.0	1.7	1.2	0.9	1.9	2.5	1.7	0.9	1.0	1.0	—	—	—	—	—	—
OT	—	2.2	1.0	—	—	0.7	—	3.0	—	4.2	—	9.5	—	—	—	—	—	—
MF	—	—	—	—	—	—	—	—	—	—	—	—	2.0	16.8	7.5	5.2	13.8	19.9
AC	—	—	—	—	—	—	—	—	—	—	—	—	4.0	4.1	3.6	10.1	3.7	6.0
n	5	4	5	8	6	1	16	4	3	1	8	1	1	9	8	4	4	—

QZ = quartz; KF = K-feldspar; PL = plagioclase; BT = biotite; HB = hornblende; OP = opaques; OT = other; MF = mafics; AC = accessories; n = number of analyses

1—Border (Camp) phase, Sibola stock; Church, 1971
2—Quartz diorite, Coles Creek; MacIntyre, 1974
3—Contact zone, Troitsa stock; Cawthorn, 1973
4—Intermediate zone, Troitsa stock; Cawthorn, 1973
5—Core zone, Troitsa stock; Cawthorn, 1973
6—Granodiorite, Whiting stock; this study
7—Granodiorite, Sibola stock; Church, 1971
8—Porphyritic granodiorite, Coles Creek; MacIntyre, 1974
9—Porphyritic granodiorite, Ox Lake; Sutherland Brown, 1969
10—Porphyritic granodiorite, Huckleberry; this study
11—Porphyritic quartz monzonite, Bergette; Church, 1971
12—Porphyritic quartz monzonite, Whiting Creek, this study
13—Porphyritic granophyre, Mount Bolom; this study
14—Quartz diorite, Berg; Panteleyev, 1981
15—Porphyritic quartz monzonite, Berg stock; Panteleyev, 1981
16—Sericitic quartz-plagioclase porphyry, Berg stock; Panteleyev, 1981
17—Plagioclase-biotite-quartz porphyry, Berg stock; Panteleyev, 1981
18—Hornblende quartz feldspar porphyry dyke, Berg; Panteleyev, 1981

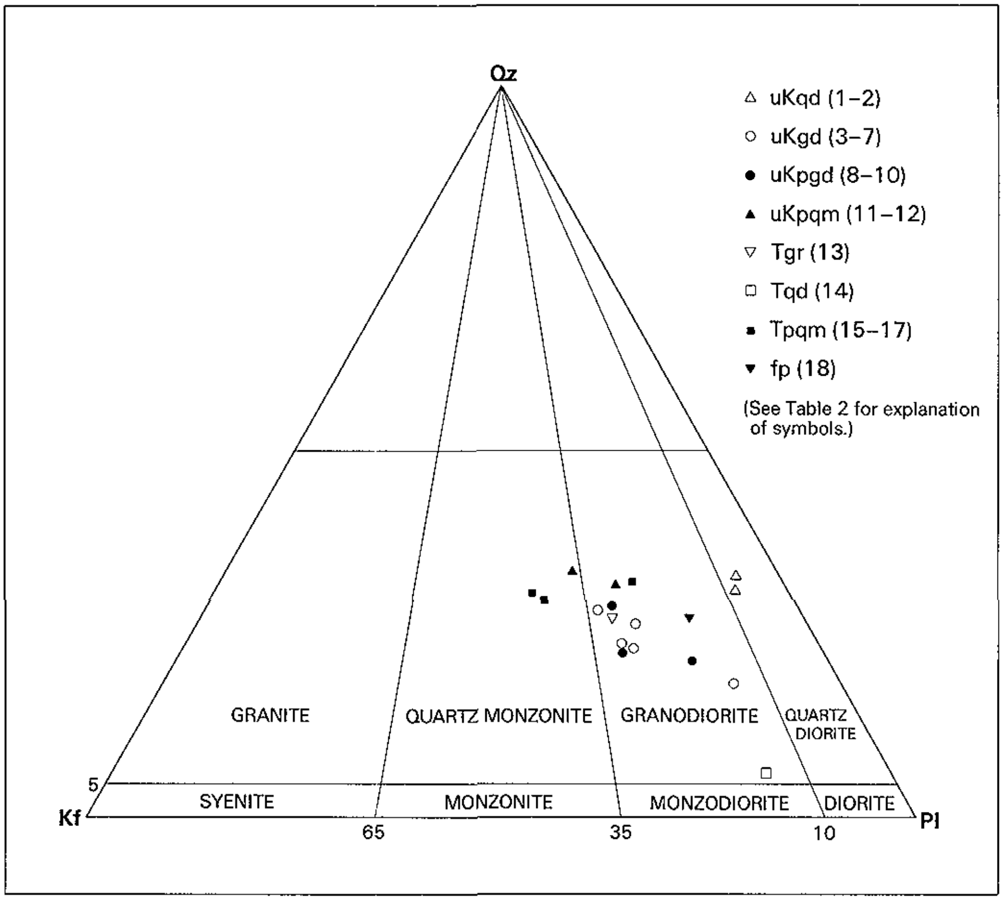


Figure 7. Ternary plot of average modal K-feldspar (Kf), plagioclase (Pl), and quartz (Qz) abundances for Cretaceous and Tertiary plutonic rocks (data recalculated to 100 per cent, from Table 2).

In the following discussion of plutonic rocks a modified version of the classification scheme of Streckeisen (1967) is used (Fig. 7). Furthermore, in the naming of granitoid rocks the order of minerals is from least to most abundant. For example, a hornblende-biotite granodiorite would contain more biotite than hornblende. The term 'porphyritic' is used for rocks with closely packed ('crowded') euhedral phenocrysts; the term 'porphyry' is applied to fine-grained crystalline rocks with some ('sparse') free-floating phenocrysts (for example, quartz porphyry, feldspar porphyry).

KASALKA INTRUSIONS (uKdr)

The term 'Kasalka intrusions' is applied to a group of intrusive rocks which are petrographically and compositionally similar to volcanic rocks of the Kasalka Group. Volcanic rock names are used for some of these fine-grained intrusions because they have textural features like those of volcanic rocks, for example, pilotaxitic groundmass.

Subvolcanic dykes, sills, and small irregular stocks of porphyritic augite-hornblende microdiorite and andesite are common in the Kasalka and Tahtsa Ranges (Plate XIX). Locally, these intrusions grade into tuff breccia dykes (Plate XX), particularly on Swing Peak ridge. On the north slope of Swing Peak ridge a series of andesite sills radiate outward from a small stock and intrude strata of the Skeena and Kasalka Groups.

Contacts are sharp and rarely show evidence of contact metamorphism. Bedding attitudes in the Skeena Group diverge from regional trends near these crosscutting intrusions.

The intrusive hornblende-augite andesite is a fine-grained, green to dark grey porphyritic rock (Plate XXI); petrographically it is identical to andesite flows at the base of Swing Peak ridge. In general, mafic minerals are less chloritized than those in extrusive equivalents; quite often augite and hornblende phenocrysts are fresh; magnetite is an abundant accessory mineral. Albite, clay, and epidote alteration of plagioclase is locally intense.

Small, elongate stocks of microdiorite intrude Hazelton Group rocks at the western end of Kasalka Butte. Finer grained equivalents of these stocks occur as dykes on Mount Baptiste, and form a small plug on Rhine Crag. These intrusions cut both Jurassic and Early Cretaceous strata. Typically, wallrocks are folded on a small scale and closely fractured within 20 metres of the contacts.

Diorites of the Kasalka intrusions are coarse to medium-grained, dark greenish grey, equigranular to subporphyritic rocks composed of a mesh of interlocking, oscillatory-zoned andesine phenocrysts with intersertal augite, hornblende, and biotite. Minor K-feldspar and quartz occupy the interstices between the larger grains. The diorite has a modal composition similar to that of andesitic rocks of the Kasalka Group; however, it contains biotite in addition to hornblende and augite. These minerals are generally partly to completely pseudomorphed by chlorite. Albite and clay alteration of plagioclase is also widespread. Primary magnetite is restricted to the least altered samples; in most samples it is oxidized to hematite.

RHYOLITIC INTRUSIONS (uKqp)

Sills and laccoliths of porphyritic dacite are common within the felsic fragmental unit of the Kasalka Group. Field relationships are often ambiguous; many may actually be flows. Porphyritic dacite dykes are common in rocks which lie stratigraphically below the Kasalka Group; these may be feeders to overlying intrusive and extrusive bodies. The best exposures of porphyritic dacite are in creeks cutting the eastern slope of the ridge west of Coles Creek. Here, the dacite appears to be a relatively flat-lying laccolith with radiating dyke-like extensions (MacIntyre, 1974) that cut both Hazelton and Kasalka Group strata.

Intrusive dacite is a fine-grained, medium to dark grey, siliceous rock. The most characteristic feature of this rock type is the presence of bipyramidal, rounded and embayed quartz phenocrysts (Plate XXII). In addition, phenocrysts of euhedral andesine, plates of biotite, and minor euhedral hornblende are present; all are set in a microgranular to granular groundmass consisting of equal proportions of quartz, plagioclase, and K-feldspar. Plagioclase and quartz also occur as angular fragments or shards.

Small, irregular dykes and sills of rhyolitic quartz 'eye' porphyry intrude the Sibola, Whiting, and Troitsa stocks (Fig. 2). The contacts are sharp and lack chilled margins (Plate XXIII). Inclusions of host rocks are common, particularly adjacent to the contacts. At the Bergette and Whiting Creek porphyry copper prospects the rhyodacite or quartz porphyry grades into breccia pipes (Plate XXIV) and dykes. Similar breccia pipes are located along the south contact of the quartz diorite at Coles Creek and on the new Lean-To property.

Rhyolitic intrusions within the Sibola and Troitsa stocks are white and siliceous; locally they are flow banded. These rocks characteristically contain 10 to 15 per cent subhedral quartz eyes and 1 to 2 per cent pyrite cubes set in a microgranular intergrowth of quartz with subordinate K-feldspar and muscovite, and a minor amount of albite. The muscovite appears to be a primary component of these rocks. Phenocrysts of other minerals are absent. Associated breccias contain angular rhyolitic clasts in a microcrystalline quartz-muscovite matrix.

Quartz 'eye' porphyry dykes parallel the northwest shore of Troitsa Lake, where they crop out as distinctive white cliffs. Similar dykes crop out on Mount Baptiste and on the south and north shores of Tahtsa Lake. Dyke contacts are generally sharp; most are steeply dipping.

Rhyolitic dykes are white to cream-coloured and siliceous; they are exceptionally resistant to weathering. Porphyritic phases contain quartz, plagioclase, and K-feldspar phenocrysts set in a microcrystalline groundmass of quartz and muscovite. Plagioclase phenocrysts are invariably pseudomorphed by fine-grained aggregates of clay, sericite, and albite. Pyrite cubes are also common in these rocks.

BULKLEY INTRUSIONS

The Bulkley intrusions, as defined by Carter (1974, 1981), comprise granodioritic stocks and dykes of earliest Late Cretaceous age (70 to 84 Ma). In the Tahtsa Lake area, three subdivisions of the Bulkley intrusions are recognized. These are: (1) small isolated stocks of porphyritic hornblende-biotite granodiorite such as the Coles Creek, Huckleberry Mountain, and Ox Lake stocks, (2) large compositionally zoned intrusions of equigranular biotite-hornblende granodiorite and biotite-hornblende quartz diorite such as the Sibola, Whiting, and Troitsa stocks, and (3) late porphyritic hornblende-biotite quartz monzonite dyke swarms and stocks that cut both (1) and (2). The areal distribution of these rocks is shown on Figure 2.

PORPHYRITIC HORNBLENDE-BIOTITE GRANODIORITE (uKpgd)

Small, subcircular stocks of porphyritic hornblende-biotite granodiorite crop out in the vicinity of Ox Lake, Huckleberry Mountain, and Coles Creek (Fig. 2). The stocks are exposed at various stratigraphic levels within the Hazelton Group. The Coles Creek stock also intrudes a laccolith of porphyritic dacite. Contacts are generally sharp and steeply dipping. Biotite hornfels aureoles are well developed around the Ox Lake and Huckleberry Mountain stocks, but are absent at Coles Creek. The latter is surrounded by an extensive zone of pervasive hydrothermal alteration (MacIntyre, 1974). In general, Hazelton Group strata dip more steeply adjacent to the stocks, suggesting that doming and uplift accompanied intrusion.

The stocks at Coles Creek, Ox Lake, and Huckleberry Mountain are essentially simple, single phase intrusions of light to dark grey, porphyritic, hornblende-biotite granodiorite (Plate XXV). The texture of these rocks ranges from fine-grained sparsely porphyritic to densely porphyritic with greater than 50 per cent euhedral phenocrysts. Coarse-grained, subporphyritic to equigranular textures characterize the core zones of the stocks, particularly at depth. Phenocrysts are mainly 2 to 6-millimetre, oscillatory-zoned andesine with subordinate brown biotite, green hornblende, and minor anhedral quartz; all are set in a microgranular interlocking groundmass of quartz, K-feldspar, and minor plagioclase. Apatite and magnetite are important accessory minerals. The average modal composition of each of the stocks is presented in Table 2. A plot of these values (Fig. 7), recast to 100 per cent, illustrates the relatively small compositional range for these plutons; all fall within the granodiorite field as defined by Streckeisen (1967).

BIOTITE-HORNBLENDE GRANODIORITE AND QUARTZ DIORITE (uKgd)

Large, compositionally zoned stocks with a granodiorite to quartz diorite bulk composition occur in the Tahtsa Lake area. The largest of these are the Sibola and Whiting stocks, which intrude rocks of the Hazelton and Skeena Groups in the core of the Sibola Range (Fig. 5). The eastern contact of the Sibola stock is sharp and steeply dipping; it may be a fault. The western contact appears to dip moderately east. Hazelton Group rocks along the eastern contact are steeply dipping, parallel to the trend of the contact.

A similar stock forms the core of a prominent peak south of the west end of Troitsa Lake. This stock, which is roughly circular in plan, intrudes west-dipping Hazelton Group strata and flat-lying porphyritic andesite of the Kasalka Group. The northern contact of the stock is steeply dipping and crosscuts bedding; the south contact is relatively flat (Plate XXVI). Unlike the Sibola stock, this intrusion produced only minor disruption of regional structural trends (Cawthorn, 1973).

The quartz diorite stock on Mount Baptiste and the quartz diorites at Coles Creek and Ox Lake are texturally and compositionally similar to the border phases of the Troitsa and Sibola stocks. Aureoles of biotite hornfels enclose both the granodiorite and quartz diorite intrusions; they extend several hundred metres into surrounding wallrocks.

Detailed petrographic study of the Troitsa Lake stock by Cawthorn (1973) indicates textural and compositional zoning from a coarse-grained biotite-hornblende quartz monzonite in the core to a finer grained biotite-hornblende granodiorite at the margins.

The Sibola stock is also zoned. A narrow marginal zone of mafic-rich, medium to fine-grained biotite-hornblende quartz diorite (camp phase of Church, 1971) encloses a core of coarse-grained subporphyritic biotite-hornblende granodiorite (Plate XXVII). Similarly, the quartz diorite at Coles Creek has a greater quartz and K-feldspar content toward the centre of the intrusion, where it approaches granodiorite in compositon (MacIntyre, 1974). Sampling of the Mount Baptiste stock was too limited to define any systematic variations in composition.

Equigranular phases of the Bulkley intrusions in the Tahtsa Lake area vary from dark grey to pinkish grey in colour, according to the relative proportions of biotite and K-feldspar present. The rocks are characterized by a hypidiomorphic granular to subporphyritic texture, consisting of closely packed, 2 to 5-millimetre, subhedral to euhedral, oscillatory-zoned oligoclase and andesine phenocrysts, many of which are partly resorbed. Smaller, subhedral biotite and hornblende grains, and anhedral quartz occupy the spaces between the plagioclase phenocrysts. K-feldspar and fine-grained granular quartz are interstitial to the larger grains. Magnetite, apatite, and sphene are ubiquitous accessory minerals.

The modal composition of samples from the Sibola and Troitsa stocks have been determined by Church (1971) and Cawthorn (1973), respectively. The average values for various zones of the intrusions are listed in Table 2 and clearly illustrate the progressive increase in modal K-feldspar and quartz toward the core zones. When recast to 100 per cent, the relative proportions of K-feldspar, quartz, and plagioclase for the main phases ofthe Sibola and Troitsa stocks are very close to those determined for porphyritic granodiorite at Ox Lake, Coles Creek, and Huckleberry Mountain (Table 2; Fig. 7). The average modal composition of the quartz diorite border phase of the Sibola stock is nearly identical to that of the Coles Creek quartz diorite.

PORPHYRITIC HORNBLENDE-BIOTITE QUARTZ MONZONITE (uKpqm)

Northwest-trending dykes of porphyritic hornblende-biotite quartz monzonite, which locally coalesce to form irregular elongate stocks, intrude the Sibola, Whiting, and Troitsa stocks (Fig. 2). The dykes rarely have chilled margins and contacts with wallrocks are usually sharp. By contrast, dykes which extend outside the stocks typically have fine-grained mafic-rich border zones and coarse-grained porphyritic cores.

The coarse-grained porphyritic quartz monzonite (Plate XXVIII) intrusions at the Bergette and Whiting Creek prospects are pinkish grey to buff-coloured rocks. The quartz monzonite contains a greater percentage of anhedral quartz phenocrysts and has more groundmass K-feldspar than the porphyritic granodiorite at Ox Lake, Coles Creek, and Huckleberry Mountain. The average modal composition of the Bergette and Whiting Creek intrusions is given in Table 2 (Nos. 11, 12). These rocks straddle the quartz monzonite-granodiorite boundary on Figure 7.

MOUNT BOLOM INTRUSION

The Mount Bolom stock forms the core of Mount Bolom and of ridges to the north in the southwest corner of the map-area, west of Troitsa Lake. It is roughly circular in plan and underlies an area of approximately 54 square kilometres. The stock intrudes metamorphic rocks of the Coast Plutonic Complex on the west and the Hazelton, Skeena, and Kasalka Groups on the east. The contacts are sharp and discordant; contact metamorphism is restricted to rocks immediately adjacent to the stock. Kasalka Group strata along the north contact are isoclinally folded, and Hazelton Group strata dip steeply, parallel to the south contact. Dykes of similar composition and texture to the Mount Bolom stock are common in the Kasalka Range and are believed to be related to the stock.

Only the eastern half of the Mount Bolom stock was mapped during this study. In this area the stock consists largely of pink, porphyritic, hornblende-biotite granophyre (Plate XXIX). The granophyre is texturally zoned from a sparsely porphyritic, fine-grained border phase, to a coarser grained, more porphyritic core. In thin section the rock contains euhedral unzoned oligoclase, and fewer, subhedral biotite and hornblende phenocrysts, set in a groundmass of interlocking laths of plagioclase with interstitial granophyric intergrowths of K-feldspar and quartz. The groundmass plagioclase is typically altered to clay and albite. Clusters of hornblende, biotite, and plagioclase crystals characterize the granophyre. Dark grey to black wallrock inclusions are also common. Similar features are found in dykes peripheral to the Mount Bolom stock. However, in contrast to the stock, these dykes contain more biotite and little or no hornblende. The Mount Bolom stock differs from the Bulkley and Kasalka intrusions; it has significantly more K-feldspar and less quartz.

COAST INTRUSIONS

Several plutonic bodies, believed to be satellitic to the Coast Plutonic Complex, occur in the western part of the map-area. The largest of these is a north-trending body of quartz diorite that intrudes rocks of the Hazelton and Skeena Groups in the western part of the Tahtsa Range. This body is sometimes referred to as the Berg quartz diorite because it is near the Berg porphyry copper deposit. There is no obvious disruption of regional structural trends near the intrusion. Biotite hornfels is well developed around the intrusion and extends up to 100 metres from the contact.

The Berg quartz diorite is zoned; a mafic-rich, fine-grained border phase grades into a coarser grained, more quartz-rich core. The rock is typically equigranular (Plate XXX); it consists mainly of interlocking, tabular laths of oscillatory-zoned andesine and labradorite. Elongate, subhedral to euhedral poikilitic hornblende has plagioclase inclusions. Biotite is subordinate to hornblende and occurs as random, anhedral grains. Border phases of the quartz diorite contain minor amounts of pyroxene, in part pseudomorphed by hornblende. The latter, in turn, is replaced by biotite, particularly near the younger Berg quartz-monzonite stock. Quartz and K-feldspar occupy interstices between the larger grains and, in places, appear to replace plagioclase. Magnetite is a common accessory mineral. The quartz diorite is hydrothermally altered near the Berg porphyry copper deposit; sericite replaces plagioclase and pyrite replaces magnetite.

Quartz diorite of the Coast intrusions contains more hornblende and somewhat less quartz than quartz diorites of the Bulkley intrusions. The modal composition of the Berg quartz diorite (Sutherland Brown, 1966) is very similar to the average values for quartz diorites of the Coast Plutonic Complex (Hutchison, 1970). K/Ar isotopic determinations confirm that the age of the quartz diorite is approximately 50 Ma (Carter, 1981),the same age as the eastern zone of the Coast Plutonic Complex.

NANIKA INTRUSIONS

The term Nanika intrusions is applied by Carter (1981) to a group of stocks of quartz monzonite composition which have K/Ar isotopic ages *circa* 50 Ma, that is, Eocene. The only known intrusion of this composition and age in the Tahtsa Lake area is the Berg porphyritic quartz monzonite stock which is located on the western slope of the Tahtsa Range (Fig. 5). This intrusion is cut by a later, northeast-trending dyke of porphyritic quartz latite. A breccia zone occurs south of the stock.

The Berg porphyritic biotite-quartz monzonite stock intrudes moderately east-dipping Hazelton Group pyroclastic rocks (Panteleyev, 1981). Emplacement of the stock has not produced any major disruption of regional structural trends. A biotite hornfels contact metamorphic aureole encloses the stock and is superimposed on both Hazelton Group rocks and the Berg quartz diorite to the east.

The Berg stock is pinkish grey and coarsely porphyritic (Plate XXXI). In outcrop the rock is rusty brown because of oxidation of abundant sulphide minerals. Phenocrysts constitute 35 to 50 per cent of the rock, the most abundant is euhedral, oscillatory-zoned oligoclase to andesine; crystals are up to 6 millimetres in diameter. Smaller plates and books of biotite, elongate hornblende needles, anhedral corroded quartz eyes, and scattered euhedral perthitic K-feldspar are also present. The groundmass is essentially a mosaic of microcrystalline quartz, orthoclase, and plagioclase in varying proportions. Magnetite is rarely preserved in these rocks; it is usually pseudomorphed by pyrite or goethite. The Berg quartz monzonite is readily distinguishable from Late Cretaceous quartz monzonite and granodiorite by its greater K-feldspar content.

Northeast-trending dykes of hornblende-quartz-feldspar porphyry occur within and marginal to the Berg quartz monzonite. The dykes are texturally similar to the quartz monzonite and contain a similar assemblage of phenocryst minerals. However, they are readily distinguished in thin section by a general lack of groundmass quartz. The modal quartz content of the dykes is apparently less than 10 per cent (Sutherland Brown, 1966). This rock type is generally unmineralized and apparently postdates formation of the Berg porphyry copper deposit.

LATE DYKES, SILLS, AND PLUGS (lm, mf, fp, ap, rh, bx)

Northwest-trending swarms of basaltic to rhyolitic dykes are common throughout the map-area; they intrude all rocks of earliest Late Cretaceous age and older. Five major groups of dykes are recognized — these are: (1) lamprophyre, (2) basalt or andesite, (3) porphyritic andesite and feldspar porphyry, (4) pink aplite porphyry, and (5) rhyolite porphyry.

Porphyritic hornblende-biotite andesite and hornblende-biotite-feldspar porphyry (Plate XXXII) dykes cut granodiorite, quartz 'eye' porphyry, and porphyritic quartz monzonite of the Troitsa and Whiting stocks. These dykes are usually unaltered relative to their pervasively altered host rocks suggesting that they are mainly post-mineral. Similar dykes intrude the quartz diorite at Coles Creek. The dykes contain abundant hornblende and biotite and lack augite, features that distinguish them from andesitic dykes of the Kasalka intrusions.

Andesite and feldspar porphyry dykes are cut by basalt and lamprophyre dykes within the Troitsa stock and at Coles Creek. Basalt dykes are also very common in the Kasalka Range, where they occur as a northwest-trending, vertical dyke swarm cutting rocks of the Kasalka Group; northeast and easterly trends are common. Individual dykes are rarely greater than 10 metres in width.

Basaltic dykes are very susceptible to weathering; in most cases, original petrographic features have been destroyed. The most characteristic feature of these rocks is the presence of calcite-filled amygdules and numerous, pipe-like vesicles.

Lamprophyre dykes are relatively rare in the Tahtsa Lake area, and generally occur as isolated dykes rather than swarms. Lamprophyre dykes cut andesite dykes within the Troitsa stock, the quartz 'eye' porphyry dyke on the south slope of Mount Baptiste, and the Mount Bolom stock southeast of Laventie Mountain. The lamprophyre is a dark grey rock consisting of to 60 per cent biotite and chlorite phenocrysts in an aphanitic, plagioclase-rich groundmass. Lamprophyres of this mineralogy are classified as kersantites by Williams, *et al.* (1954).

Pink aplite porphyry dykes commonly cut Skeena Group rocks on the southwest shore of Tahtsa Lake and white rhyolite porphyry dykes cut Hazelton Group rocks north of the Whiting Creek deposit. Both types of dykes trend northwest and dip steeply. The rhyolite porphyry dykes are relatively fresh and appear to be largely post-mineral. Locally aplite porphyry dykes are pervasively altered to clay and K-feldspar.

POTASSIUM/ARGON AGE DATING

The British Columbia Ministry of Energy, Mines and Petroleum Resources, in conjunction with the geochronology laboratory at the University of British Columbia, has determined K/Ar isotopic ages for many of the intrusive bodies in the Tahtsa Lake area (Carter, 1981; Table 3; Fig. 8). The only K/Ar isotopic age available for the Kasalka Group is from a sample of dacitic lapilli tuff collected from the felsic fragmental unit on the south side of Swing Peak ridge. The whole rock K/Ar age, as determined by Teledyne Isotopes Inc., is 105 ± 5 Ma. A porphyritic andesite dyke that cuts Skeena Group rocks on the north slope of Swing Peak gave a whole rock age of 104 ± 8 Ma.

The porphyritic granodiorite stocks at Whiting Creek, Ox Lake, Coles Creek, and Huckleberry Mountain have all been dated and yield ages of 84.1 ± 2.9, 83.4 ± 3.2, 83.8 ± 2.8, and 82.0 ± 3.0 Ma, respectively. These ages are slightly younger than the

87 ± 4 Ma whole rock age determined for the porphyritic andesite laccolith of the Kasalka intrusions that cuts lahar of the Kasalka Group on Swing Peak ridge. The Troitsa stock and the Bergette porphyritic quartz monzonite have younger ages of 75.7 ± 2.3 and 76.7 ± 2.5 Ma.

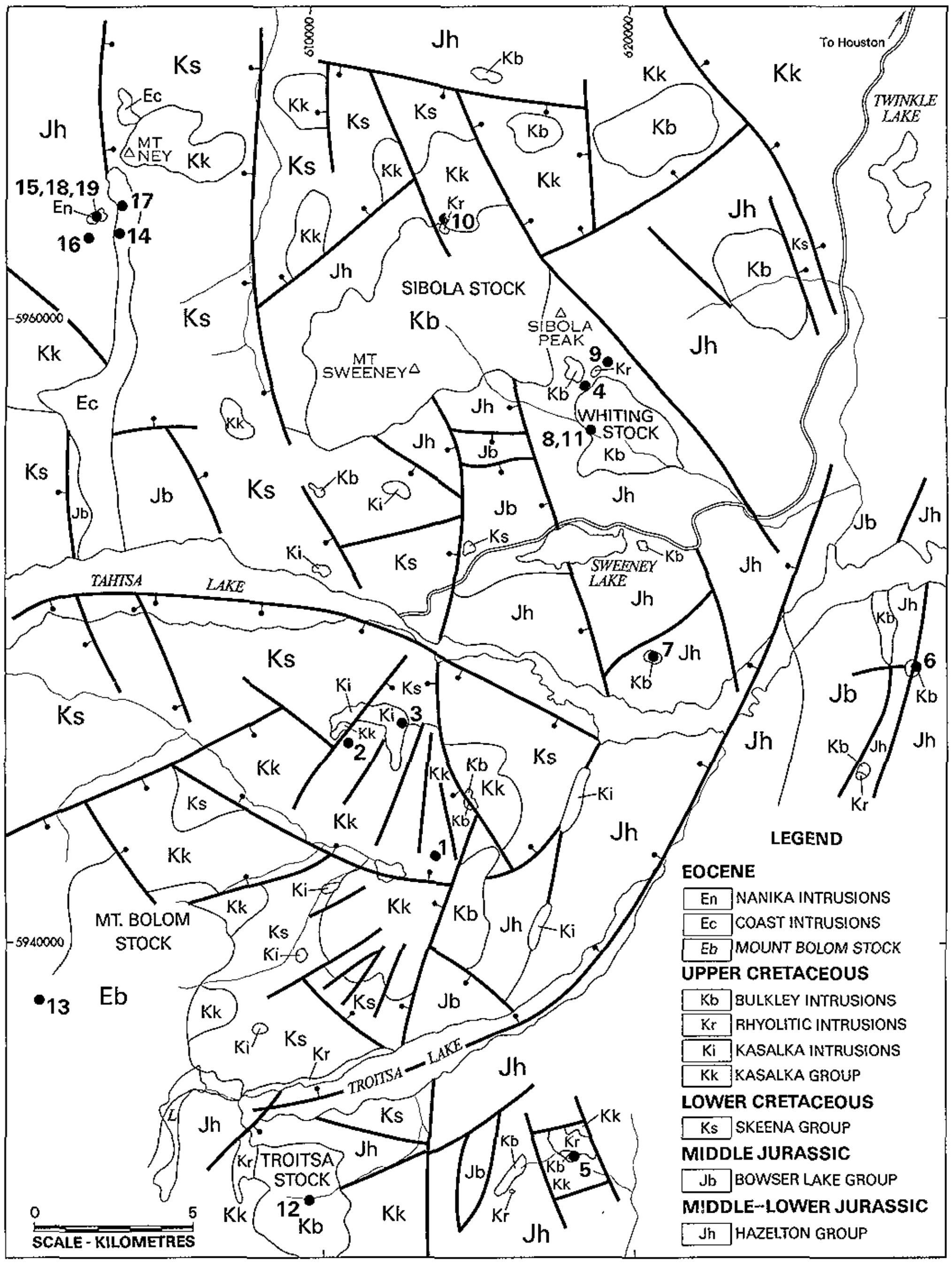


Figure 8. Geological map showing location of K/Ar age date samples; numbers refer to samples listed in Table 3.

TABLE 3. POTASSIUM/ARGON AGE DATES, TAHTSA LAKE DISTRICT

No.	SAMPLE	LOCATION	ROCK TYPE	MATERIAL	%K	%Ar* gm x 10^5	APP. AGE Ma	LABOR-ATORY	REFERENCE/ COLLECTOR
1	M211	Swing Peak	lapilli tuff	whole rock	1.79	0.776	105±5	Teledyne	MacIntyre, 1976
2	D80	Swing Peak	porphyritic andesite	whole rock	1.27	0.544	104±8	Teledyne	MacIntyre, 1976
3	D131	Swing Peak	poprhyritic andesite	whole rock	1.05	0.376	87.0±4	Teledyne	MacIntyre, 1976
4	WC53A	Whiting Creek	porphyritic monzonite	biotite	6.39	2.097	84.1±2.9	U.B.C.	Godwin, 1981
5	NC9	Coles Creek	porphyritic granodiorite	biotite	6.89	2.337	83.8±2.8	U.B.C.	MacIntyre, 1974
6	NC69-5	Ox Lake	porphyritic granodiorite	biotite	4.25	1.435	83.4±3.2	U.B.C.	Carter, 1981
7	NC67-44	Huckleberry	porphyritic granodiorite	biotite	6.29	2.079	82.0±3	U.B.C.	Carter, 1981
8	8-350	Whiting Creek	porphyritic granodiorite	biotite	6.12	1.958	81.3±2.7	U.B.C.	Godwin, 1981
9	QWC1-740	Whiting Creek	biotite hornfels	whole rock	1.99	0.620	78.5±3	U.B.C.	Godwin, 1981
10	B87	Bergette	porphyritic quartz monzonite	biotite	N.A.	N.A.	76.7±2.5	U.B.C.	Church, 1971
11	M72	Whiting Creek	quartz-biotite-feldspar porphyry	biotite	6.76	2.038	76.0±2.2	U.B.C.	MacIntyre, 1976
12	—	Troitsa	porphyritic granodiorite	biotite	7.09	2.169	75.7±2.3	U.B.C.	Cawthorn, 1973
13	GSC78-72	Mount Bolom	porphyritic granophyre	biotite	5.38	N.A.	57.9±1.9	U.B.C.	G.S.C.
14	NC67-8	Berg	quartz diorite	biotite	2.30	0.497	54.0±3	U.B.C.	Carter, 1981
15	NC67-11	Berg	porphyritic quartz monzonite	biotite	6.76	1.413	52.0±2	U.B.C.	Carter, 1981
16	NC67-12	Berg	biotite hornfels	whole rock	2.92	0.617	52.0±3	U.B.C.	Carter, 1981
17	NC67-13	Berg	quartz diorite	biotite	6.97	1.396	49.9±2.1	U.B.C.	Carter, 1981
18	NC67-9	Berg	hornblende-quartz-feldspar porphyry	biotite	6.69	1.283	48.0±3	U.B.C.	Carter, 1981
19	NC67-10	Berg	porphyritic quartz monzonite	biotite	6.56	1.249	47.0±3	U.B.C.	Carter, 1981

The Mount Bolom stock has recently been dated by the Geological Survey of Canada at 57.9±1.9 Ma. This is slightly older than the porphyritic quartz monzonite and quartz diorite intrusions at the Berg porphyry copper deposit which have yielded ages of 52.0±2 and 49.9±2.1 Ma, respectively. Biotite from a late porphyritic dyke cutting the Berg porphyritic quartz monzonite stock gave the two youngest ages in the district at 48.0±3 and 47.0±3 Ma.

STRUCTURE

The Tahtsa Lake area has a complex history of faulting and regional uplift related to evolution of the Pacific Orogen and, in particular, to formation of the Coast Crystalline Belt. The major structural elements in the area are high-angle normal and reverse faults which bound uplifted, down-faulted, and tilted blocks. No major thrust faults are recognized, but they may be present, particularly in older Hazelton Group rocks.

The predominant trend of faulting is northwest with subordinate northeast and north trends. Aerial photograph linears, fractures, and late stage dykes also have a predominant northwest orientation and subordinate northeast trend (Fig. 9).

Broad open to tight folds occur in both Hazelton Group and Skeena Group rocks. These folds generally trend northerly in the north and south parts of the map-area, but trends swing to westerly around the perimeter of the Kasalka Range. By contrast, deformation of Late Cretaceous volcanic rocks is restricted to gentle warping of strata.

Late Cretaceous volcanic rocks of the Kasalka Group are cut by numerous northwest and northeast-trending faults, particularly within the Kasalka Range. Offset along these faults is variable, the greatest occurring along faults on the north slope of Swing Peak ridge and Mount Baptiste; fault blocks south of Swing Peak ridge have been down thrown by as much as 1 000 metres. These movements account for the great thickness of Kasalka Group volcanic rocks preserved in the Kasalka Range. This area appears to have been a major structural depression possibly of a volcanic origin; that is, a caldera or cauldron subsidence complex. Rocks near faults are typically brecciated and pervasively altered to sericite, quartz, and pyrite.

The Bulkley intrusions and associated porphyry copper deposits are peripheral to the Kasalka Range structural depression. Late porphyritic dykes and fractures that cut these intrusions have a predominant northwest trend consistent with those observed in both older and younger rocks. Subordinate northeast trends are also present, although northeast-trending dykes are relatively uncommon compared to the number that trend northwest.

Northwest-trending shear zones cut the Troitsa and Coles Creek stocks. At Coles Creek, intense sericitic alteration centred on these shears has been superimposed on earlier alteration assemblages (MacIntyre, 1974). Steeply dipping shear zones also occur within, and adjacent to, the Ox Lake and Huckleberry Mountain stocks; these have north and northeast trends, respectively. Similarly, porphyritic quartz monzonite dykes within the Sibola stock, which are northwest trending, are cut and locally offset by northeast-trending shears.

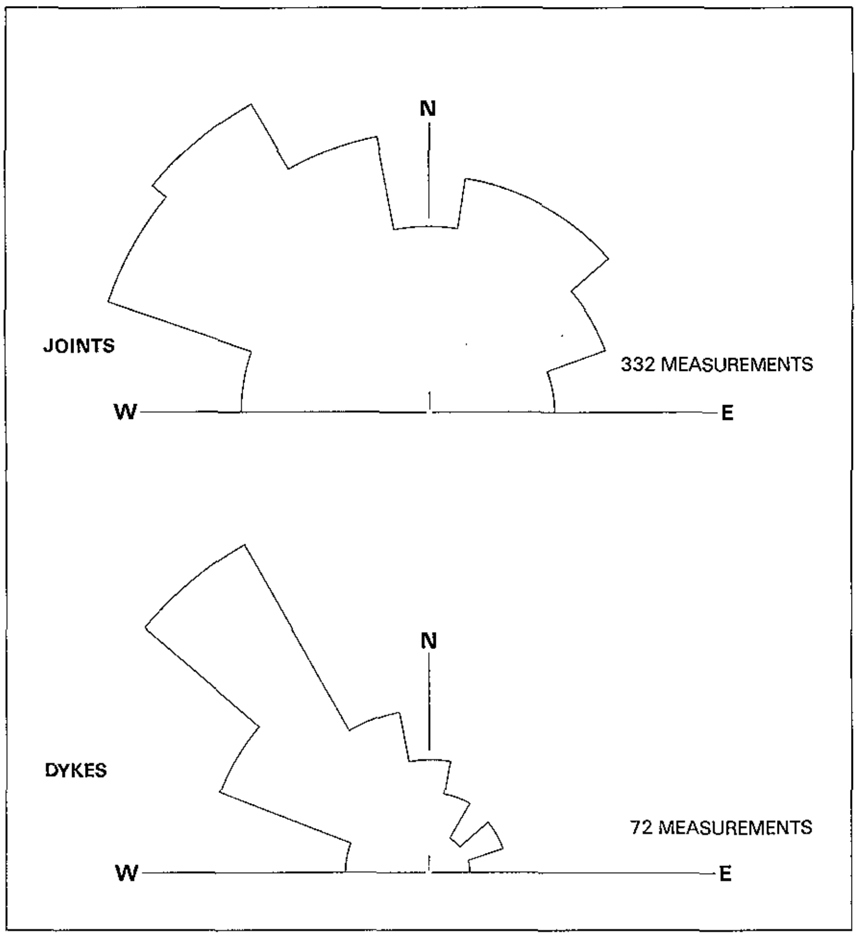


Figure 9. Frequency diagram for trends of joints and dykes, Tahtsa Lake area.

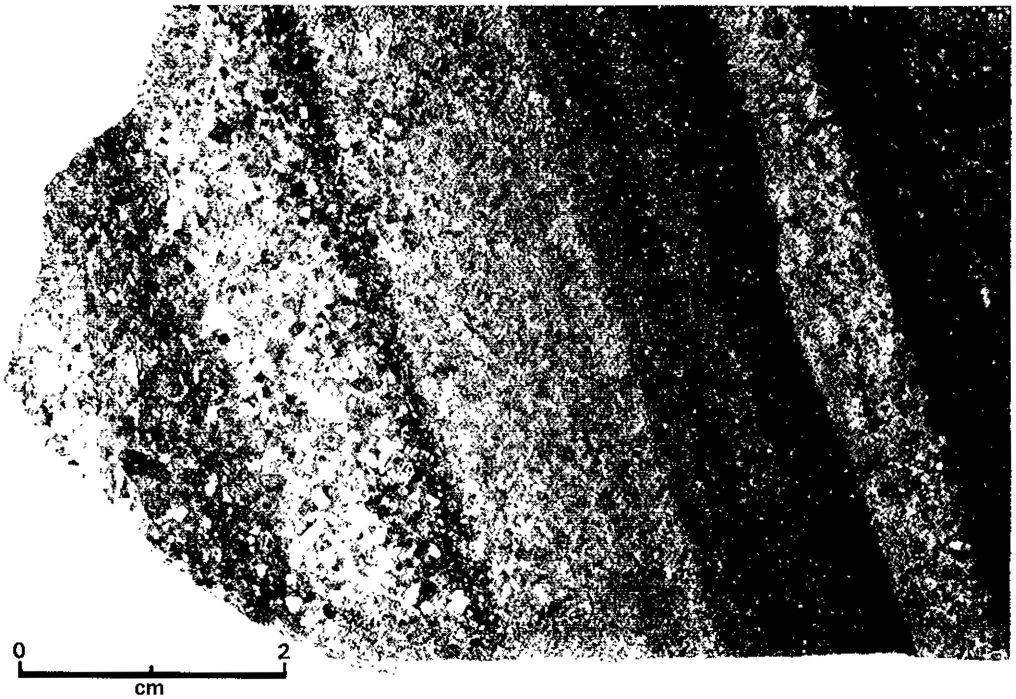


Plate I. Thin-bedded ash and crystal tuff, Telkwa Formation, Hazelton Group.

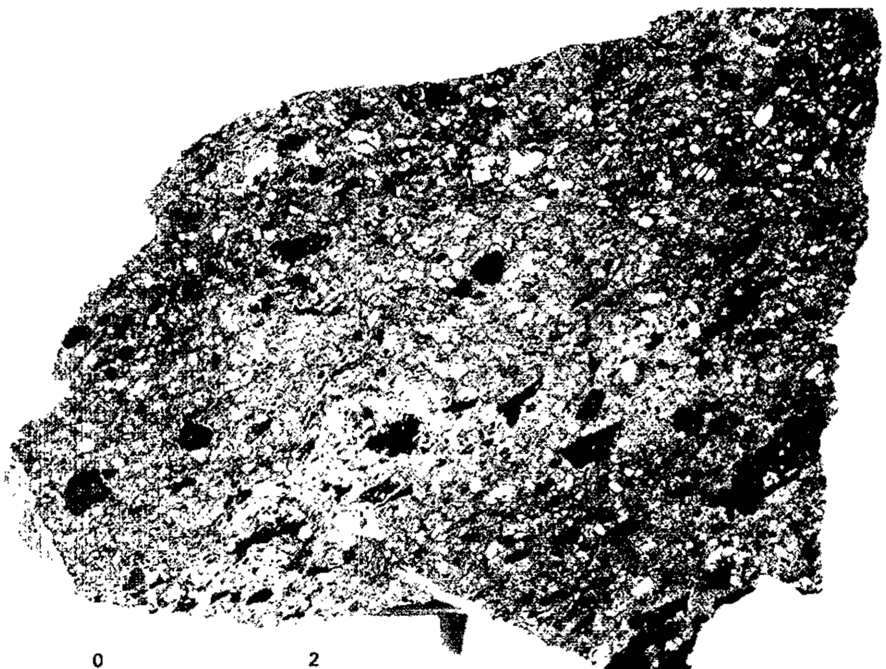


Plate II. Typical lapilli tuff, Telkwa Formation, Hazelton Group.

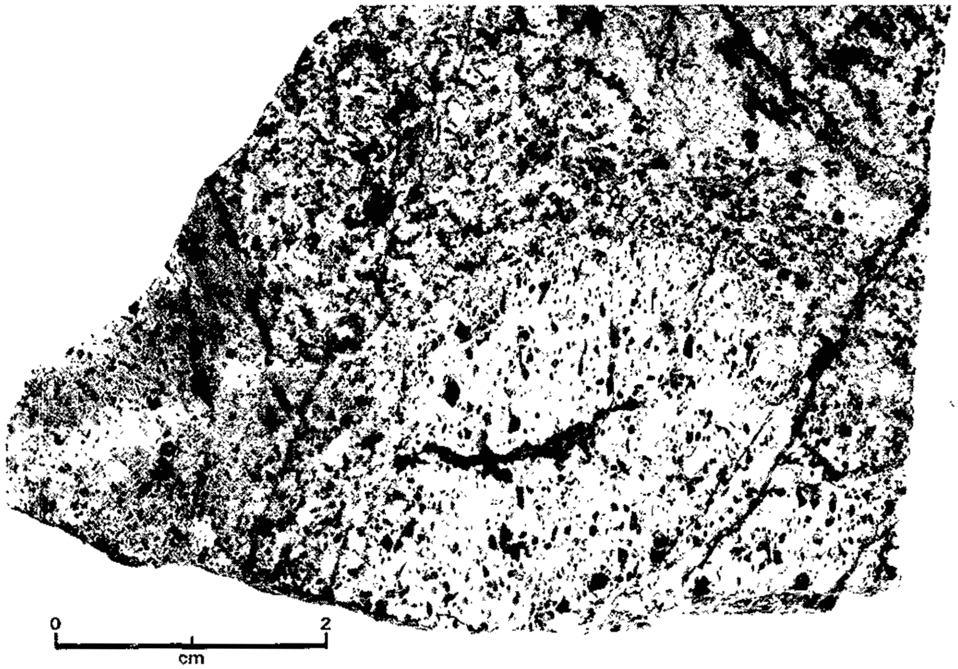


Plate III. Felsic lapilli tuff with rounded clasts in siliceous matrix, felsic volcanic-chert unit, Hazelton Group.

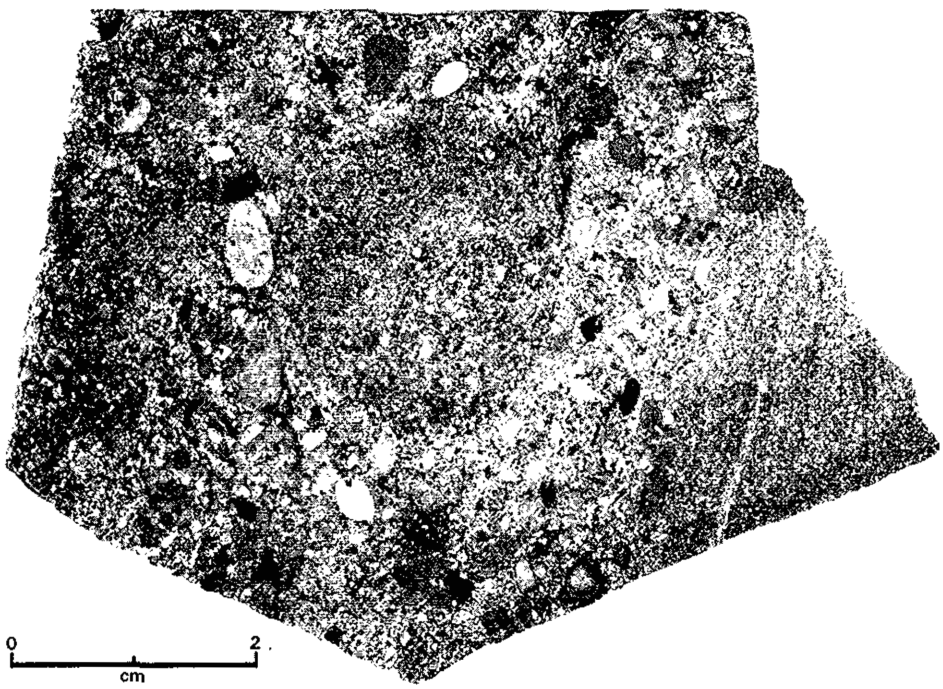


Plate IV. Poorly sorted pebble conglomerate with cherty clasts, Ashman Formation, Bowser Lake Group.

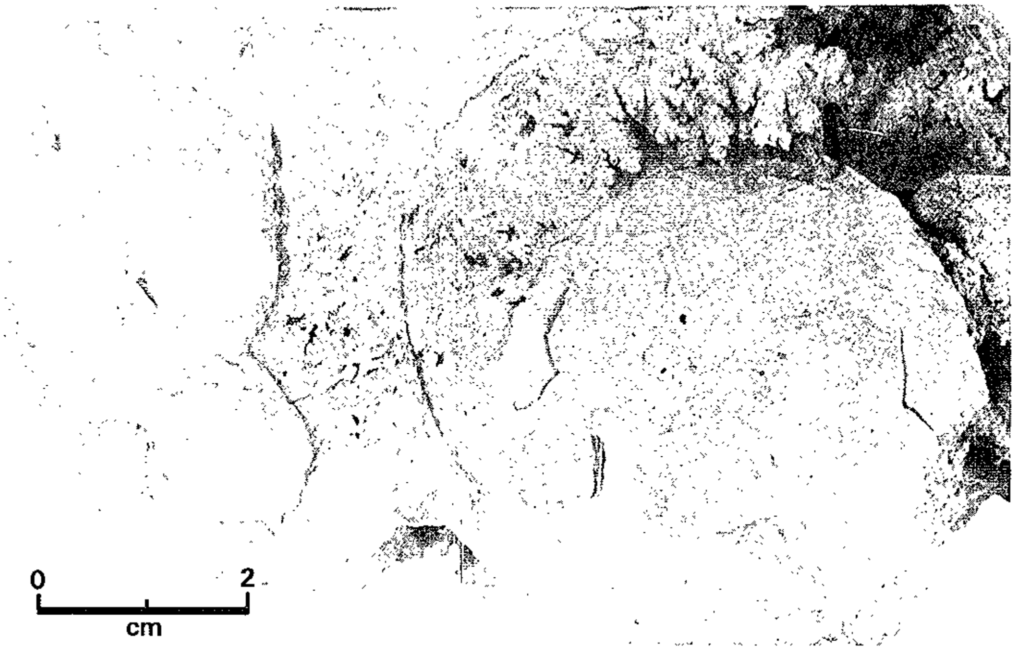


Plate V. Large ammonite in siltstone, Ashman Formation, Bowser Lake Group.

Plate VI. Poorly sorted boulder conglomerate that apparently underlies amygdaloidal basalt flows at base of Skeena Group.

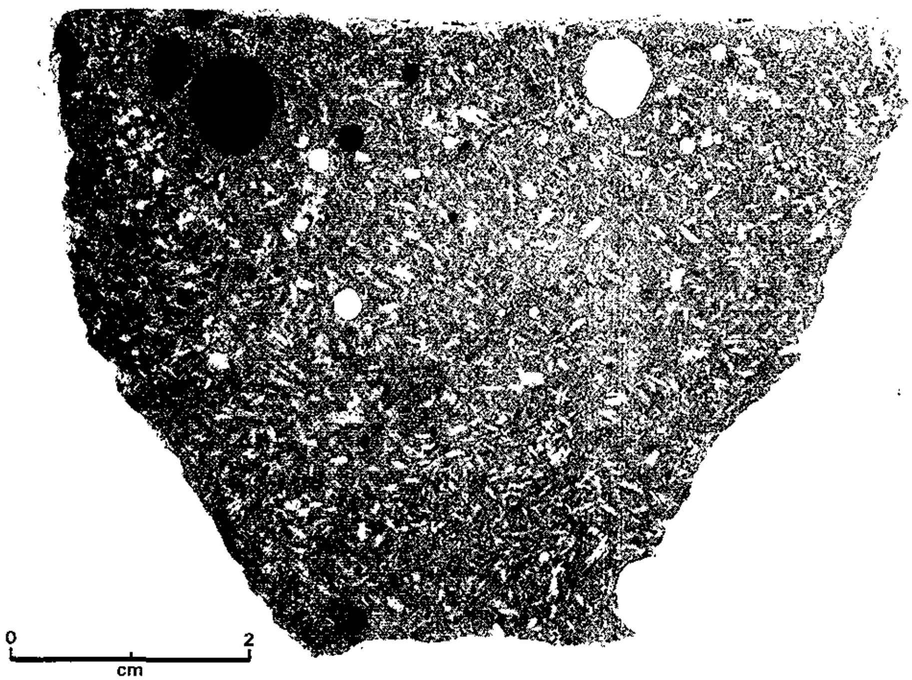


Plate VII. Typical sample of amygdaloidal basalt with trachytic texture, amygdaloidal basalt unit, Skeena Group (black amygdule filled with chlorite; white amygdule filled with zeolite).

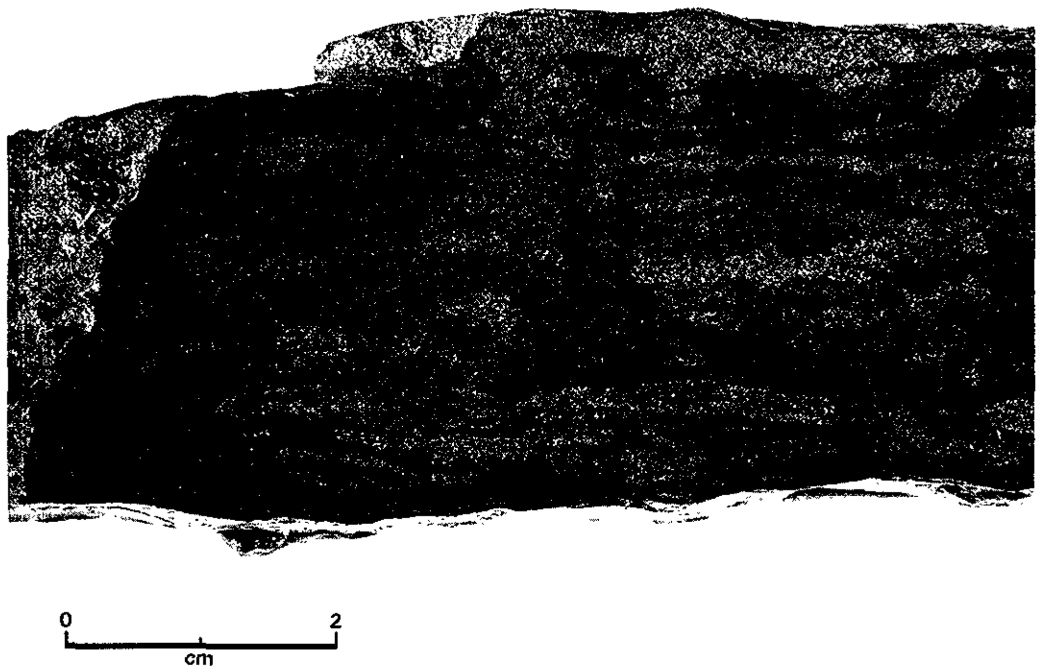


Plate VIII. Flaser-bedded silty mudstone with dewatering structures, marine sedimentary unit, Skeena Group.

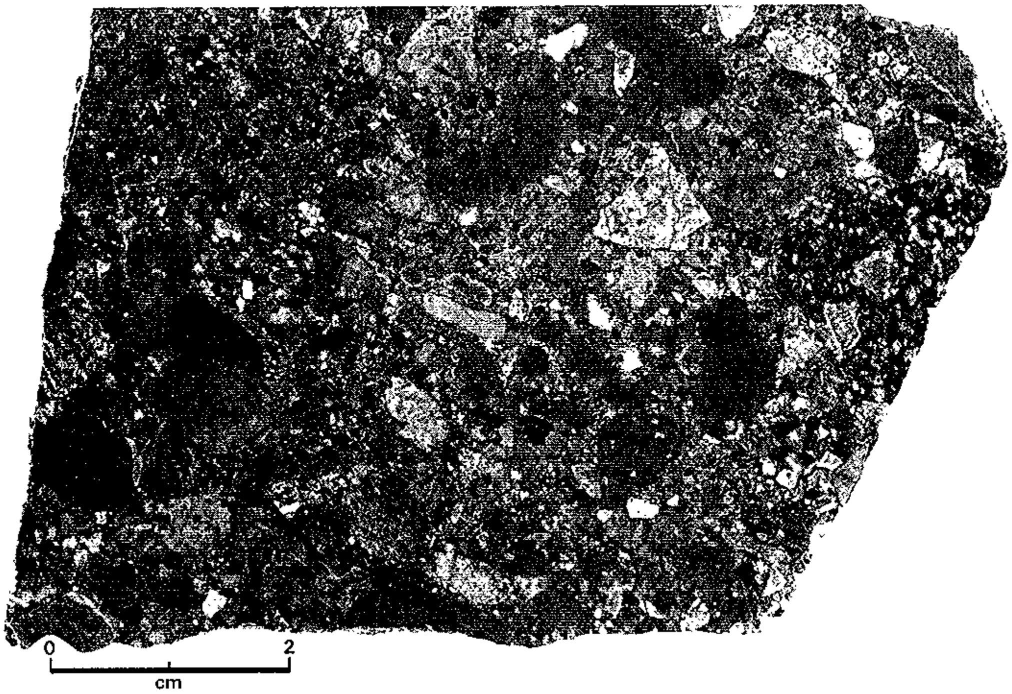


Plate IX. Red poorly sorted polymictic pebble conglomerate, basal unit, Kasalka Group.

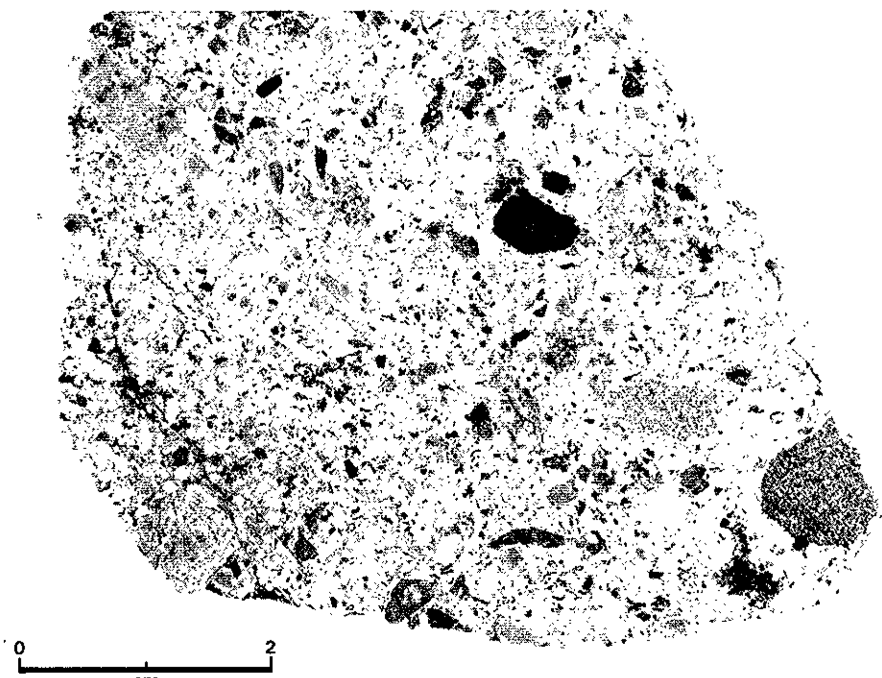


Plate X. Felsic lapilli tuff with white crystal fragments in matrix, felsic fragmental unit, Kasalka Group.

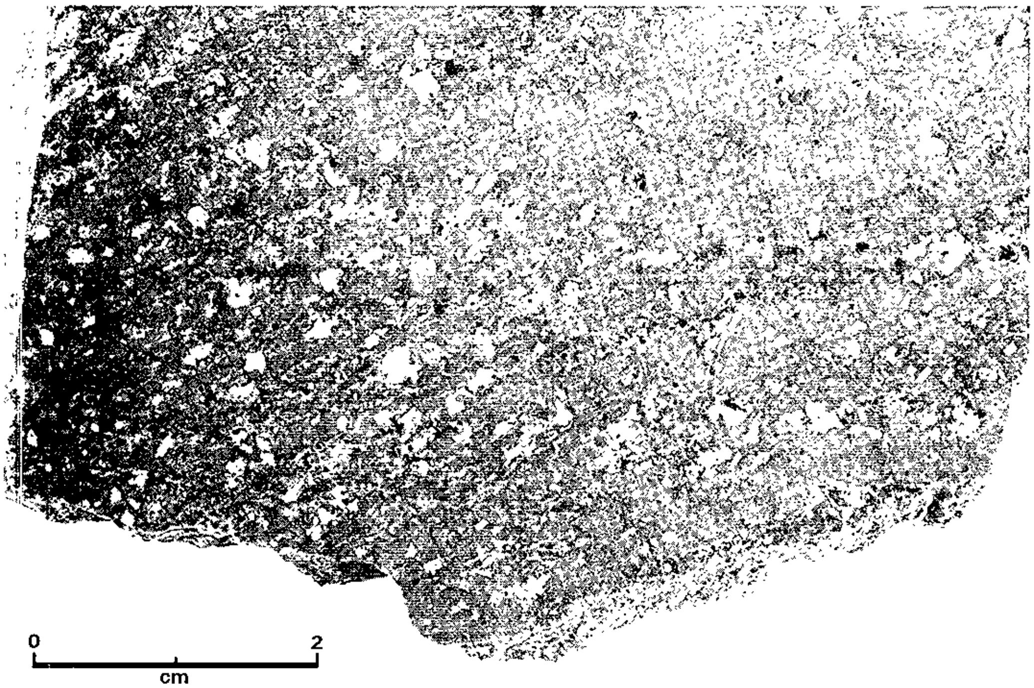


Plate XI. Partly welded ash flow tuff, felsic fragmental unit, Kasalka Group.

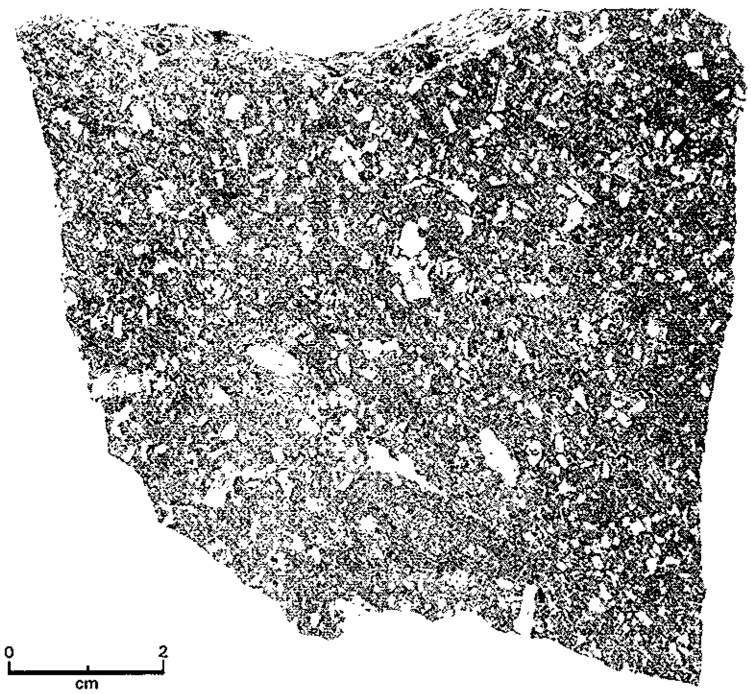


Plate XII. Typical coarse-grained porphyritic hornblende-augite andesite, porphyritic andesite unit, Kasalka Group.

Plate XIII. Typical exposure of crudely stratified lahar, lahar unit, Kasalka Group.

Plate XIV. Bedding surface of very coarse bed within lahar unit, showing size of porphyritic andesite boulders.

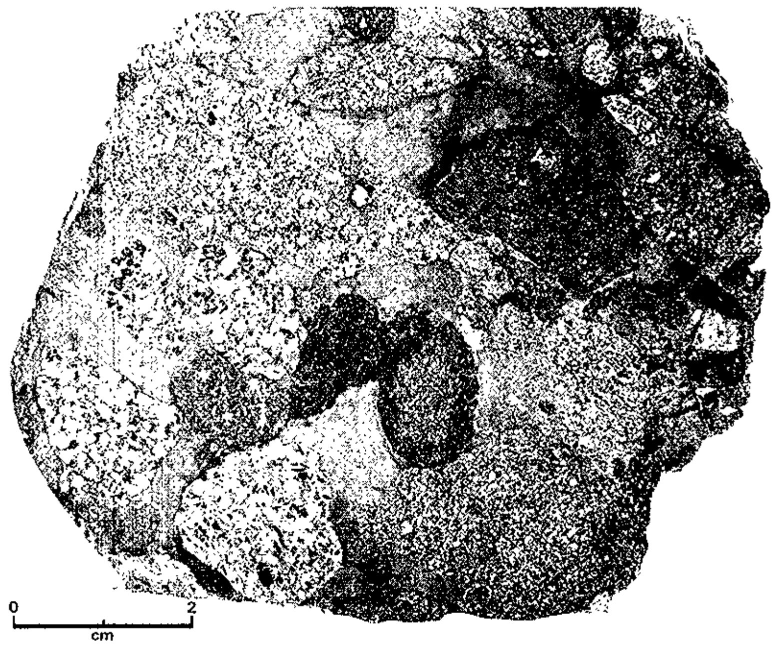


Plate XV. Typical sample of lahar with subangular to rounded clasts of porphyritic andesite in muddy crystal rich matrix.

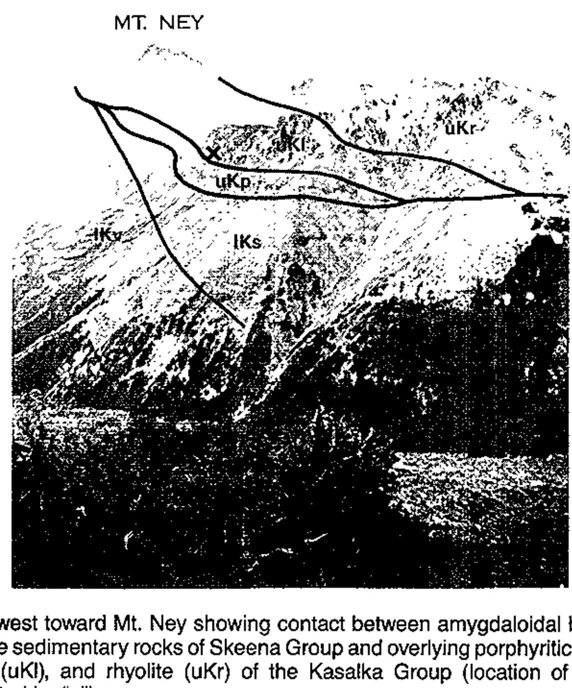


Plate XVI. View west toward Mt. Ney showing contact between amygdaloidal basalt (lKv) and marine sedimentary rocks of Skeena Group and overlying porphyritic andesite (uKp), lahar (uKl), and rhyolite (uKr) of the Kasalka Group (location of following plate indicated by "x").

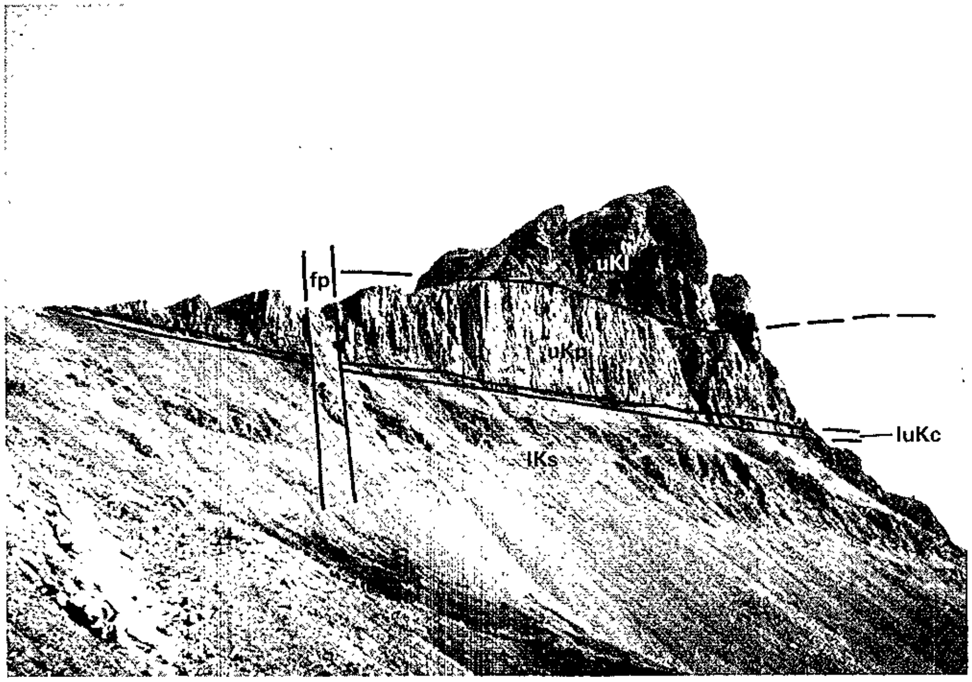


Plate XVII. Columnar jointed porphyritic andesite flow (uKp) and lahar (uKl) of Kasalka Group unconformably overlying marine sedimentary rocks of the Skeena Group (lKs). Sequence is cut by late feldspar porphyry dyke (fp).

Plate XVIII. View of south slope of Swing Peak, showing contact between lahar unit and overlying basalt unit, Kasalka Group.

Plate XIX. View of Rhine Crag, a prominent volcanic neck of porphyritic hornblende-augite microdiorite typical of the Kasalka Intrusions.

Plate XX. Tuff-breccia pipe cutting lahar unit on Swing Peak ridge (note angular nature of porphyritic andesite clasts).

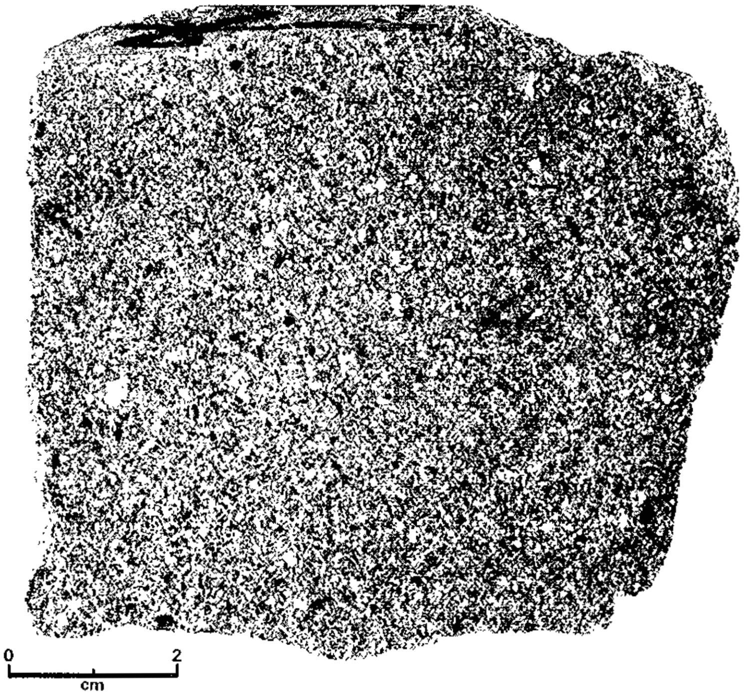


Plate XXI. Typical sample of fine-grained porphyritic hornblende-augite andesite or microdiorite, Kasalka Intrusions.

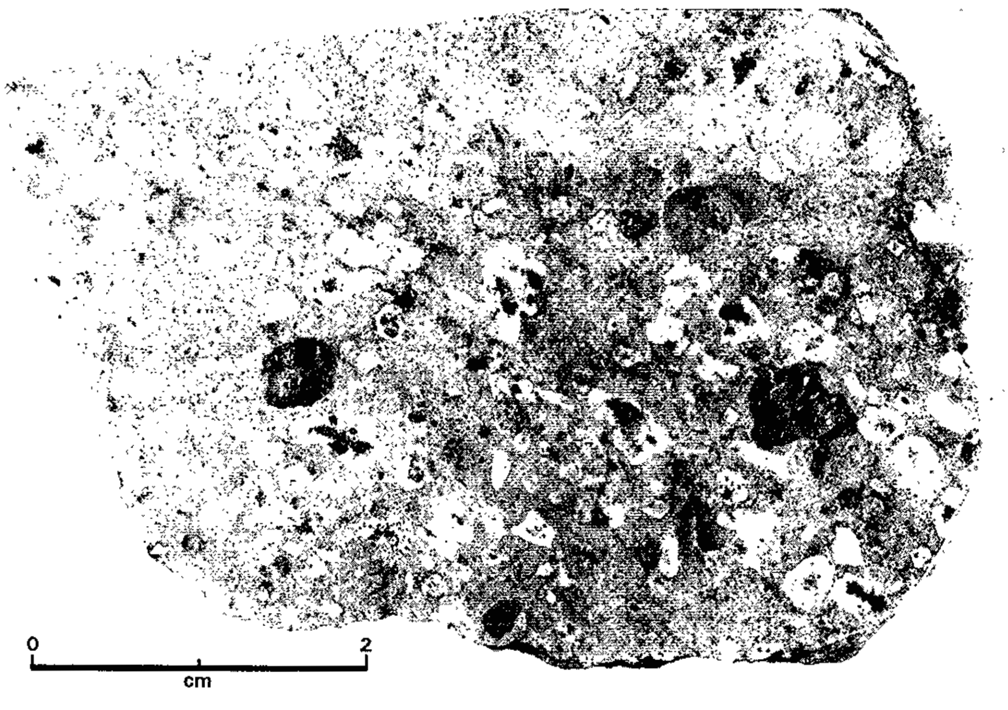


Plate XXII. Intrusive dacite or quartz porphyry, Coles Creek.

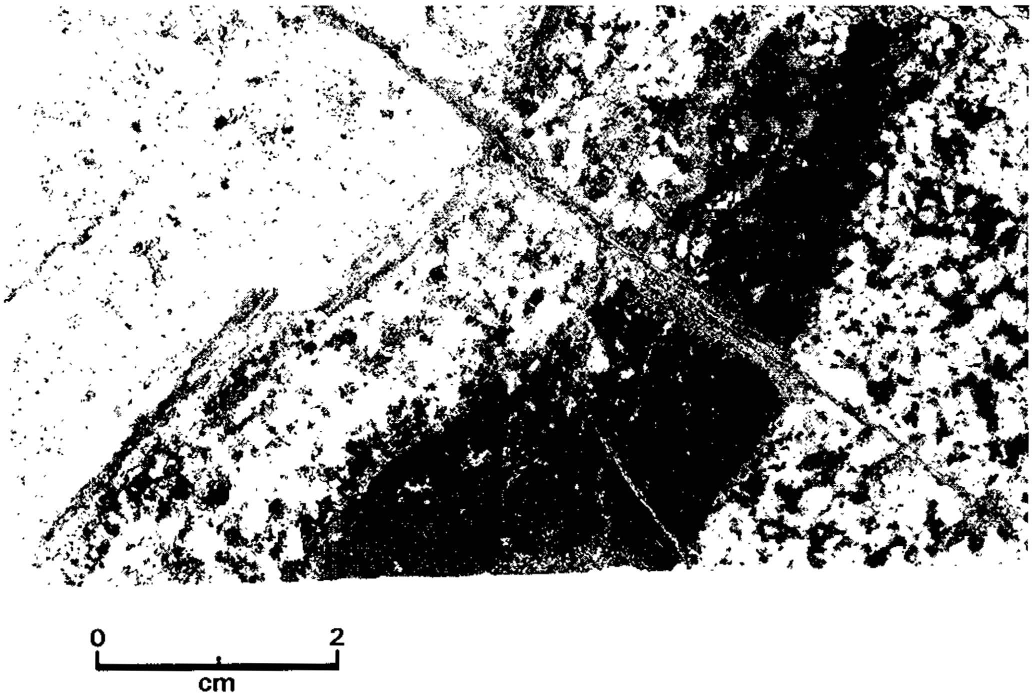


Plate XXIII. Contact between quartz porphyry and granodiorite, Whiting Creek; black band is magnetite (note late pyrite veinlet cutting across contact).

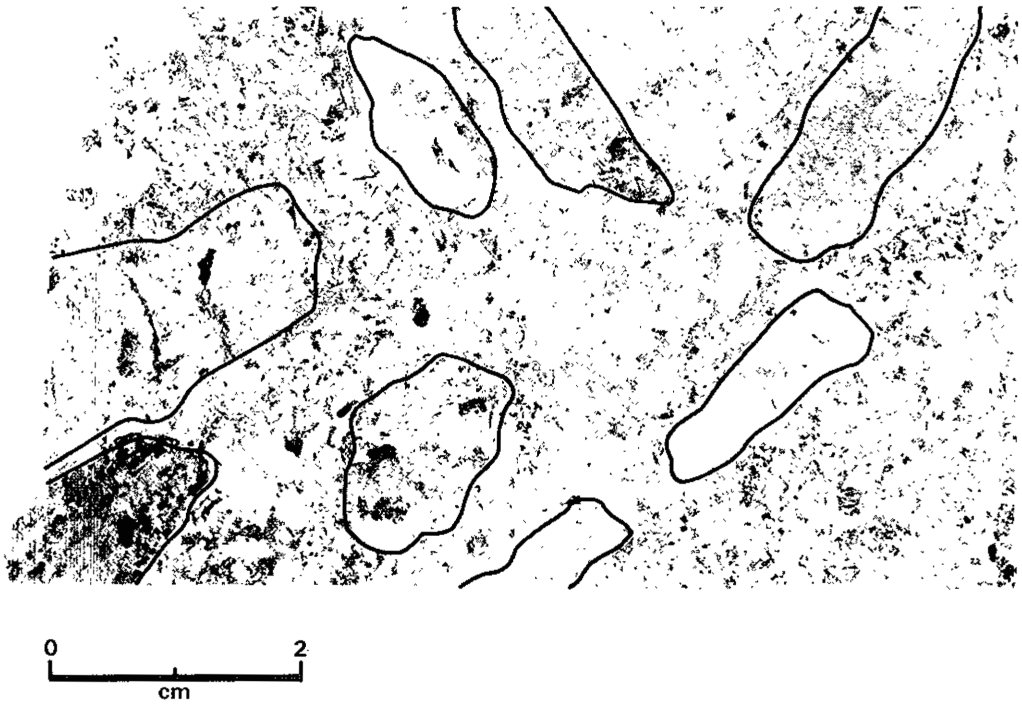


Plate XXIV. Drill core sample of quartz porphyry breccia, Whiting Creek.

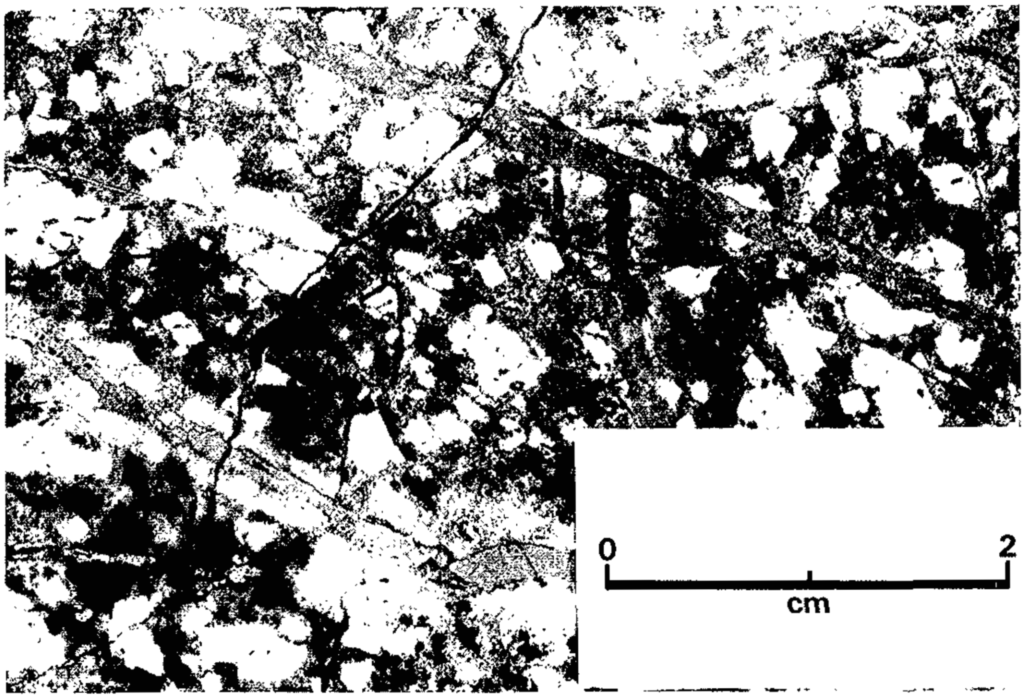


Plate XXV. Biotite-orthoclase—altered porphyritic hornblende-biotite granodiorite with quartz-pyrite vein stockwork, Coles Creek.

Plate XXVI. Sharp, flat-lying contact between granodiorite (uKgd) of Troitsa stock and overlying rusty hornfels; late feldspar porphyry dykes (fp) cut across the contact.

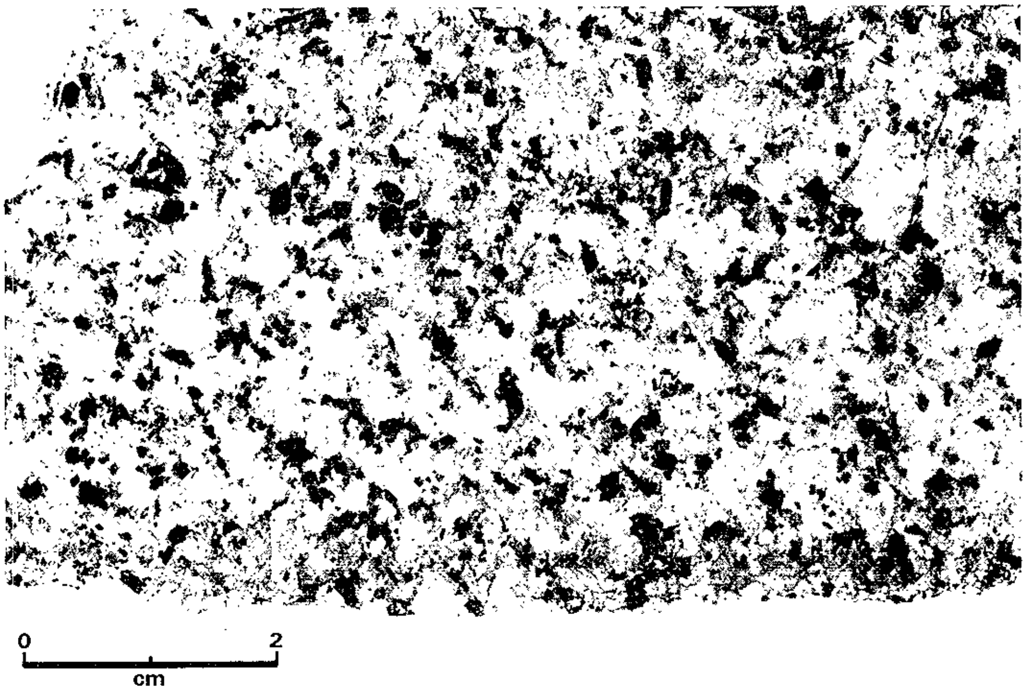


Plate XXVII. Typical sample of biotite-hornblende granodiorite, Whiting stock, Bulkley Intrusions.

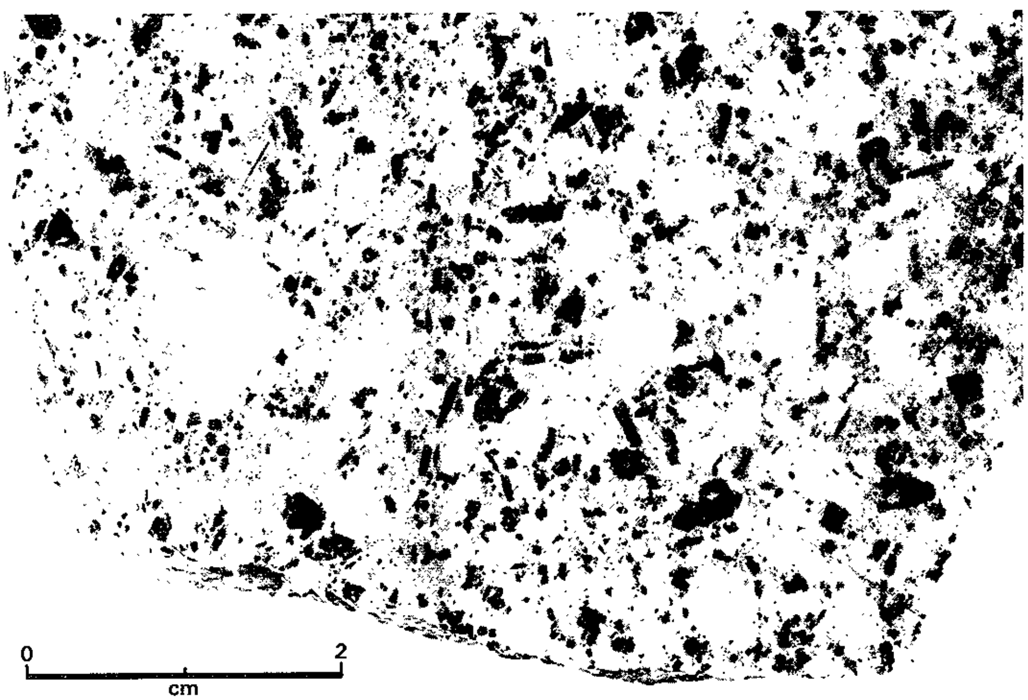


Plate XXVIII. Typical sample of porphyritic hornblende-biotite quartz monzonite, Bergette stock, Bulkley Intrusions.

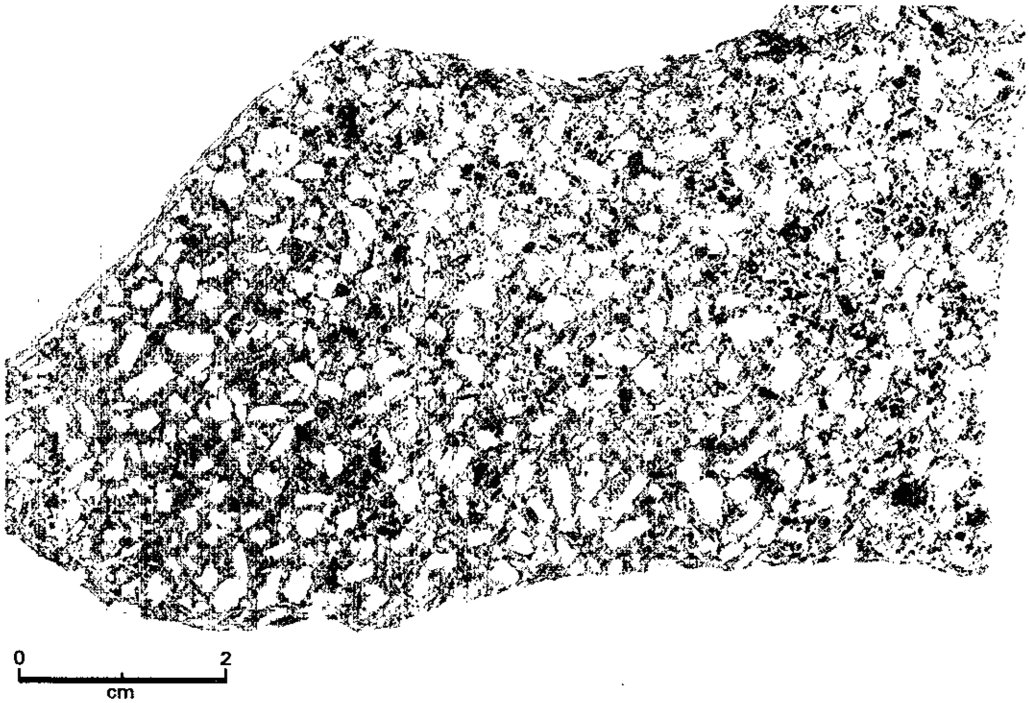


Plate XXIX. Porphyritic hornblende-biotite granophyre, Mt. Bolom stock.

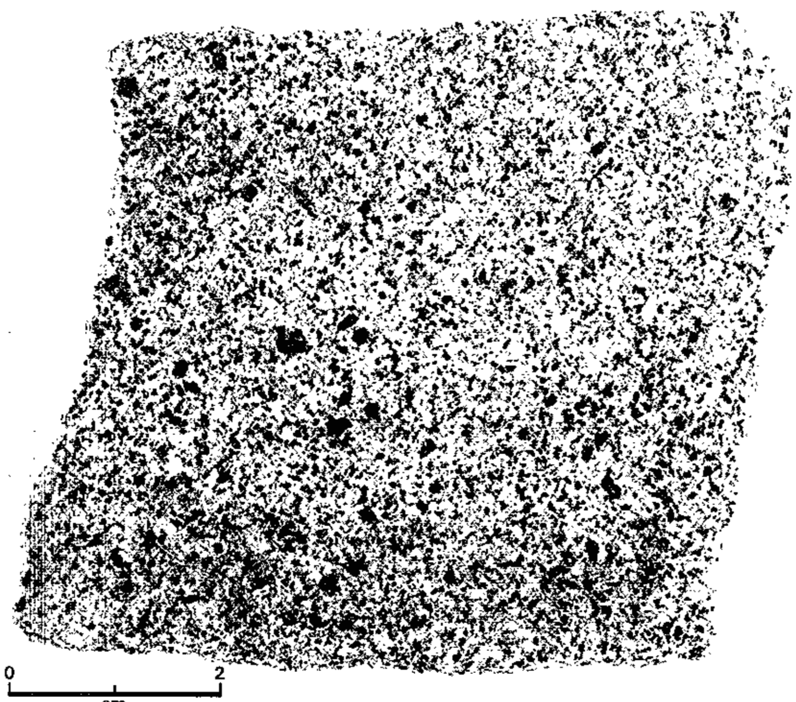


Plate XXX. Biotite-hornblende quartz diorite, Coast Intrusions, Berg property.

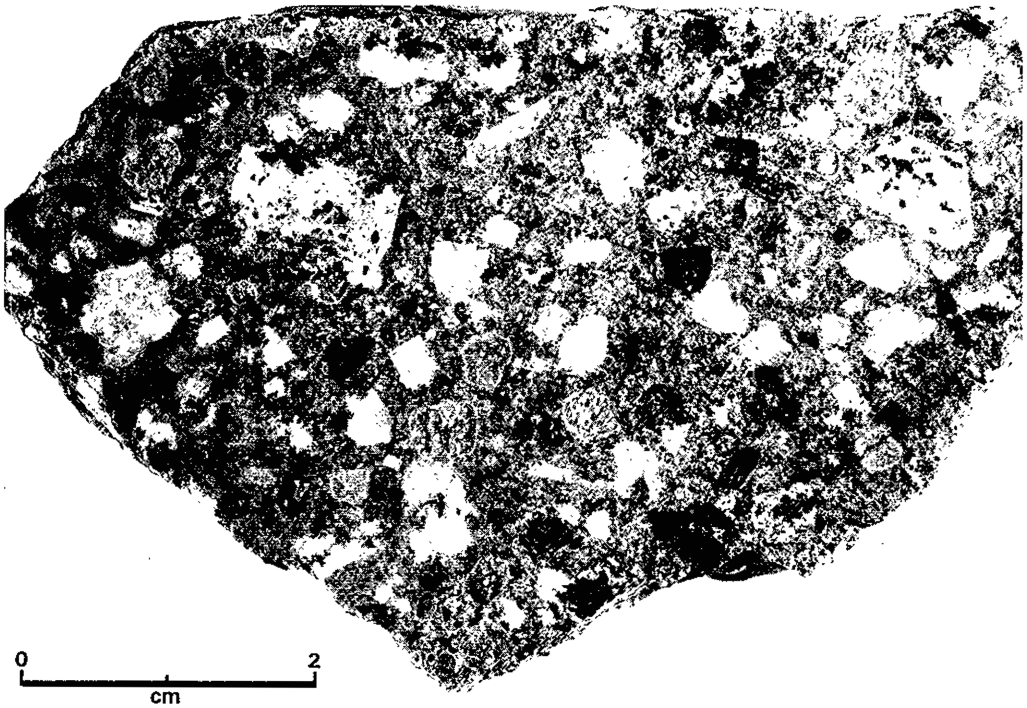


Plate XXXI. Porphyritic hornblende-biotite quartz monzonite, Berg stock.

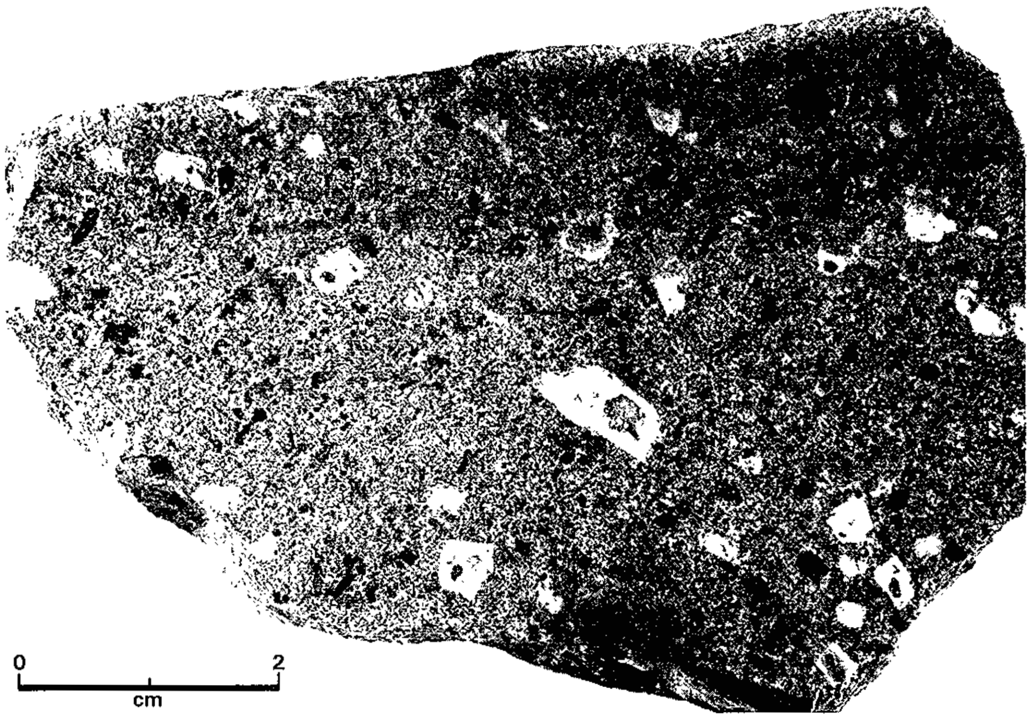


Plate XXXII. Typical post-mineral hornblende-feldspar porphyry dyke, Whiting Creek.

3

GEOCHEMISTRY

The whole rock chemical composition of representative samples of Late Cretaceous volcanic and plutonic rocks from the Tahtsa Lake area were determined by the author using X-ray fluorescence spectroscopy at the University of Western Ontario. Analytical results and calculated CIPW molecular norms are given in Appendix C; sample locations are shown on Figure 10.

The major oxide compositions of analysed rock samples are plotted on a Harker silica-variation diagram (Fig. 11). The data points cover a range of SiO_2 values from 58 to 80 per cent, and define normal trends with Al, Fe, Mg, Ca, and Ti decreasing, K increasing, and Na remaining approximately constant for increasing SiO_2 content. The scatter of data points about the trend lines is typical for such plots (for example, Larsen, 1948; Bateman and Dodge, 1970) and reflects varying degrees of alteration and differentiation for the different rock units sampled. The trend lines for Late Cretaceous rocks in the Tahtsa Lake area parallel those determined by Williams (1942) for volcanic rocks of the Crater Lake area, Cascades volcanic province (Fig. 11).

The relative proportions of alkalies ($Na_2O + K_2O$), total Fe as FeO, and MgO recalculated to 100 per cent, are plotted on Figure 12. All data points plot within the calc-alkaline field as defined by Kennedy (1933) and Tilley (1950). The AFM trend line for rocks of the Tahtsa Lake area parallel those for the Lower California batholith and lavas from the Cascades volcanic province, northwestern United States. These trends are typical for calc-alkaline rocks and are characterized by a general lack of iron enrichment toward more mafic compositions.

KASALKA GROUP

Whole rock chemical analyses of Kasalka Group volcanic rocks are presented in Appendix C. In general, there is a trend from early silicic compositions in the felsic fragmental unit to intermediate compositions in the porphyritic andesite and lahar units to mafic compositions in the late basalt unit. SiO_2 values are between 57 and 64 per cent for mafic and intermediate units, and between 70 and 80 per cent for rhyolites, with corresponding ranges of K_2O values between 1.5 to 2.4, and 2.7 to 4.2 per cent, respectively. The more rhyolitic volcanic rocks are characteristically corundum normative.

The relative proportions of normative orthoclase, plagioclase, and quartz, recalculated to 100 per cent for analysed Kasalka Group rocks, are plotted on a ternary diagram (Fig. 13). Samples of intermediate volcanic rocks from the felsic fragmental and porphyritic andesite

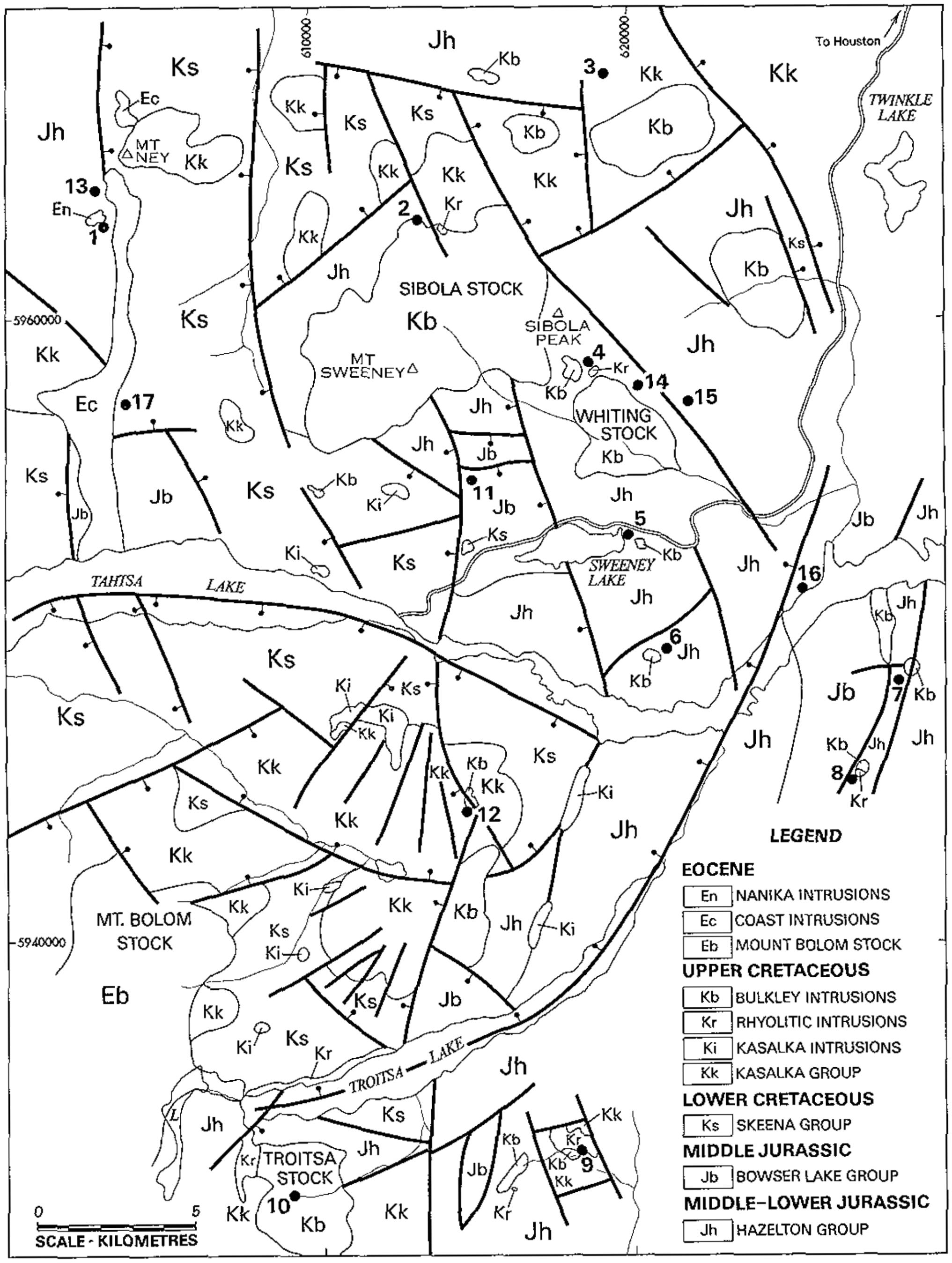


Figure 10. Geological map showing location of whole rock analysis samples listed in Appendix C.

units, plot mainly within the latite-andesite field, as defined by Streckeisen (1967); felsic volcanic rocks from these units plot within the dacite and rhyodacite fields. The lack of samples in the lower part of the dacite field corresponds to an absence of samples with SiO_2 values between 64 and 70 per cent. This suggests that volcanic rocks of the Kasalka Group are bimodal. More detailed sampling is required to determine if this feature is real. Andesitic rocks of the Kasalka Group have chemical compositions similar to those of the Andesite Formation of Chile (compare analyses 5 and 6 to A in Appendix C). The rhyolitic rocks are similar to the average rhyolite of Cascade volcanos (B in Appendix C).

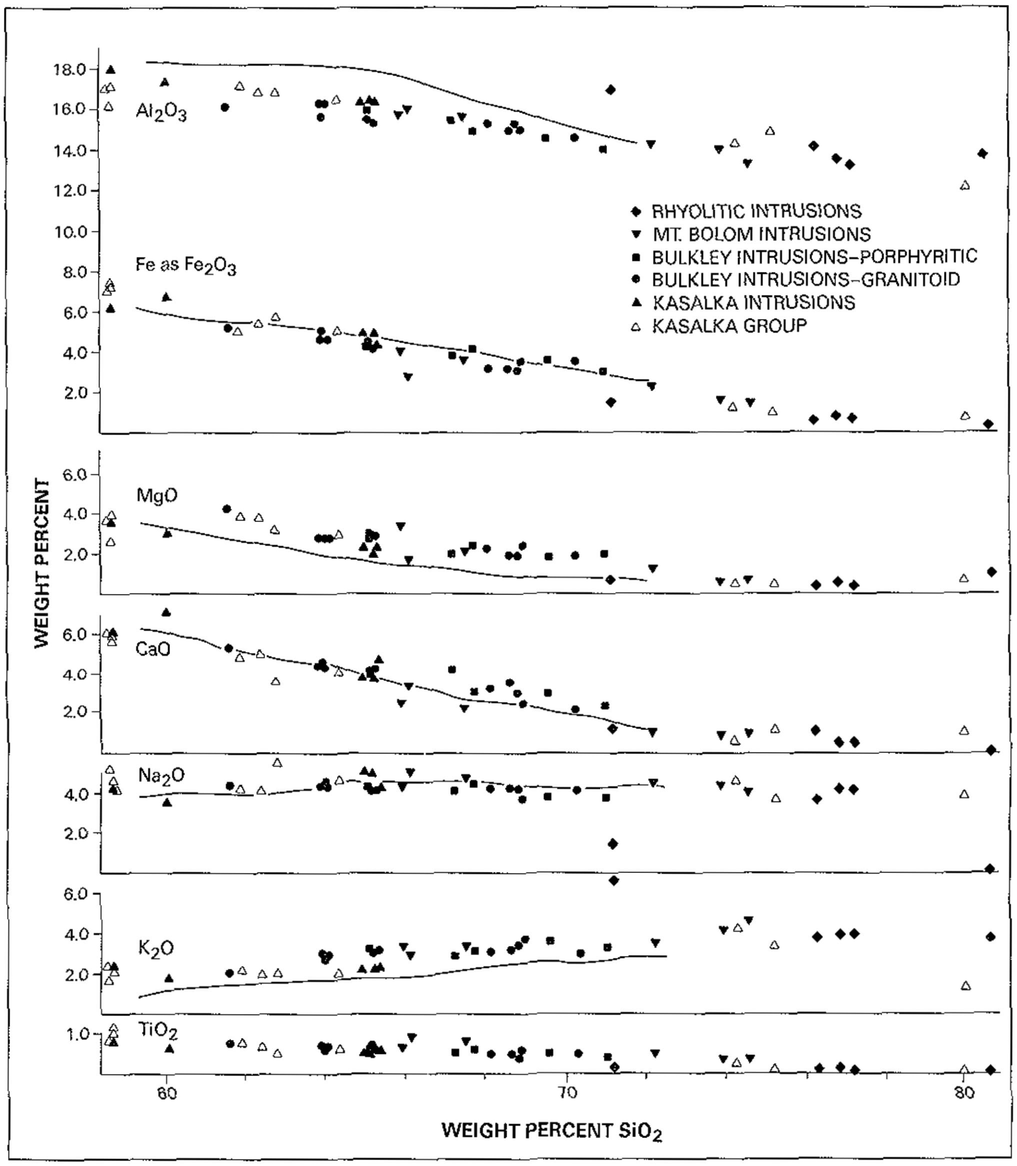


Figure 11. Harker silica variation diagram for volcanic and plutonic rock samples, showing Cascades trend line, Tahtsa Lake area (analytical data given in Appendix C).

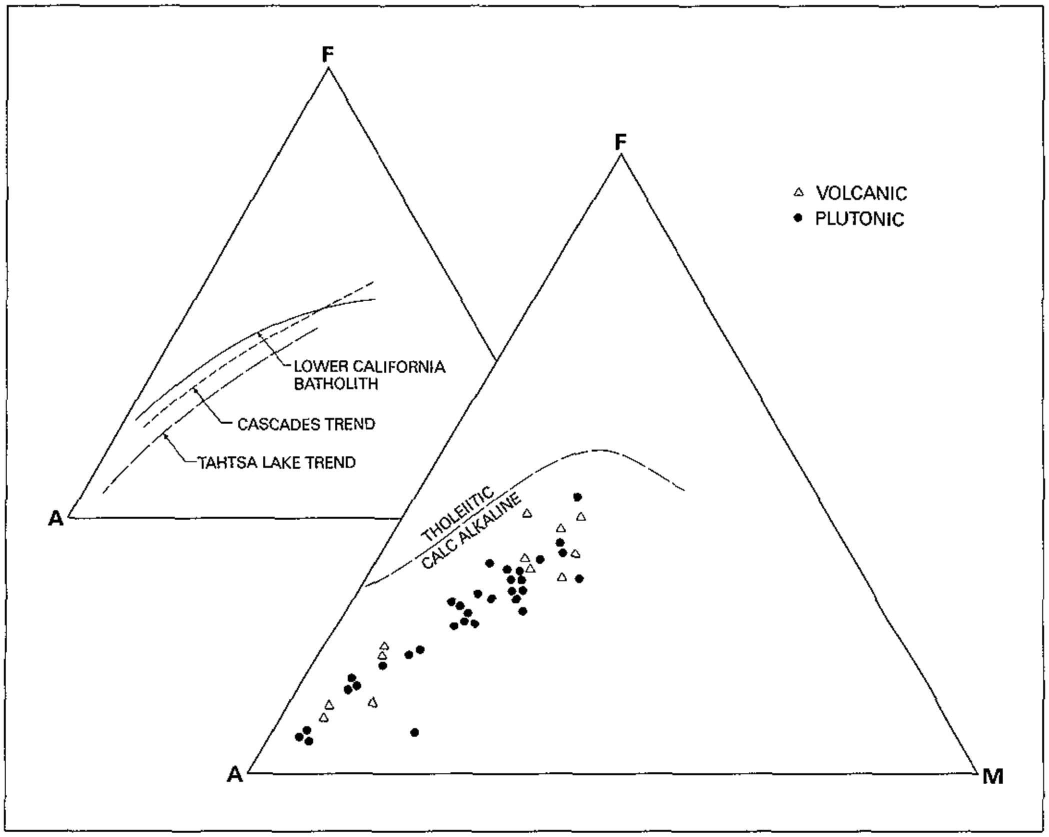


Figure 12. Ternary polt of alkalies, iron, and magnesium for volcanic and plutonic rock samples (for base data *see* Appendix C).

KASALKA INTRUSIONS

Chemical analyses of five typical samples of the Kasalka intrusions are presented in Appendix C. These rocks have chemical compositions very similar to intermediate flows of the Kasalka Group, especially in terms of K_2O content (Fig. 14). As expected, the Kasalka intrusions also fall within Streckeisen's latite-andesite field.

BULKLEY INTRUSIONS

Chemical analyses of typical samples of the Bulkley intrusions in the Tahtsa Lake area are given in Appendix C. These samples contain between 60 and 71 per cent SiO_2 with 2.0 to 3.6 per cent K_2O (Fig. 14). The Bulkley intrusions differ from the Kasalka Group volcanic rocks and Kasalka intrusions by having greater K_2O at any given SiO_2 content. The only exception is the quartz diorite at Coles Creek which has a composition similar to that of porphyritic andesite of the Kasalka Group.

The relative proportions of normative quartz, plagioclase, and orthoclase, recalculated to 100 per cent for analysed samples of the Bulkley intrusions, are plotted on Figure 13. With the exception of the two samples of quartz diorite, all data points fall within the field for the Bulkley intrusions as defined by Carter (1981). On a normative basis, these rocks are granodiorites. Data points for the porphyritic intrusions cluster about the trend line defined by analyses of the Sibola stock; this suggests that there is no significant difference in the relative proportions of major oxides for porphyritic and equigranular phases of the Bulkley intrusions. All these rocks have compositions similar to average granodiorite as determined by Nockolds (1954; C in Appendix C).

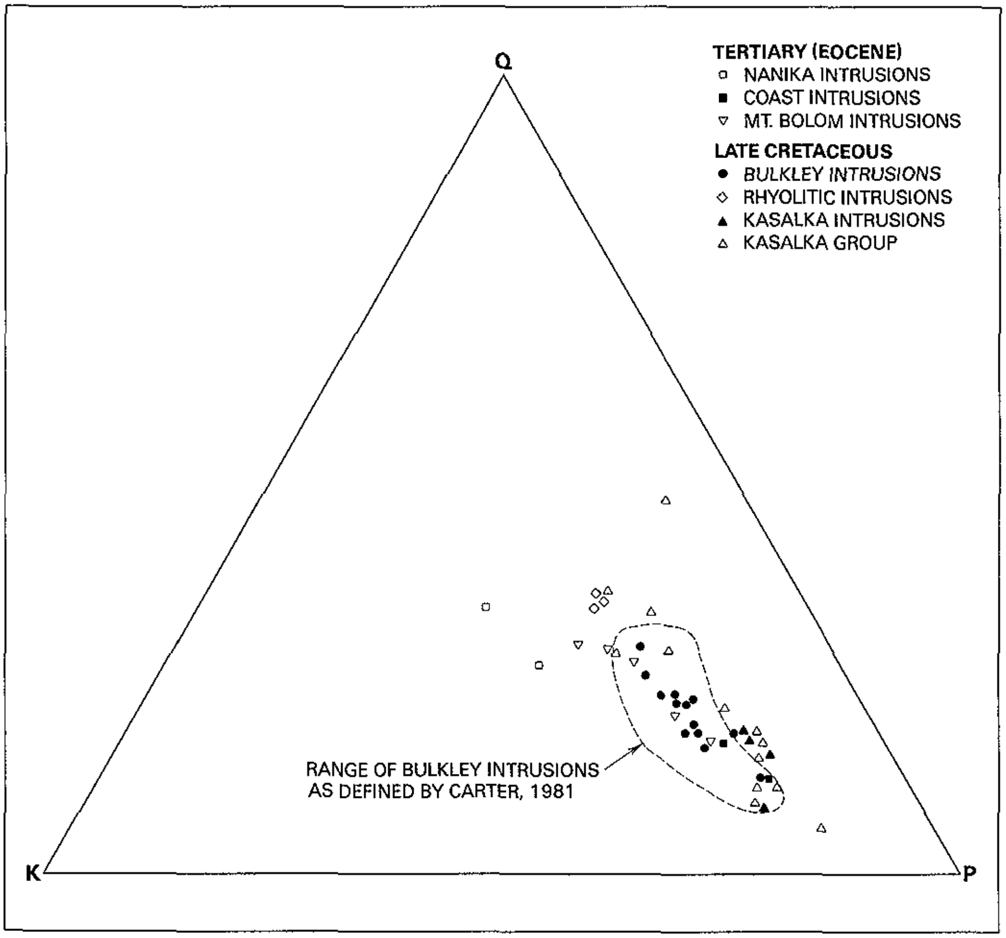


Figure 13. Ternary plot of normative quartz, plagioclase, and K-feldspar for volcanic and plutonic rock samples (for base data *see* Appendix C).

RHYOLITIC INTRUSIONS

Three samples of the Whiting Creek quartz porphyry and two samples of the quartz porphyry dyke on the north shore of Troitsa Lake were analysed (Appendix C). The Whiting Creek samples (analyses 32, 33, 36, Appendix C), have SiO_2 values between 70 and 81 per cent with variable K_2O and Na_2O contents. This variability reflects different intensities of hydrothermal alteration. The samples from Troitsa Lake (analyses 34, 35, Appendix C) are very similar in composition to the rhyolitic flows capping peaks near the Bergette prospect (for example, analysis 11), particularly in K_2O content (Fig. 14). Both the Whiting Creek and Troitsa Lake quartz porphyries are corundum normative.

MOUNT BOLOM INTRUSION

The chemical compositions of five samples of porphyritic granophyre from the Mount Bolom stock and a related dyke on Swing Peak, are given in Appendix C. These samples have between 65 and 75 per cent SiO_2, with a corresponding range of K_2O from 2.9 to 4.7 per cent. The more differentiated phases of the Mount Bolom intrusions tend to be more silicic than those of the Bulkley intrusions, falling within the quartz monzonite field. This is also shown on the K_2O-SiO_2 variation diagram (Fig. 14) where the trend line for the Mount Bolom intrusions overlaps and appears to be a continuation of that determined for the Bulkley intrusions. Another difference between the Bulkley and Mount Bolom intrusions is that the latter tends to be corundum normative.

COMPARISON OF LATE CRETACEOUS AND TERTIARY PLUTONIC ROCKS

Carter (1981) has shown that the Late Cretaceous Bulkley intrusions are less potassic than the Eocene Nanika intrusions for any given SiO_2 content. This is best shown on the K_2O-SiO_2 variation diagram (Fig. 14) where data points for two analyses of the Berg quartz monzonite (data from Carter, 1981) fall well above the trend line for the Bulkley intrusions. By contrast, two analyses of the Berg quartz diorite (Appendix C), which is believed to be part of the Coast intrusions, plot within the fields defined for the Bulkley and Kasalka intrusions (Fig. 14). On a chemical basis, these rocks cannot be distinguished from their older counterparts.

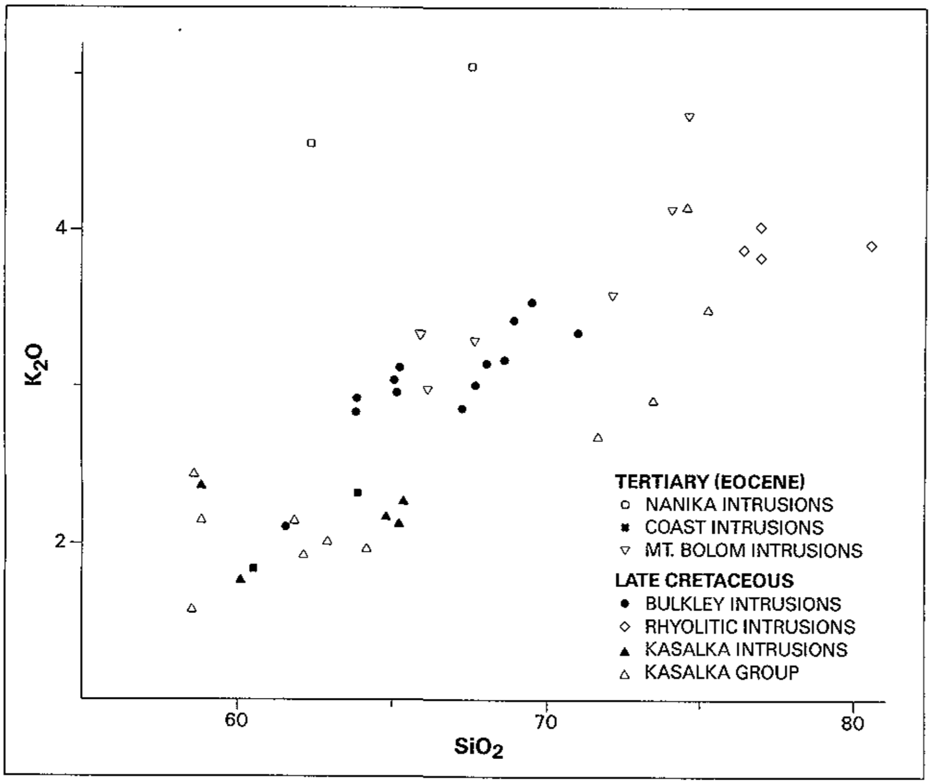


Figure 14. Plot of K_2O versus SiO_2 for chemically analysed Cretaceous and Tertiary volcanic and plutonic rock samples.

4

MINERAL DEPOSITS

The most economically important mineral deposits in the Tahtsa Lake district are extensive zones of disseminated and fracture-controlled chalcopyrite and molybdenite that are spatially associated with porphyritic granodiorite and quartz monzonite of the Bulkley and Nanika intrusions. The most extensively explored of these porphyry copper deposits are Berg, Huckleberry Mountain, Ox Lake, and Whiting Creek. Similar types of mineralization occur at the Troitsa, Coles Creek, Sylvia, Wee, Lean-To, and Bergette properties. High-grade lead-zinc-silver veins also occur in the district, the most significant of these is the Emerald Glacier mine. Locations and a summary of the main mineral deposits and occurrences in the Tahtsa Lake district are given on Figure 15 and Table 4, respectively.

BERG (MI 93E-46)

The Berg deposit (No. 1, Fig. 15) is in the northwest corner of the map-area. A prominent gossan outlines the mineralized zone which is near the head of a west-draining cirque valley. This gossan attracted prospectors to the area as early as 1914. In 1929 lead-zinc-silver-copper veins peripheral to the deposit were discovered but, because of surface leaching, the porphyry system was not recognized until 1961 when Kennco Explorations (Western), Limited staked the Berg claims. Diamond drilling was done on the property in the periods 1964 to 1967 and 1971 to 1975; a total of 17 846 metres were drilled in 103 holes. This work has defined geological reserves of 400 million tonnes averaging 0.4 per cent copper and 0.05 per cent molybdenite (Panteleyev, 1981).

The Berg porphyry copper deposit is spatially associated with a small stock of porphyritic biotite-quartz monzonite that intrudes hornfelsed andesitic fragmental rocks of the Hazelton Group (Fig. 16). Biotite extracted from samples of this stock has given potassium-argon isotopic ages in the range 47.0 to 52.0 Ma (*see* Table 3). Carter (1974) has included the Berg stock as part of the Eocene Nanika intrusions, which are typically quartz monzonite in composition and occur immediately east of the Coast Crystalline Belt. The Berg stock is the only example of this group of intrusions in the map-area.

Panteleyev (1981) has subdivided the Berg stock into several phases. The earliest phase appears to be the quartz monzonite porphyry, which constitutes the core and southeastern portions of the stock. Possibly younger phases are sericitized quartz plagioclase porphyry, which occurs as an irregular southeastern tail to the stock, and plagioclase-biotite-quartz porphyry, which comprises the northern half of the stock. A relatively unaltered, northeast-trending dyke of hornblende-quartz-feldspar porphyry cuts the stock. Biotite from this dyke gave a potassium-argon age of 48.0 ± 3 Ma.

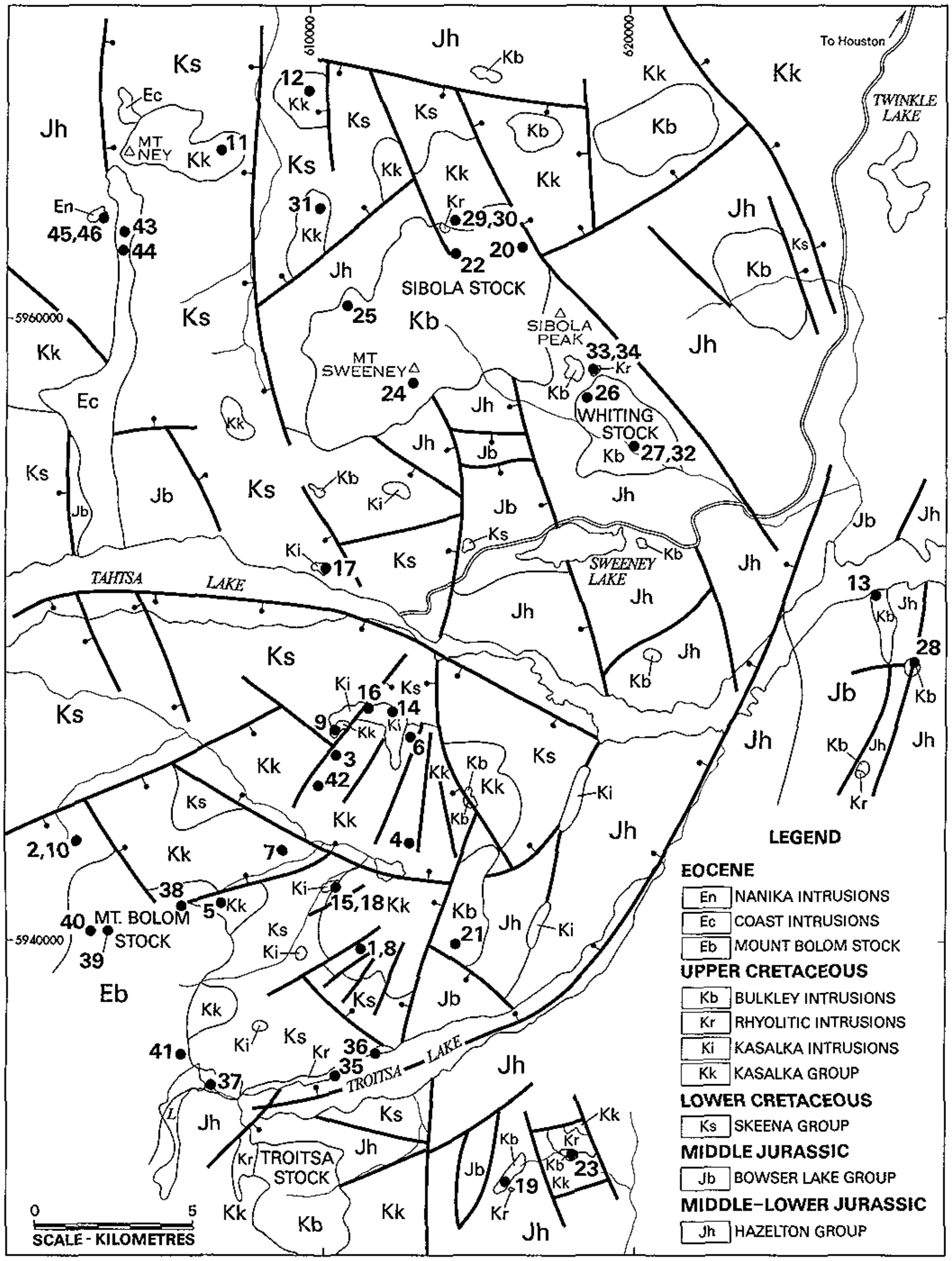


Figure 15. Geological map showing the location of mineral deposits and occurrences, Tahtsa Lake district.

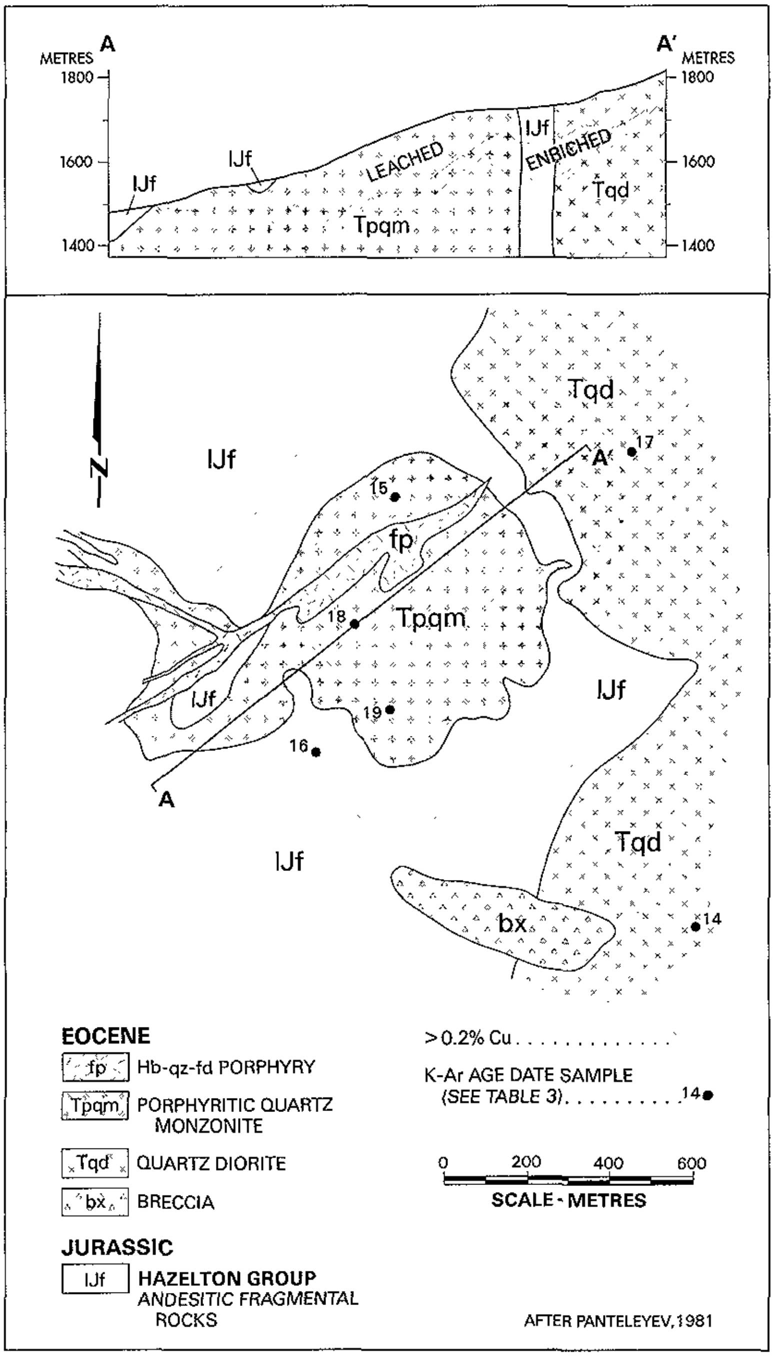


Figure 16. Geologic setting of the Berg deposit (after Panteleyev, 1981).

TABLE 4. MAJOR MINERAL OCCURRENCES

MAP No.	NAME	MOST RECENT OPERATOR	COMMODITY	RESERVES	DESCRIPTION	REFERENCE
1	BERG (93E—46)	Placer Development, 1980	Cu, Mo	400 m.t. 0.4% Cu 0.05% MoS_2	Annular zone about Eocene porphyritic quartz monzonite stock, supergene enriched.	Panteleyev, 1981
2	BERGETTE (93E—52)	Granges Exploration, 1973	Cu, Mo	non-defined	Quartz porphyry breccia pipe contains molybdenite, pyrite, and chalcopyrite. Pyritic veinlets occur in hornfels adjacent to the main stock.	Church, 1971
3	SYLVIA (93E—89)	Hudson's Bay Oil and Gas, 1976	Cu	non-defined	Pyrite and chalcopyrite occur in Upper Cretaceous (uK) quartz diorite and Jurassic volcanic rocks	GEM 1974, p. 246
4	WHITING CREEK (WHIT) (93E—49, 50)	Saskatchewan Mining and Development Corp., 1981	Mo, Cu	123.5 m.t. 0.043% MoS_2 0.062% Cu (Ridge Zone)	Quartz-molybdenite veinlets occur in altered uK quartz porphyry; chalcopyrite and molybdenite veinlets occur in potassic altered uK granodiorite and porphyritic quartz monzonite.	Cann, 1980
5	WEE (93E—86)	Hudson's Bay Oil and Gas, 1979	Cu	non-defined	Pyrite and chalcopyrite occur in breccia intruded by small uK(?) quartz diorite stocks.	GEM 1974, pp. 243-244
6	HUCKLEBERRY (LEN) (93E—37, 38, 39)	Granby Mining Corp., 1974	Cu, Mo	87 m.t. 0.408% Cu 0.025% MoS_2	Annular zone of disseminated and veinlet sulphides in hornfels adjacent to uK porphyritic granodiorite stock.	James, 1976
7	OX LAKE (OX) (93E—4)	ASARCO Exploration Co. of Canada, 1982	Cu, Mo	23.6 m.t. 0.35% Cu equiv.	Zone of disseminated and veinlet sulphides in hornfels and breccia adjacent to small uK porphyritic granodiorite stock.	Richards, 1976
8	REA, TL, LEAN-TO (93E—40)	Lansdowne Oil and Minerals, 1983	Cu, Mo, Ag	non-defined	Pyrite, chalcopyrite, arsenopyrite, pyrrhotite, marcasite, sphalerite, and tetrahedrite occur in quartz porphyry breccia pipe.	GEM 1972, p. 340; Ager and Holland, 1983
9	COLES CREEK (FAB) (93E—41, 42, 43, 44)	Amax Potash Corp., 1972	Cu, Mo, Pb, Zn, Ag	non-defined	Quartz vein stockwork with chalcopyrite and minor molybdenite occurs in potassic altered uK porphyritic granodiorite stock; galena and sphalerite occur in argillic altered uK volcaniclastic rocks and dacite porphyry; chalcopyrite, molybdenite, galena, sphalerite, and magnetite occur in quartz porphyry breccia pipe.	MacIntyre, 1974

TABLE 4. MAJOR MINERAL OCCURRENCES — *Continued*

MAP No.	NAME	MOST RECENT OPERATOR	COMMODITY	RESERVES	DESCRIPTION	REFERENCE
10	TROITSA (OVP) (93E—3, 5, 9)	Cerro Mining Co. of Canada, 1971	Cu	non-defined	Chalcopyrite occurs in altered feldspar porphyry dykes cutting uK granodiorite.	Cawthorn, 1973
11	EMERALD GLACIER (93E—1) also GLACIER, STANLEY (93E—47, 48)	Emerald Glacier Mines, 1982	Pb, Zn, Ag	non-defined producer, 1951–1953 4 200 tonnes averaging 12.1% Pb 11.5% Zn 408 g/tonne Ag 0.27 g/tonne Au	North-trending, steep-dipping shear zone with quartz, calcite, galena, sphalerite, and minor chalcopyrite and pyrite.	Sutherland Brown, 1967
12	SWANNELL, CAPTAIN (SWING, SAM) (93E—35)	Tahtsa Mines, 1981	Pb, Zn, Ag	non-defined	Galena, sphalerite, pyrite, and minor tetrahedrite occur in steep northwest-trending shear zones cutting uK volcanic rocks.	Goldsmith and Kallock, 1981
13	LEAD EMPIRE (SET, LOST, ICE) (93E—8)	Sierra Empire Mines, 1971	Pb, Zn, Ag	non-defined	Pyrite and quartz with variable galena and sphalerite occur in shear zones near Eocene quartz diorite.	Duffell, 1959
14	WEST VIEW (93E—74)	?	Zn, Pb, Ag, Au	non-defined	Quartz, sphalerite, minor galena, and pyrite in veins.	MMAR 1916, p. K163
15	ORIENTAL (93E—51)	?	Ag, Au	non-defined	Minor pyrite in quartz veins.	May be Gold Crown, Bellecini, Golden Chest, Jollimont claims described in MMAR 1916
16	RIVERSIDE (93E—36)	?	Au, Ag, Cu, Zn	non-defined	Pyrite and arsenopyrite occur in quartz veins with minor chalcopyrite and sphalerite.	Duffell, 1959
17	GLORY (93E—7)	?	Ag, Pb, Cu, Au	non-defined	Pyrite, chalcopyrite, galena, and specular hematite occur in quartz stringers.	Duffell, 1959

MMAR = British Columbia Minister of Mines Annual Report.
GEM = Geology, Exploration and Mining in British Columbia.
m.t. = million tonnes.

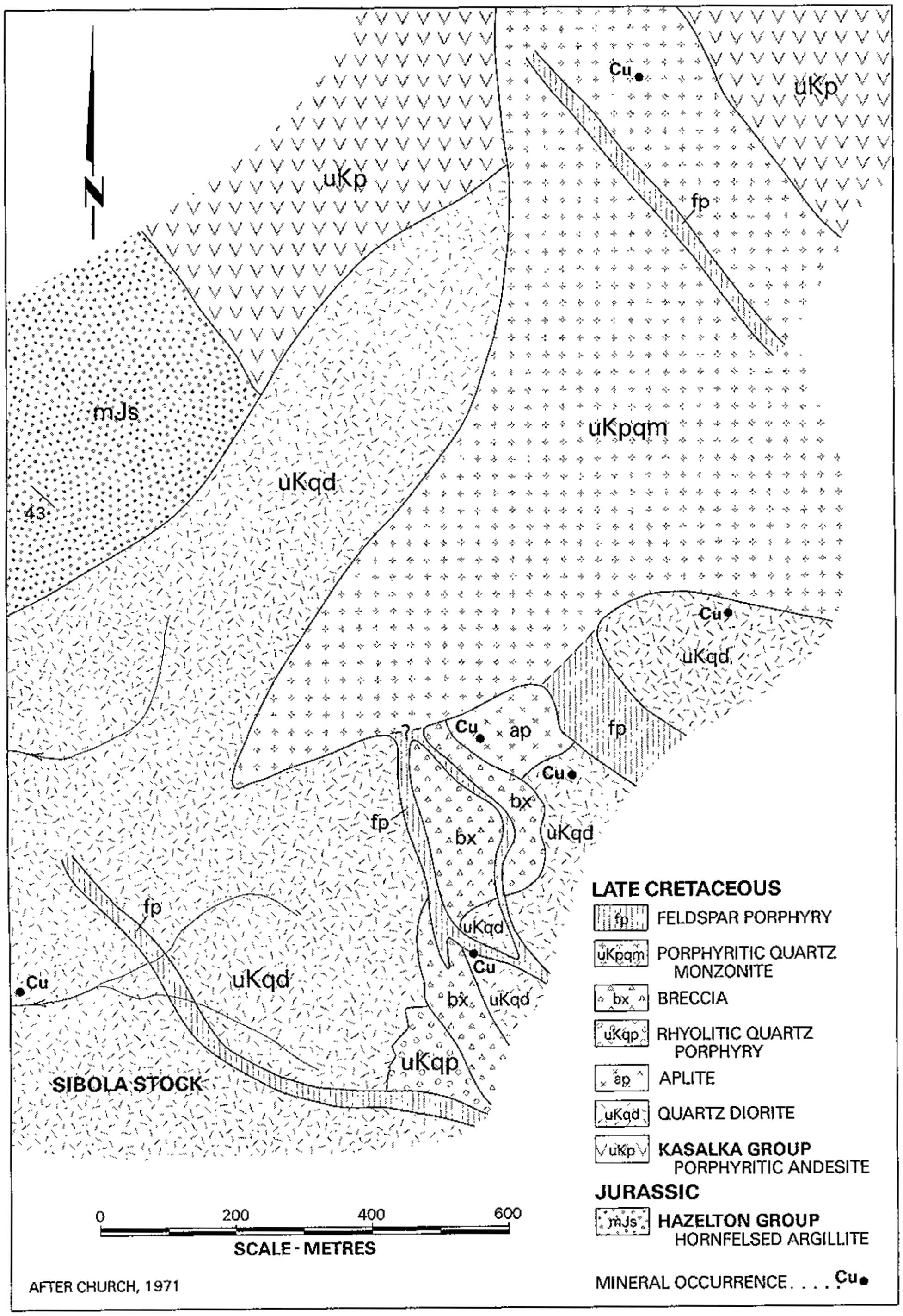


Figure 17. Geologic setting of the Bergette property (after Church, 1971).

An elliptical breccia pipe, which cuts quartz diorite and Hazelton Group rocks, is located southeast of the Berg stock. This breccia is composed of small (less than 3-centimetre), subangular to subrounded fragments of porphyry that are carbonate, clay, sericite, and chlorite altered (Panteleyev, 1981). Breccias related to emplacement of various phases of the Berg stock and fault-related breccias have also been observed in drill core.

The Berg porphyry copper deposit is defined by concentric, annular zones of hydrothermal alteration and sulphide deposition that enclose the Berg stock. A classic zonal arrangement has been documented by Panteleyev (1981) and others. Pervasive potassic alteration (quartz-K-feldspar-biotite-sericite) occurs in the core of the stock and grades outward through zones of phyllic (quartz-sericite-pyrite) and propylitic (epidote-chlorite) alteration. Local argillic (clay) alteration is present.

The Berg deposit is essentially a multistage vein stockwork that has been superimposed on pervasively altered biotite hornfels surrounding the Berg stock. The earliest veins are quartz-pyrite-chalcopyrite-molybdenite with or without alteration envelopes of quartz-sericite, chlorite, or K-feldspar. Quartz-molybdenite veins are slightly younger and are more abundant near the contact of the Berg stock where quartz vein stockworks are best developed (Panteleyev, 1981). Quartz-pyrite and pyrite veins with or without alteration envelopes represent the third stage of vein development; these veins are cut by late quartz-carbonate and quartz-anhydrite-carbonate veins with minor amounts of pyrite, chalcopyrite, sphalerite, tetrahedrite, galena, and epidote. The pyritic and base metal-bearing veins are most common in the propylitic alteration zone that encloses the Berg porphyry copper deposit. Gypsum-filled fractures define a late, subhorizontal fracture cleavage that cuts all alteration zones and sulphide-bearing veins.

One of the unique features of the Berg deposit relative to other porphyry deposits of the Canadian Cordillera is the presence of a leached capping and a supergene-enriched blanket. The leached capping, which is essentially barren of copper, extends to a depth of 38 metres (Panteleyev, 1981). The supergene-enriched blanket is up to 91 metres thick (Fig. 16); it is characterized by a 1.25 times increase in copper over primary grade. The bottom of the supergene-enriched zone is marked by the appearance of gypsum-bearing veinlets.

BERGETTE (MI 93E-52)

The Bergette porphyry copper prospect (No. 2, Fig. 15) is in the north-central part of the map-area, near the northern contact of the Sibola stock. Like other porphyry prospects in the area, a prominent gossan led prospectors to the area in the early 1960's. The property was first staked by Kennco Explorations, (Western) Limited; it was restaked by G.O.M. Stewart in 1970 for Frontier Exploration Limited. Granges Exploration Aktiebolag optioned the property in 1971; six diamond-drill holes totalling 1 222 metres were subsequently completed. Results were encouraging and in 1972, 14 percussion holes totalling 1 219 metres were drilled. A further 1 220 metres of diamond drilling was completed in 1973. The property has remained relatively inactive since that time.

Several intrusive phases have been described at the Bergette property by Church (1971). These include the relatively fine-grained biotite-hornblende quartz diorite border phase of the Sibola stock, a triangular-shaped stock of porphyritic biotite-hornblende quartz monzonite, that occurs along the margin of the Sibola stock, a small breccia pipe of rhyolitic quartz porphyry within the Sibola stock, and late northwest-trending feldspar porphyry dykes (Fig. 17). The mineralized zones at Bergette appear to be spatially associated with the porphyritic quartz monzonite stock and the western margin of the Sibola stock. Biotite from porphyritic quartz monzonite yielded a potassium-argon isotopic age of 76.7±2.5 Ma (Table 3).

The main exploration targets on the Bergette property have been the breccia pipe, and fracture-controlled mineralization along the western margin of the Sibola stock. The breccia zone is approximately 500 metres in length. It cuts the Sibola quartz diorite and extends from the southwest tip of the porphyritic quartz monzonite stock southward to a small plug of rhyolitic quartz porphyry (Fig. 17) that is within the Sibola stock.

Although strongly oxidized on surface, in drill core the breccia is seen to vary from pervasively altered and crackled rock to rock with abundant interfragment cavities and rotated fragments (Church, 1971). Within the breccia gypsum, pyrite, uncommon molybdenite, and fluorite occur as fracture coatings and veinlets. Vugs are partly filled with calcite, pyrite, chalcopyrite, magnetite, epidote, biotite, chalcocite, and zeolites. Late northwest-trending feldspar porphyry dykes cut the breccia zone.

Reticulate fractures containing pyrite, chalcopyrite, and minor molybdenite with varying amounts of quartz and adularia, occur in the western margins of the Sibola stock and in adjacent hornfelsed Hazelton Group rocks. Sericitic alteration envelopes are common, especially within the volcanic sequence. Because of the sporadic nature of the alteration and sulphide mineralization no systematic zoning pattern has been documented at the Bergette property.

SYLVIA (MI 93E-89)

The Sylvia prospect (No. 3, Fig. 15) is at the north-central edge of the map-area at approximately 1 040 metres elevation. This area is relatively flat with sparse outcrop and thick forest cover. Access to the claims is by means of the Berg exploration road, which connects to the Tahtsa Lake forest access road at Twinkle Lake. Exploration on the Sylvia claims was done by Hudson's Bay Oil and Gas Company Limited in the period 1974 to 1976. The company completed 16 percussion drill holes totalling 875 metres and several induced polarization, magnetometer, and soil geochemical surveys.

Percussion drilling on the Sylvia claims intersected quartz diorite and andesitic fragmental rocks; these contain disseminated and fracture-controlled pyrite, chalcopyrite, and minor molybdenite. The extent and grade of this mineralization is not known. The host rocks are believed to be Late Cretaceous in age. The quartz diorite may be the border phase of a compositionally zoned stock that underlies the northern edge of the map-area.

WHITING CREEK (MI 93E-49, 50)

The Whiting Creek property (Whit claims) is located between Mount Sweeney and Sweeney Lake in the east-central part of the map-area (No. 4, Fig. 15). A very pronounced red to orange-coloured gossan has developed on the south-facing slope of Mount Sweeney. This gossan, which covers an area roughly 5 kilometres by 2 kilometres, is visible for tens of kilometres and attracted prospectors to the area as early as 1914. However, like the Berg prospect, high-grade lead-zinc-silver veins peripheral to the porphyry deposits were the original exploration targets; it was not until 1963 that the Whit claims were staked by Kennco Explorations, (Western) Limited. Kennco diamond drilled 21 holes totalling 988 metres in 1964 and 1965. The property was optioned by Quintana Minerals Corporation in 1972 and a single 457-metre diamond-drill hole completed.

In 1980 and 1981 the Saskatchewan Mining and Development Corporation actively explored the Whiting Creek property, completing 26 diamond-drill holes totalling 5 598 metres. This work outlined drill-inferred reserves of 123.5 million tonnes averaging 0.043 per cent molybdenite and 0.062 per cent copper in the Ridge zone (Cann, 1981). These reserves include approximately 40 million tonnes that average 0.10 per cent molybdenite and 0.17 per cent copper (Goodz, *et al.*, 1983).

The Whiting Creek hydrothermal system is centred on a cluster of intrusions that have been exposed by down-cutting creeks draining the south slope of Mount Sweeney (Fig. 18). The largest intrusive body is the Whiting hornblende-biotite granodiorite stock which crops out in the valley of Whiting Creek. This stock probably represents the top of a large intrusive body that underlies most of the Sibola Range. The Whiting stock is cut by a later porphyritic hornblende-biotite granodiorite to quartz monzonite phase.

A small plug of feldspar-quartz porphyry to quartz porphyry is exposed on the ridge north of Whiting Creek at the north contact of the Whiting stock. This plug is cut in half by an east-trending body of porphyritic hornblende-biotite granodiorite that may be a late stage offshoot of the nearby Whiting stock.

A pervasively altered zone occurs on the west side of the Whiting Creek property. Within this zone is an intrusive body that appears to have been a porphyritic granodiorite or quartz monzonite, as indicated by relic textures in the altered rock. This pre-alteration intrusion is cut by several smaller, weakly altered stocks of hornblende-biotite granodiorite that are texturally similar to intrusive rocks cutting the Whiting stock and quartz porphyry plug. Several small breccia pipes comprised of fragments of both porphyritic and non-porphyritic hornblende-biotite granodiorite (Plate XXIV) occur within and adjacent to the porphyritic granodiorite intrusions (Fig. 18).

Late, predominantly northwest-trending biotite-hornblende-feldspar porphyry (Plate XXXII) and feldspar-quartz porphyry or rhyolite porphyry dykes cut all intrusive phases at Whiting Creek. The dykes are relatively unaltered to weakly, quartz-epidote-chlorite altered (propylitic alteration assemblage). They are relatively resistant and form prominent outcrops that form the cores of spurs and ridges on the south slope of Mount Sweeney.

Potassium-argon isotopic age dating at Whiting Creek (Table 3) suggests two main episodes of magmatic activity. The earliest is represented by emplacement and crystallization of the Whiting stock and the associated porphyritic granodiorite phase in the period 84 to 81 Ma (Nos. 4 and 8, Table 3). These ages are very close to those obtained for the Huckleberry, Ox Lake, and Coles Creek stocks. The pervasively altered porphyritic granodiorite or quartz monzonite stock at Whiting Creek is probably also of the same vintage. A younger episode of magmatic activity is inferred from the 76.0 ± 2.2 Ma age obtained on a late, northwest-trending, quartz-biotite-feldspar porphyry dyke that cuts the Whiting stock. This age is similar to those obtained for quartz-biotite-feldspar porphyry intrusions at the Bergette and Troitsa prospects. The quartz porphyry plug appears to post date the Whiting granodiorite stock but predate the porphyritic granodiorite.

Four mineralized zones are recognized at Whiting Creek (Cann, 1981). These are: the Sweeney zone, which occurs in biotite hornfelsed Hazelton Group rocks south of the Whiting stock; the Creek zone, which occurs within the Whiting stock; the Ridge zone, which is associated with the quartz porphyry plug; and the Rusty zone, located in hornfelsed rocks south of the altered porphyritic quartz monzonite stock (Fig. 18). To date reserves have been defined only for the Ridge zone; the other zones have not been extensively drill tested.

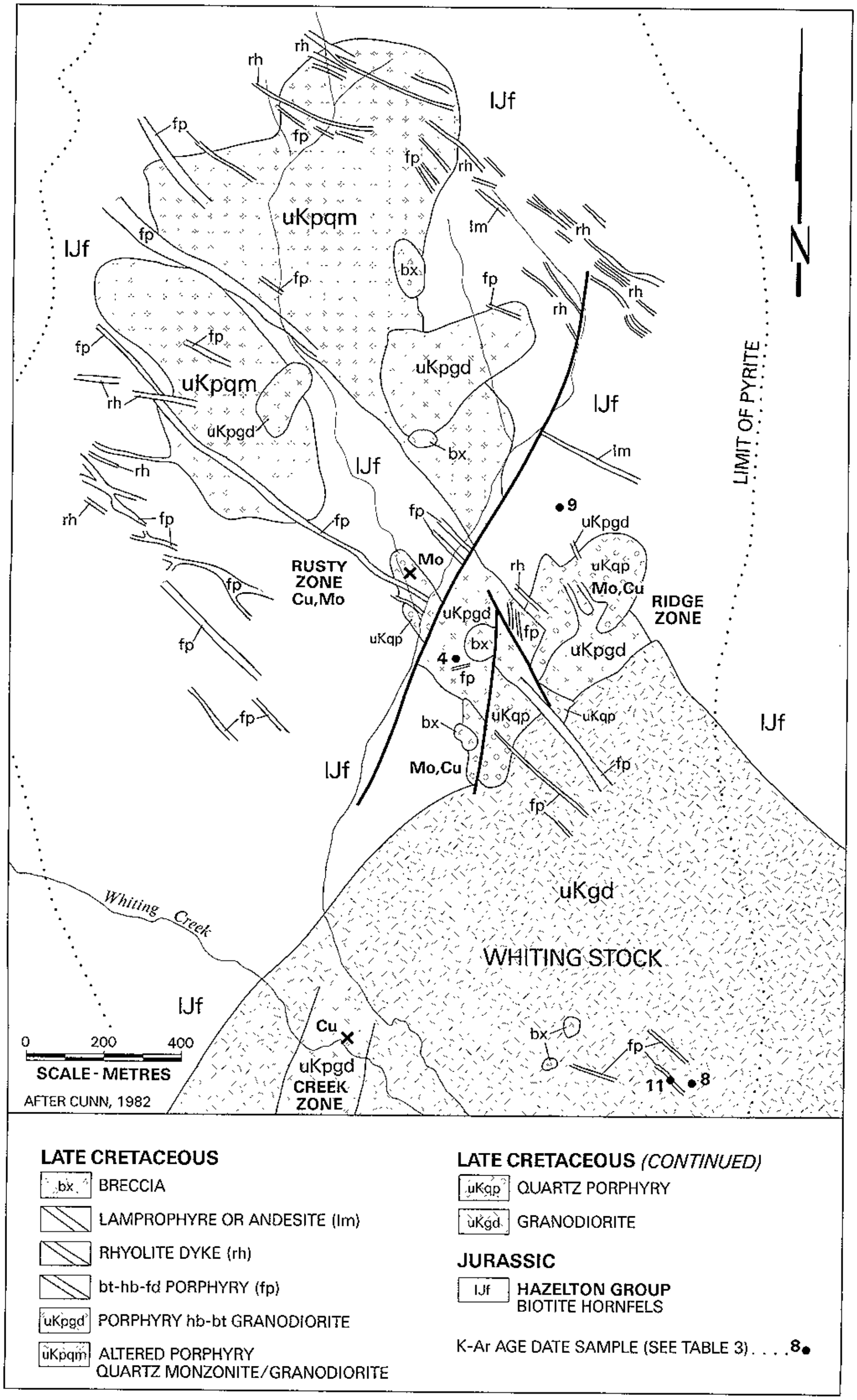


Figure 18. Geologic setting of the Whiting Creek property (after Cann, 1981).

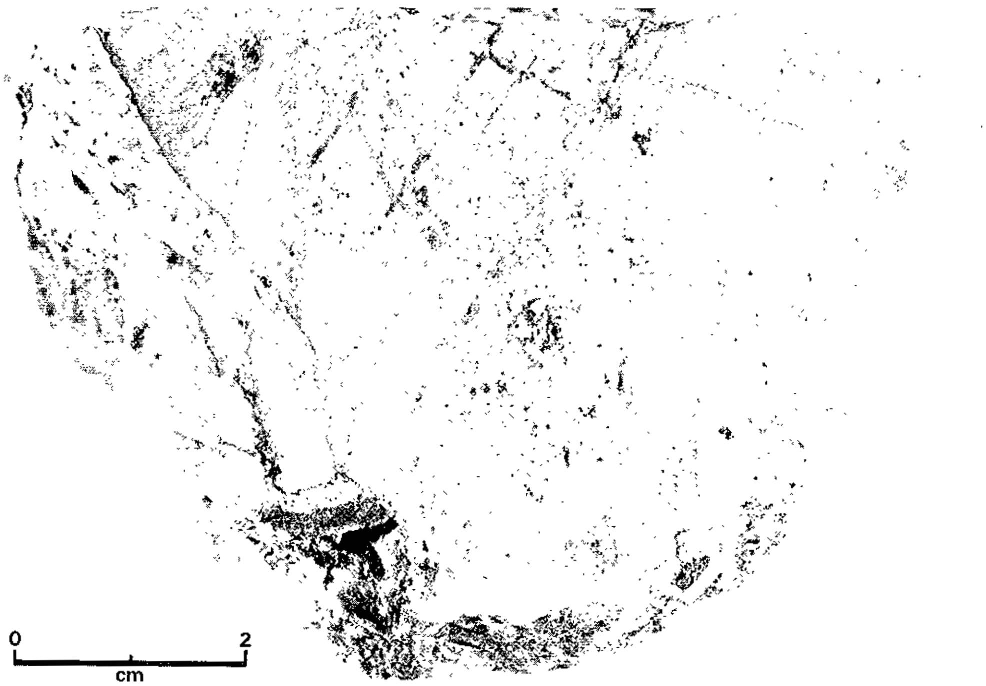


Plate XXXIII. Quartz-molybdenite vein stockwork cutting quartz porphyry, Whiting Creek.

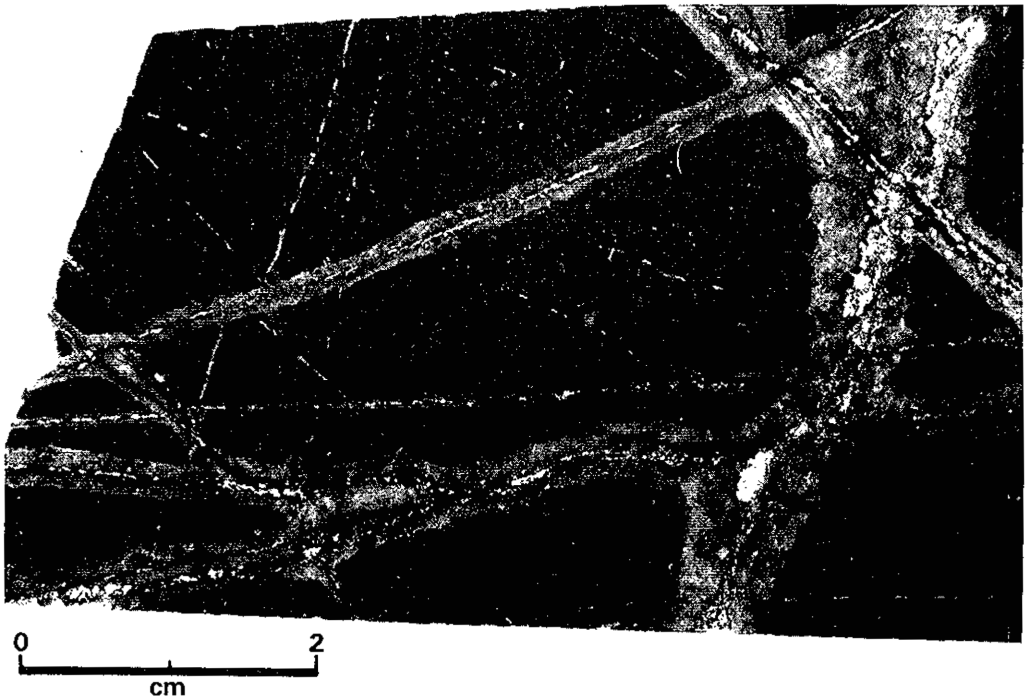


Plate XXXIV. Pyrite veinlets with bleached alteration envelopes cutting biotite hornfels, Whiting Creek.

The Sweeney zone was defined by an induced polarization survey and subsequently percussion drilled. The zone occurs around a small plug of granodiorite which may be satellitic to the Whiting stock. The mineralization occurs in biotite hornfelsed Hazelton Group fragmental rocks; it comprises disseminated pyrite and veinlets of pyrite or quartz-epidote-pyrite-chalcopyrite with bleached alteration selvages. Minor disseminated chalcopyrite and molybdenite occur within the granodiorite plug.

Diamond and percussion drilling in the Creek zone intersected veinlets and disseminations of chalcopyrite and pyrite in hornblende-biotite granodiorite. The best drill intersection averaged 0.244 per cent copper and 0.026 per cent molybdenite over 196 metres. Higher grade intersections occur within zones of potassic alteration that are characterized by pink K-feldspar-rich alteration envelopes on quartz-sulphide veinlets and fine-grained secondary biotite after primary biotite. The potassic alteration zones apparently occur on either side of a late porphyritic granodiorite phase of the Whiting stock. Crosscutting vein relationships within the Creek zone indicate that pyrite veinlets with or without epidote and chlorite formed earliest; these were followed by chalcopyrite, quartz-chalcopyrite, quartz-molybdenite, and finally gypsum veinlets (Cann, 1981).

The Ridge zone comprises molybdenite-bearing quartz vein stockworks within the pervasively altered quartz porphyry (Plate XXXIII) plug and adjacent hornfelsed Hazelton Group rocks. Low-grade copper mineralization similar to that in the Creek zone occurs in a moderate to pervasive phyllic to potassic altered, porphyritic hornblende-biotite granodiorite that cuts the quartz porphyry plug. Copper grades increase toward a small breccia pipe at the west side of the quartz porphyry plug. Highest grade zones within the quartz porphyry are characterized by pervasive quartz flooding, and development of banded quartz-molybdenite veins and closely spaced vein stockworks. The earliest veins appear to be barren quartz followed by veins of pyrite, quartz-chalcopyrite-pyrite, molybdenite with or without quartz, pyrite with or without quartz, quartz, and finally anhydrite with or without calcite and quartz (Cann, 1981).

The Rusty zone, which has mainly been tested by wide-space percussion drill holes, is located along the southern contact of the altered porphyritic quartz monzonite stock; it is mineralogically similar to the Ridge zone. Molybdenite occurs in quartz vein stockworks within biotite hornfelsed volcanic rocks (Plate XXXIV); chalcopyrite is concentrated in biotite-hornblende-feldspar porphyry dykes that cut the zone. Potassic alteration envelopes are common on chalcopyrite-bearing veinlets.

WEE (MI 93E-86)

The Wee property (No. 5, Fig. 15), which is currently owned by Hudson's Bay Oil and Gas Company Limited, is at the east end of Sweeney Lake. Geochemical and geophysical surveys were conducted on the property in 1974, 1976, and 1978. Four diamond-drill holes were completed in 1973 and an additional 365 metres of diamond drilling in two holes was done in 1979. This drilling intersected sporadic concentrations of chalcopyrite and pyrite as open space fillings in small breccia bodies. The breccias contain tuff, andesite, granodiorite, and quartz monzonite clasts; they occur within a southerly dipping sequence of Hazelton Group fragmental rocks. Several small, weakly altered stocks of granodiorite, which are probably offshoots of a larger intrusive body at depth, are also present on the property. These intrusions are assumed to be of Late Cretaceous age.

HUCKLEBERRY (LEN; MI 93E-37, 38, 39)

The Huckleberry porphyry copper deposit (No. 6, Fig. 15) underlies a poorly drained valley at the foot of Huckleberry Mountain. Although exposures on the south face of the mountain contain disseminated pyrite and are rusty weathering, the main deposit is not well exposed. The deposit was discovered by Kennco Explorations, (Western) Limited who were attracted to the area by anomalous stream sediment samples collected during a regional reconnaissance program. Subsequent work led to the discovery of outcrops with low-grade copper mineralization on the top of a small knoll protruding from the swampy valley floor. The Len claims were staked in 1962 and in the same year nine diamond-drill holes totalling 290 metres were completed. An additional 1 417 metres of diamond drilling in nine holes was completed in 1964. The property was relatively inactive until 1970 and 1971 when Kennco drilled 14 more holes totalling 2 259 metres. Grandby Mining Corporation subsequently optioned the property from Kennco and in 1973 and 1974 they did 16 191 metres of diamond drilling in 65 holes. This work has defined mineable reserves of 77.7 million tonnes grading 0.40 per cent copper and 0.025 per cent molybdenite at a waste-to-ore ratio of 1.17 to 1 (James, 1976).

The geology of the Huckleberry porphyry copper deposit is relatively simple. A small, subcircular stock of hornblende-biotite granodiorite intrudes and has hornfelsed andesitic fragmental rocks of the Hazelton Group. Drill intersections indicate that the contact of the stock is moderately dipping with local irregular offshoots (Fig. 19). Biotite extracted from relatively fresh granodiorite yielded a potassium-argon isotopic age of 82.0 ± 3 Ma (No. 7, Table 3), that is, Late Cretaceous. Some post-mineral dykes of diabase composition cut the deposit (James, 1976).

The Huckleberry stock is texturally similar to porphyritic phases of the larger Whiting and Sibola stocks, which are believed to underlie most of the Sibola Range. The Huckleberry stock may be an offshoot of these larger intrusive bodies. This hypothesis is partially supported by a flattening of the stock contact with depth, and also the observation that biotite hornfelsing of volcanic rocks is far more extensive than would be expected from such a small intrusive body.

A zone of weak to moderate potassic alteration centred on the Huckleberry stock extends outward into surrounding volcanic rocks. Pervasive sericite-quartz-carbonate-pyrite alteration that occurs near the margins of the stock may be superimposed on the potassic alteration. Alteration of biotite hornfels away from the stock is largely restricted to bleached sericitic alteration envelopes on sulphide veinlets and fractures. Metamorphic biotite is generally replaced by chlorite within the Huckleberry pyritic zone, which extends for considerable distance east of the stock (Fig. 19). This chloritic alteration may represent a broad propylitic alteration zone established during the final stages of hydrothermal alteration.

The Huckleberry deposit is hosted by altered volcanic rocks on the east side of the Huckleberry stock (Fig. 19). The mineralized zone contains narrow fractures, patches, and blebs of chalcopyrite and minor molybdenite, with variable amounts of associated quartz, pyrite, magnetite, orthoclase, carbonate, chlorite, and sericite. Molybdenite-bearing veinlets appear to postdate chalcopyrite (James, 1976). Grade is largely controlled by the density of fracturing in the brittle, hornfelsed host rocks. The geometry of the deposit is defined by the 0.3 per cent copper isograd on Figure 19. The deposit is roughly tabular and elongated in a northerly direction. Porphyritic granodiorite apparently underlies most of the deposit, although the distance from the contact to the deposit is variable.

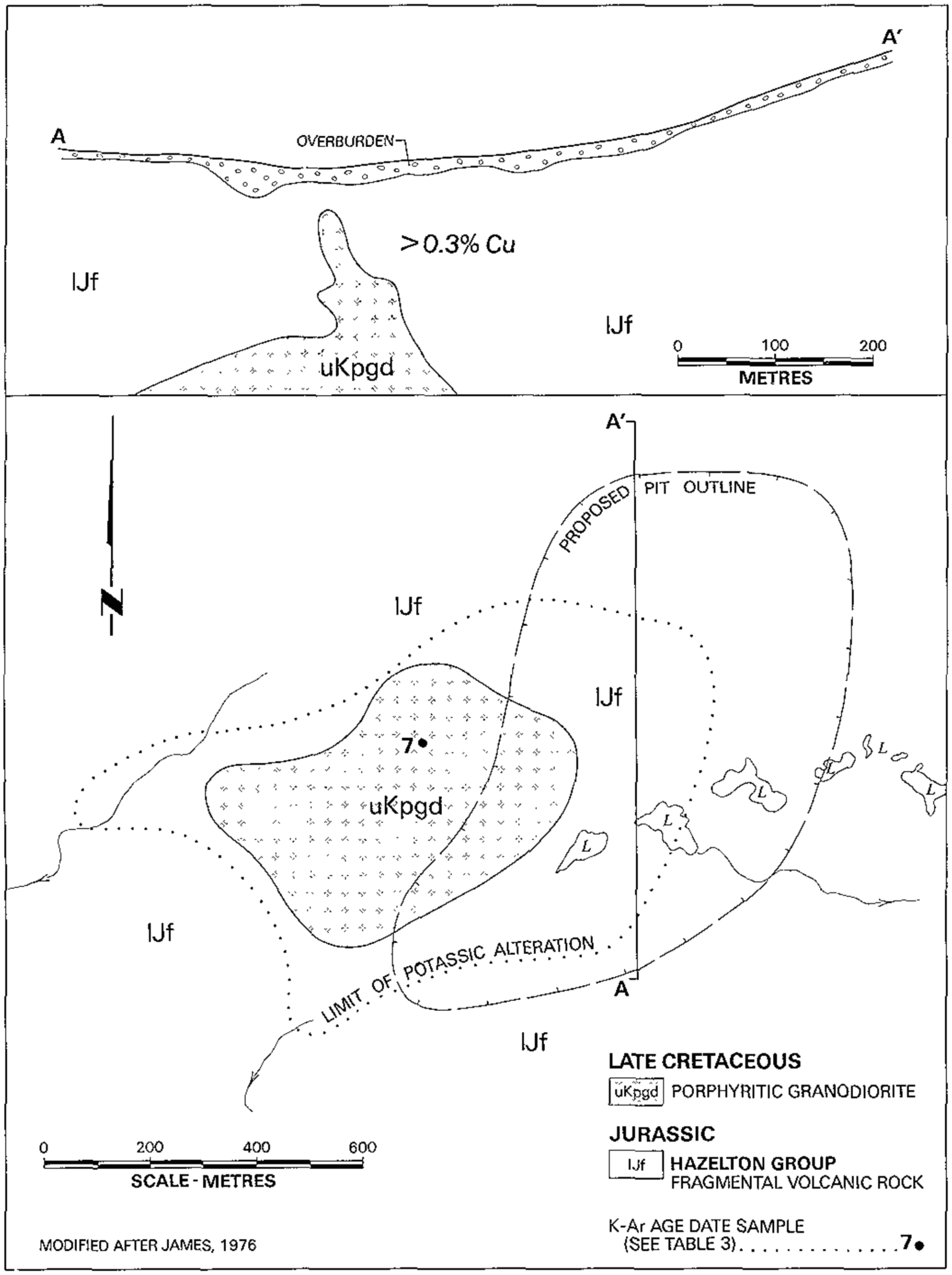


Figure 19. Geologic setting of the Huckleberry deposit (modified after James, 1976).

OX LAKE (MI 93E-4)

The Ox Lake occurrence (No. 7, Fig. 15) was located in 1968 by a regional prospecting program conducted by Silver Standard Mines Limited and American Smelting and Refining Company. The deposit is located in an area of subdued topography with extensive forest cover. Surficial expression of the deposit is limited to a small gossan on the bluff overlooking Ox Lake. The property was tested in 1968 and 1969 by 4 850 metres of diamond drilling in 35 drill holes. This work defined reserves of 29 million tonnes averaging 0.35 per cent copper equivalent (Richards, 1976).

The geology of the Ox Lake property, like Huckleberry Mountain, is relatively simple. A small subcircular, single phase stock of porphyritic hornblende-biotite granodiorite intrudes and has hornfelsed felsic to intermediate tuffs of the Hazelton Group (Fig. 20).

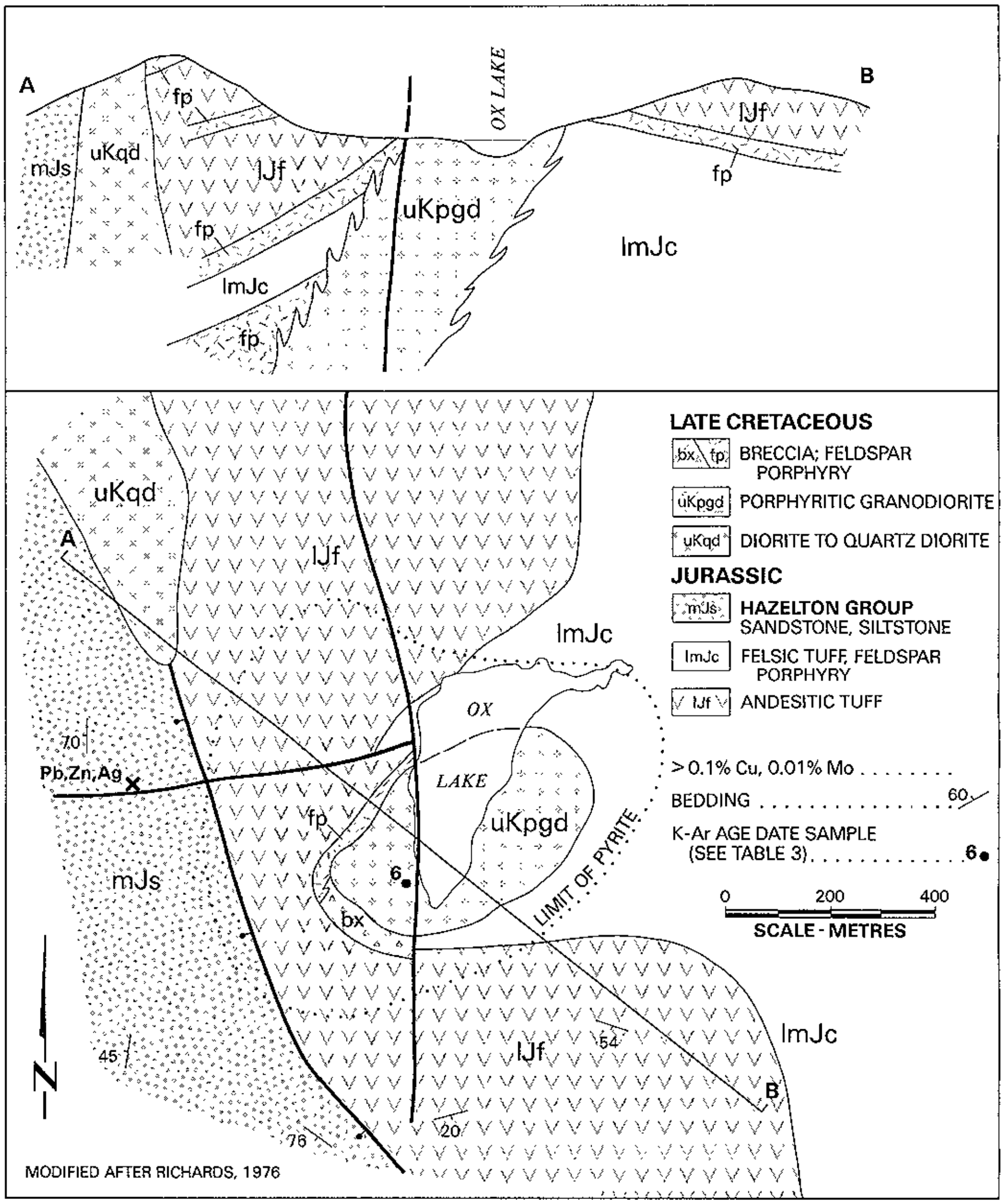


Figure 20. Geologic setting of the Ox Lake deposit (modified after Richards, 1976).

Unlike the Huckleberry stock, which appears to be an offshoot of a larger granitic mass at depth, the Ox Lake stock has a relatively steep plunge of approximately 50 degrees to the west with no obvious flattening of the contact down dip. Narrow dykes or fingers of porphyritic granodiorite are common near the stock contact; on the southwest end of the stock an intrusive breccia is associated with these dykes. Biotite from the stock has given a potassium-argon isotopic age of 83.4 ± 3.2 Ma (No. 6, Table 3).

A medium-grained diorite to quartz diorite intrusion, which appears to have been emplaced along a fault contact between the marine sedimentary and andesitic fragmental units of the Hazelton Group (Fig. 20), crops out northwest of the porphyritic granodiorite stock.

Unlike properties such as Whiting Creek and Bergette, late dykes are relatively rare at Ox Lake, although Richards (1976) reports the occurrence of some basic dykes in drill intersections.

Two major faults are recognized at Ox Lake; these trend north and west respectively. The faults, which produce well-defined lineaments on air photographs, apparently intersect just north of the porphyritic granodiorite stock (Fig. 20); the degree of offset on them is believed to be relatively minor. A galena-sphalerite vein up to 1 metre wide crops out on the ridge west of Ox Lake and appears to have been emplaced along the west-trending fault.

The Ox Lake deposit is a crescent-shaped zone of disseminated and vein-controlled pyrite, chalcopyrite, and molybdenite in biotite hornfelsed andesitic fragmental rocks that lies west of the porphyritic granodiorite stock (Fig. 20). Grades averaging 0.5 per cent copper and 0.02 per cent molybdenum occur adjacent to the stock; grades gradually lessen outward. The molybdenum zone is narrower and less extensive than the copper zone. Relatively low-grade copper-molybdenum mineralization occurs in felsic tuff on the east side of the stock. As at Huckleberry, the stock is relatively unaltered and contains only minor amounts of sulphide minerals near the contact. A pyritic halo encloses the stock and extends beyond the zone of copper and molybdenum concentration.

Richards (1976) defined four main stages of vein development at Ox Lake based on observed crosscutting relationships. At the earliest stage, K-feldspar and biotite filled microfractures and formed alteration envelopes of the same mineralogy. This type of veining occurs mainly in felsic tuffs east of the stock and defines a small zone of potassic alteration. Stage two includes two distinct groups of veinlets. Away from the stock, in propylitically altered andesitic fragmental rocks, veinlets with variable proportions of chlorite, epidote, actinolite, pyrite, hematite, magnetite, chalcopyrite, calcite, quartz, and apatite with alteration envelopes of K-feldspar, albite, and biotite predominate. Where these stage two veinlets cut feldspar porphyry, they contain pyrite and chalcopyrite and have alteration envelopes of quartz and sericite. Stage three quartz-molybdenite veinlets, with or without calcite, pyrite, and chalcopyrite, have sericite-kaolinite-montmorillonite alteration envelopes; these are found mainly in the altered southwest margin of the porphyritic granodiorite stock. Late-stage veins include calcite-pyrite, gypsum-anhydrite, and siderite-calcite-pyrite-sphalerite-galena; all lack appreciable wallrock alteration. These veins are most common west of the Ox Lake stock.

REA, TL, LEAN-TO (MI 93E-40)

The REA and TL claims (No. 8, Fig. 15) were staked by Bethlehem Copper Corporation Ltd. in 1969. They cover a relatively low-lying area east of Kasalka Creek with anomalous copper-silver soil geochemistry. In 1972 a road was constructed from the mouth of

Kasalka Creek to the area of interest, and eight percussion drill holes totalling 454 metres were completed. In 1980 the property was restaked as the LEAN-TO claims by Lansdowne Oil and Minerals Limited. A moderately strong copper anomaly with coincident gold, silver, lead, and zinc anomalies was outlined by soil sampling east of the area explored by Bethlehem Copper Corporation Ltd. In 1982, 38 shallow diamond-drill holes totalling 917 metres were completed in this area (Ager and Holland, 1983). This work led to the discovery of a mineralized breccia pipe.

The LEAN-TO property is underlain by volcanic and sedimentary rocks of the Hazelton Group. Fine-grained monzonite and quartz porphyry intrude these rocks east of the main creek valley on the old REA claims. A zone of disseminated pyrite with minor copper, molybdenum, and silver values is associated with these intrusions.

A small knoll 2 kilometres northeast of the area explored by Bethlehem Copper is underlain by a resistant quartz porphyry plug and an adjacent stock of medium-grained granodiorite. These rocks apparently intrude and metamorphose andesitic fragmental rocks of the Hazelton Group and, to the south, fine to medium-grained porphyritic dacite which might be part of the Kasalka Group.

Within the quartz porphyry plug is a pervasively quartz-carbonate-altered breccia zone that is composed of angular clasts of quartz porphyry and hornfels. This breccia is host to significant copper-silver mineralization. The best drill intersection to date is 18 metres averaging 1.59 per cent copper and 42.2 grams silver per tonne (1.24 ounces per ton) (Ager and Holland, 1983).

The Lean-To breccia contains pervasive pyrite that is associated with intense quartz veining and silicification. Pyrrhotite, arsenopyrite, chalcopyrite, sphalerite, and marcasite, which are later, are associated with carbonate veining and alteration. A late stage of pyrite veining is also present within the breccia. Tetrahedrite occurs as a replacement of chalcopyrite. Minor molybdenite and native gold have also been reported. The Lean-To breccia is similar to other breccias associated with quartz porphyry intrusions, such as at Bergette, Whiting Creek, and Coles Creek.

COLES CREEK (FAB; MI 93E-41, 42, 43, 44)

The original claims on the Coles Creek property (No. 9, Fig. 15) were simultaneously staked in 1966 by Kennco Explorations, (Canada) Limited and Amax Exploration, Inc. to cover a prominent gossan exposed by an east-flowing creek that drains a cirque valley south of Troitsa Lake. Kennco completed several X-ray diamond-drill holes in 1967 but dropped their claims in 1969. Amax, after several geochemical and geophysical surveys, tested the property in 1972 with seven diamond-drill holes totalling 853 metres.

The Coles Creek property, like Ox Lake and Huckleberry Mountain, has porphyry copper-type mineralization associated with a single phase, subcircular porphyritic hornblende-biotite granodiorite stock (Fig. 21). This stock intrudes and has hornfelsed Hazelton Group andesitic fragmental rocks along its western contact. A north-trending fault cuts the stock near its western margin; east of this fault porphyritic granodiorite intrudes a dacite porphyry (Plate XXII) laccolith that was emplaced along the Hazelton Group-Kasalka Group contact (MacIntyre, 1974). Lapilli tuff, pebble conglomerate, and volcanic sandstone beds of the lower part of the Kasalka Group are preserved within a graben south of the stock; to the west a northeast-trending quartz diorite intrudes and has hornfelsed

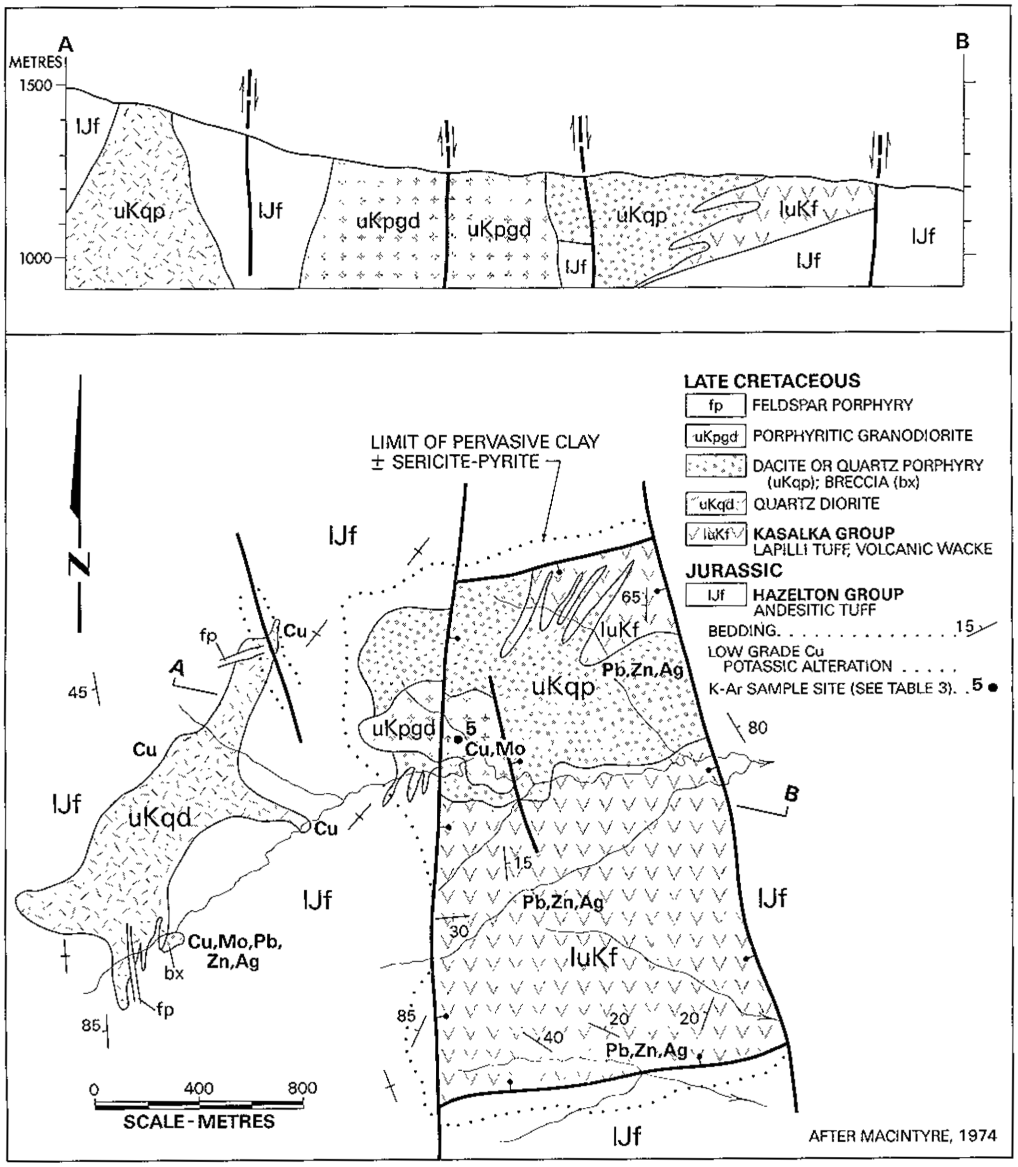


Figure 21. Geologic setting of the Coles Creek property (after MacIntyre, 1974).

Hazelton Group andesitic fragmental rocks. Potassium-argon analyses of biotite from the porphyritic granodiorite stock indicate an isotopic age of 83.8 ± 2.8 Ma (No. 5, Table 3). The quartz diorite is probably of similar age.

The main exploration target on the Coles Creek property is a zone of low-grade copper and molybdenum concentration within the porphyritic granodiorite stock. This zone is comprised of chalcopyrite, pyrite, and molybdenite in quartz vein stockworks and sulphide-filled microfractures (Plate XXV). Pervasive biotite-orthoclase alteration is associated with this mineralization (MacIntyre, 1974). Chalcopyrite-magnetite-biotite stringers with biotite selvages and pyrite-tourmaline stringers and veinlets with sericite-quartz-pyrite alteration envelopes are also present; these crosscut early quartz vein stockworks. Late calcite and ankerite veinlets occur below the zone of weathering.

Rocks within the graben and peripheral to the porphyritic granodiorite stock are pervasively altered. A zone of sericite-quartz-pyrite alteration encloses the stock and grades outward into sericite-carbonate-kaolinite alteration. Permeable Kasalka Group volcanic-sandstone beds south and east of the stock have been cemented with silica and contain very fine-grained disseminations of pyrite with variable amounts of sphalerite and galena. These rocks have anomalous silver concentrations up to 26 grams per tonne (MacIntyre, 1974). Gold concentrations were not determined.

The type of alteration and metal concentrations within the graben at Coles Creek is similar to that found in modern geothermal systems. This suggests that an epithermal environment has been preserved within the graben. To date this target has not been tested by drilling. Crosscutting veins and shear zones containing pyrite, sphalerite, and galena are also present; these may have been major conduits for hydrothermal fluid circulation within the graben.

A small west-dipping breccia pipe is located along the southeast contact of the quartz diorite intrusion (Fig. 21). The breccia is comprised of angular to tabular clasts of pervasive sericite-carbonate-kaolinite-altered quartz diorite, quartz porphyry, and hornfelsed argillite; these are suspended in a coarse-grained and vuggy matrix of quartz, calcite, sericite, chalcopyrite, magnetite, and minor molybdenite. Variable amounts of galena and sphalerite are also present and are associated with a late stage of carbonate-kaolinite alteration and vug filling. The breccia was tested by two diamond-drill holes in 1972 with the best intersection containing 1.02 per cent copper and 5 grams silver per tonne over 3 metres.

Small zones of biotite-orthoclase alteration with attendant low-grade copper mineralization also occur within the quartz diorite intrusion. This exploration target has not been tested by drilling.

Hazelton Group andesitic fragmental rocks peripheral to the Coles Creek intrusions contain pervasive and vein-controlled chlorite and epidote, typical of propylitic alteration assemblages. Magnetite is common within these rocks and there are local, small stringers of galena and sphalerite.

TROITSA (OVP; MI 93E-3, 5, 9)

The OVP claims (No. 10, Fig. 15) were staked in 1966 by the Silver Standard Mines Limited-American Smelting and Refining Company exploration joint venture. The showings on the property were apparently discovered during a follow-up of anomalous silt geochemistry. The original claims covered a prominent peak immediately south of the west end of Troitsa Lake. In 1967 and 1968, the property was tested by 827 metres of diamond drilling in six drill holes. Results were discouraging and the claims were allowed to lapse. The area was restaked in 1969 by Aston Resources Limited and in 1972 Quintana Minerals Corporation optioned the property and completed a single 457-metre diamond-drill hole.

The geology of the Troitsa Lake property was described by Cawthorn (1973) as part of a Master of Science thesis study. The property is underlain by a compositionally zoned, circular stock of hornblende-biotite granodiorite to quartz monzonite that intrudes rocks of the Hazelton, Skeena, and Kasalka Groups (Fig. 2). The Troitsa stock appears to have a relatively flat top, as indicated by the horizontal contact visible on the south-facing side of Troitsa Peak (Plate XXVI). A thick, lensoid-shaped mass of quartz porphyry or rhyolite with sill-like extremities intrudes the stock along its western margin. Northwest and rarely northeast-trending dykes of quartz porphyry, lamprophyre, andesite, and feldspar porphyry cut both the granodiorite and quartz porphyry intrusions. Biotite extracted from a sample of porphyritic granodiorite collected near the centre of the stock gave a potassium-argon isotopic age of 75.7 ± 2.3 Ma (No. 12, Table 3).

A zone of low-grade copper concentration is centred on feldspar porphyry dykes within the central part of the Troitsa stock. The mineralization occurs as widely spaced fractures filled with quartz, pyrite, chalcopyrite, and rarely molybdenite. Some of the fractures have thin alteration envelopes. Minor galena, sphalerite, and stibnite have also been observed. The host granodiorite is propylitically altered; mafic minerals are replaced by chlorite and feldspars are partly saussuritized. Epidote, calcite, and biotite also occur along fractures. Feldspar porphyry dykes are locally pervasively altered to quartz-sericite and biotite-orthoclase. The best grades of copper are associated with biotite-orthoclase alteration.

EMERALD GLACIER (MI 93E-1, 47, 48)

The Emerald Glacier deposit (No. 11, Fig. 15) is located on the south slope of Sweeney Mountain at an elevation of 1 950 metres. The showings were originally staked by W. J. Sweeney in 1915. James Cronin leased the property from 1917 to 1919 and drove an exploration adit along the main vein. This adit was advanced and two new adits were added by The Consolidated Mining and Smelting Company of Canada, Limited in the period 1927 to 1931. In 1951, Emerald Glacier Mines Limited reopened the earlier workings and between 1951 and 1953, 4 200 tonnes of ore averaging 12.1 per cent lead, 11.5 per cent zinc, 408 grams silver per tonne, and 0.27 gram gold per tonne were shipped to a custom mill in Nelson. In 1966, the old Silver Standard mill at Hazelton was dismantled and moved to the Emerald Glacier property. In the same year approximately 450 tonnes of ore was mined producing 129 tonnes of concentrate containing 34 836 kilograms of zinc, 15 382 kilograms of lead, and 69 608 grams of silver. A further 2 200 tonnes of ore was milled in 1967 producing 392 tonnes of zinc concentrate and 142 tonnes of lead concentrate (Sutherland Brown, 1967). From 1968 to 1973 some minor underground development work was done but no ore was shipped. The mine currently consists of four adit levels at elevations of 5400, 6000, 6250, and 6400 feet. All production to date has come from the 6400 level.

The geology of the Emerald Glacier mine has been described by Sutherland Brown (1967). The deposit is a northwest-trending, steeply east-dipping sheared quartz vein system containing galena, sphalerite, chalcopyrite, and pyrite. Minor amounts of calcite, rhodochrosite, and altered rock fragments also occur in the veins. The vein system is mainly hosted by volcanic sandstones of the Bowser Lake Group close to the fault contact with older andesitic fragmental rocks of the Hazelton Group. Several northwest-trending dykes that cut the section near the Emerald Glacier deposit appear to postdate the vein mineralization.

Although the Emerald Glacier vein system is comprised of an *en echelon* group of veins occupying a braided shear, all production has come from a single oreshoot. This main oreshoot is approximately 120 metres long and up to 3 metres wide. Wallrocks are strongly kaolinized; they are locally silicified and pyritized at the contact of the oreshoot.

The proximity of the Emerald Glacier veins to the Sibola stock suggests a genetic relationship.

SWANNELL, CAPTAIN (SWING, SAM; MI 93E-35)

The Captain and Swannell groups of claims (No. 12, Fig. 15) were staked on the northeast slope of Swing Peak, just south of Tahtsa Reach, to cover several lead-zinc-silver vein showings. Recently, the property has been restaked by Tahtsa Mines Limited as the Sam and Swing claims. The Tahtsa Mining Company did the first exploration work on the property in 1929 and 1930, driving a 116-metre adit on the 1 520-metre level. Four short diamond-drill holes were completed in 1962. A lower, 27-metre adit and 24-metre vertical raise were driven in 1980. Tahtsa Mines Limited has also constructed a four-wheel-drive road from their camp and barge landing on the shores of Tahtsa Reach to the lower workings.

The main exploration target on the property is a north-trending, steeply east-dipping shear zone containing galena, sphalerite, pyrite, arsenopyrite, and tetrahedrite in a gangue of quartz, minor calcite, and wallrock fragments (Duffell, 1959). Goldsmith and Kallock (1981) also report the occurrence of chalcopyrite and jamesonite. A selected sample from the vein assayed 12.4 per cent lead, 5.42 per cent zinc, 2 155 grams silver per tonne (63.07 ounces per ton), and a trace of gold. In addition to the Captain vein, several parallel subsidiary veins or shear zones are also present. The Captain vein is hosted by a fine to medium-grained porphyritic diorite that intrudes the felsic fragmental unit of the lower Kasalka Group.

LEAD EMPIRE (SET, LOST, ICE; MI 93E-8)

William Sweeney first located and staked lead-zinc-silver veins peripheral to the Berg porphyry copper deposit in 1929. W. H. Patmore restaked the showings in 1948 as the Lead Empire group (Duffell, 1959) and some trenching was done in 1951 and 1952. More recently, in the period 1969 to 1971, Sierra Empire Mines Ltd. completed 25 diamond-drill holes totalling 2 505 metres on the Set, Lost, and Ice claims (No. 13, Fig. 15). This work concentrated on lead-zinc-silver and copper-molybdenum veins and shear zone replacements located near the northern boundary of the Berg property. These veins and shear zones cut both quartz diorite and hornfelsed Hazelton Group fragmental rocks. During mapping an occurrence of galena in the basal red pebble conglomerate of the Kasalka Group was also noted.

WEST VIEW (MI 93E-74)

The West View claim (No. 14, Fig. 15) was apparently located on the ridge between Comb and Whiting Creeks, immediately east of the Whiting Creek porphyry prospect. The showing is described in the 1916 *Minister of Mines, B.C.*, Annual Report (p. K163) as a 'rather irregular vein about 4 feet wide, in which the filling is partly quartz and partly wall-rock.' Sphalerite, pyrite, and galena occur in the vein. One sample of high-grade material was reported to contain 'gold, 0.64 oz.; silver, 5.7 oz.; copper, trace; lead 3.3 per cent; zinc 48.6 per cent' (*op. cit.*). The West View vein may be related to the Whiting Creek porphyry copper system.

ORIENTAL (MI 93E-51)

Several showings in the vicinity of Sibola Peak are described in the 1916 *Minister of Mines, B.C.*, Annual Report under the names Lone Star, Gold Crown, Bellecini, Golden Chest, and Jolimont. The location of these showings is uncertain but they may have been on or close to the Oriental group of Crown-granted claims that are now situated on the ridge east of Comb Creek (No. 15, Fig. 15). The showings are mainly steep, northwest-trending pyrite-quartz veins that locally contain gold and silver.

RIVERSIDE (MI 93E-36)

The Riverside showing (No. 16, Fig. 15) was located on the north side of the now-flooded Tahtsa River, immediately east of Huckleberry Mountain (Duffell, 1959). The showing is described in the 1945 *Minister of Mines, B.C.*, Annual Report as a steep-dipping, east-trending fracture containing quartz, arsenopyrite, and minor pyrite, sphalerite, and chalcopyrite. The vein is hosted by andesitic fragmental rocks of the Hazelton Group. A sample of arsenopyrite-rich material is reported to have assayed 0.13 ounce gold per ton and 0.2 ounce silver per ton (*Minister of Mines, B.C.*, Ann. Rept., 1945, p. A67). Similar veins occur to the west on the south-facing slope of Huckleberry Mountain; they are typically less than 10 centimetres in width.

GLORY (MI 93E-7)

The Glory occurrence (No. 17, Fig. 15) is included in the mineral inventory for the Whitesail map-area (93E) and is apparently the same as the Tahtsa Range occurrence described by Duffell (1959). The showing, which is located south of the Berg porphyry copper deposit, is comprised of several northeast-trending narrow quartz stringers containing pyrite, chalcopyrite, galena, specular hematite, and minor gold. The stringers cut both Eocene quartz diorite and adjacent andesitic fragmental rocks of the Hazelton Group.

5

INTERPRETATION

The most significant result of this study is the discovery that Late Cretaceous continental volcanic rocks unconformably overlie rocks of the Skeena and Hazelton Groups in the Tahtsa Lake area. This Late Cretaceous succession, which has been given the informal name Kasalka Group (MacIntyre, 1976), is now widely recognized in west-central British Columbia. Limited potassium-argon age dating in the Tahtsa Lake district indicates that the base of the Kasalka Group may be as old as 105 Ma. Upper parts of the succession are apparently older than 87 Ma as indicated by an isotopic age determined on a crosscutting intrusion. The Kasalka Group is correlative in age with the Kingsvale Group in southern British Columbia and the Mount Nansen Group in the Yukon.

TAHTSA LAKE CAULDRON SUBSIDENCE COMPLEX

In the Kasalka Range, a 1 500-metre-thick section of the Kasalka Group is preserved in a fault-bounded area that is believed to be part of a cauldron subsidence complex (MacIntyre, 1976). Evidence supporting this hypothesis includes the presence of high angle, inward dipping normal faults that bound successively more downthrown fault blocks, thinning and fining of explosive volcanic units away from the area of subsidence, the presence of peripheral rhyolitic and dioritic ring dykes, and the occurrence of numerous andesitic feeder dykes and necks within the area of subsidence. Subsidence appears to have been asymmetric; the maximum downward movement of approximately 1 000 metres occurred along the north side of Swing Peak ridge. This type of asymmetric subsidence was also noted by Lambert (1974) in the younger Bennett Lake cauldron subsidence complex.

Rocks near major faults within the cauldron subsidence complex are typically brecciated and pervasively altered to phyllic and argillic alteration assemblages. Small plugs and dykes of fine-grained porphyritic diorite and andesite have been emplaced along these fault zones; the faults may have been conduits for andesitic flows deposited within the subsided area. Thick beds of chaotic breccia and conglomerate occur within the Kasalka Group sequence adjacent to the faults on Swing Peak ridge; these rocks, which are interbedded with lahar and volcanic sandstone, are interpreted to be landslides and slumps off steep fault scarps. Basalt flows cap this sequence and may represent late-stage moat volcanic rocks.

Granodioritic plugs and stocks have been exhumed to various depths in the area peripheral to the inferred cauldron subsidence complex. These intrusions are interpreted to be offshoots of a granitic mass (batholith) that underlies the Tahtsa and Kasalka Ranges. Small, subcircular stocks of porphyritic diorite and granodiorite may represent the roots of now-eroded volcanic cones.

TIMING OF IGNEOUS AND HYDROTHERMAL EVENTS

The temporal relationships between volcanism, plutonism, and hydrothermal activity are best documented at Coles Creek (MacIntyre, 1974). Here, a dacite porphyry laccolith was injected into the base of the Kasalka Group shortly after crystallization of nearby quartz diorite (border phase of a larger granitic mass at depth?). This was followed by faulting and fracturing with concomitant intrusion of granodiorite magma upward into the base of the laccolith. Crystallization of porphyritic granodiorite was accompanied by fracturing and development of extensive zones of pervasive phyllic and advanced argillic alteration of the epithermal type within the dacite laccolith and overlying Kasalka Group volcanic rocks. Potassic alteration was restricted to the outer margins of the stock. Syn-ore and post-ore faulting resulted in preservation of the near-surface parts of this hydrothermal system. Similar systems may have been present at other porphyry prospects in the district but have now been removed by erosion. Figure 22 and Table 5 summarize the inferred relationships between various intrusive phases and types of mineral deposits in the Tahtsa Lake district.

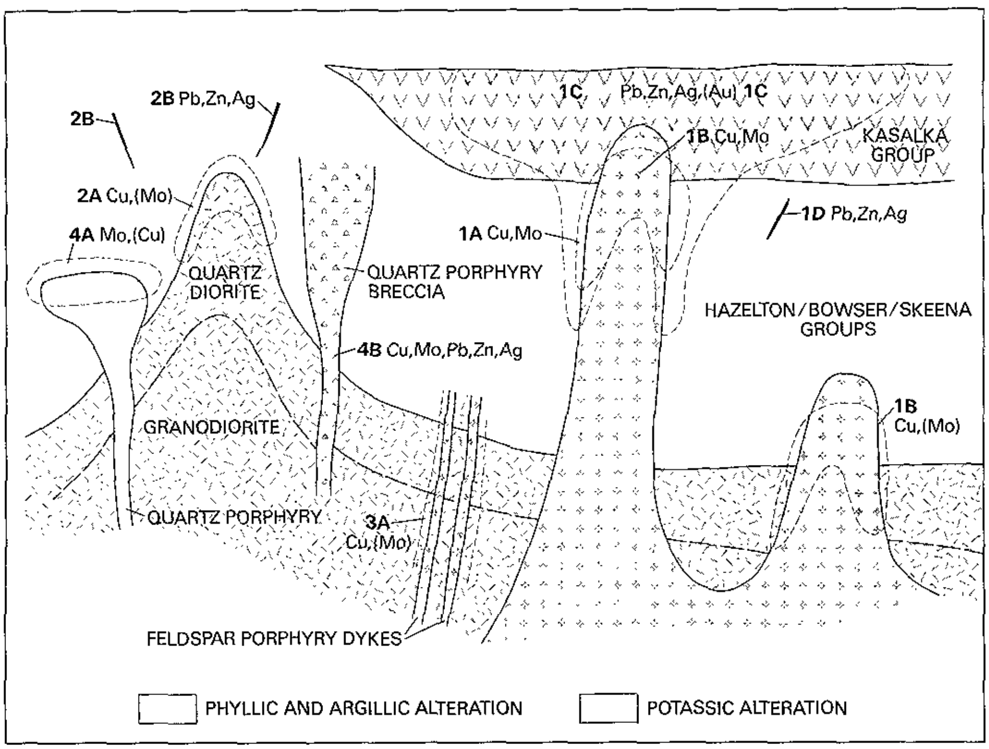


Figure 22. Schematic relationships between intrusive rocks and mineral deposits (*see* Table 5 for deposit type classification).

TABLE 5. PLUTONIC-HYDROTHERMAL RELATIONSHIPS, TAHTSA LAKE DISTRICT

1. DEPOSITS RELATED TO SUBCIRCULAR STOCKS OF PORPHYRITIC GRANODIORITE AND QUARTZ MONZONITE	
A. Annular zones of disseminated and fracture-controlled pyrite, chalcopyrite, and molybdenite surrounding stock	BERG HUCKLEBERRY OX LAKE WHITING CREEK *(RUSTY ZONE)*
B. Zones of quartz veining with chalcopyrite, molybdenite, and attendant potassic alteration within stock	COLES CREEK WHITING CREEK *(CREEK ZONE)*
C. Pervasive argillic altered zones with fine-grained disseminated and fracture-controlled pyrite, galena, and sphalerite; silver and gold (?) bearing; high-level epithermal system	COLES CREEK *(GRABEN)*
D. Veins and veinlets of pyrite and quartz with galena and sphalerite in propylitic zone peripheral to stock	LEAD EMPIRE
2. DEPOSITS RELATED TO QUARTZ DIORITE AND GRANODIORITE STOCKS	
A. Low-grade zones of disseminated and fracture-controlled pyrite and chalcopyrite with potassic alteration near contact of stock	WHITING CREEK *(SWEENEY ZONE)* BERGETTE COLES CREEK SYLVIA WEE
B. Quartz veins and veinlets with pyrite, galena, sphalerite; minor arsenopyrite, tetrahedrite, specular hematite, and chalcopyrite; veins peripheral to stock	EMERALD GLACIER CAPTAIN WEST VIEW ORIENTAL GLORY RIVERSIDE (?)
3. DEPOSITS RELATED TO FELDSPAR PORPHYRY DYKES	
A. Low-grade zones of disseminated and fracture-controlled pyrite, chalcopyrite, and molybdenite adjacent and within potassic and phyllic altered dykes	TROITSA WHITING CREEK
4. DEPOSITS RELATED TO QUARTZ PORPHYRY PLUGS, PIPES, AND LACCOLITHS	
A. Zones of pervasive phyllic alteration with quartz flooding with disseminated and vein-controlled pyrite, molybdenite, and minor chalcopyrite	WHITING CREEK *(RIDGE ZONE)*
B. Brecciated and phyllic altered quartz porphyry with superimposed breccia-healing phases of chalcopyrite, molybdenite, magnetite, pyrite, galena, sphalerite, and minor arsenopyrite and tetrahedrite; locally high grade; silver bearing	COLES CREEK LEAN-TO BERGETTE

Potassium-argon ages for the Sibola, Whiting, and Troitsa granodiorite stocks indicate that these intrusions are 7 to 8 Ma younger than the Coles Creek, Ox Lake, Huckleberry Mountain, and Whiting Creek porphyritic granodiorite stocks. This apparent age difference may be due to slower crystallization at greater depth, which would delay the acquisition of argon retention temperatures, not to different ages of emplacement. If this is the case, then the Bulkley intrusions of the Tahtsa Lake district may actually be related to a single episode of magmatic activity and not two distinct periods as indicated by the grouping of isotopic age dates.

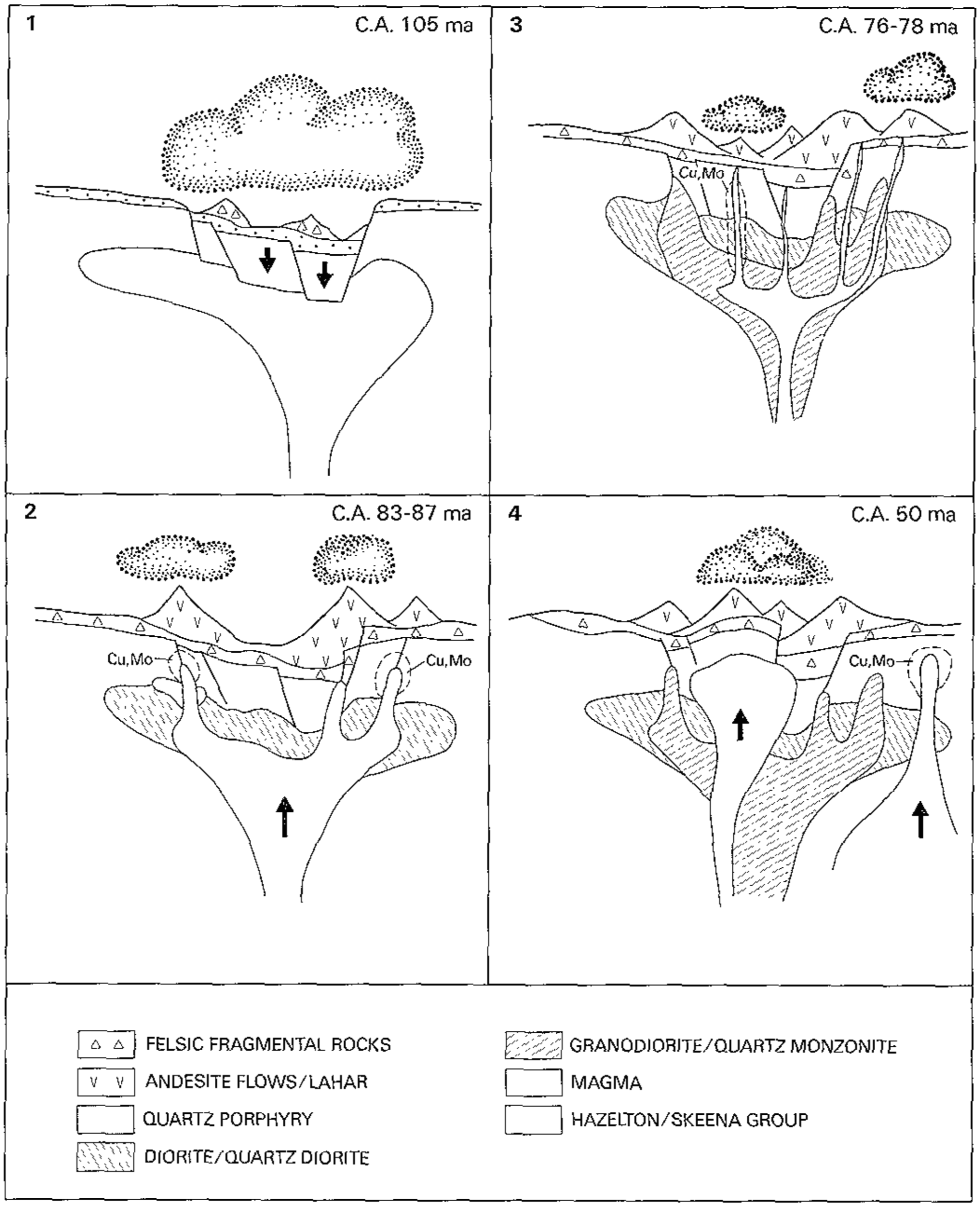


Figure 23. Evolution of the Tahtsa Lake cauldron subsidence complex (*see* text for explanation of stages).

GENETIC MODEL

A genetic model for evolution of the Tahtsa Lake district is presented on Figure 23. This model depicts the various episodes of volcanic and plutonic activity that took place in construction of the Late Cretaceous volcanic arc. In the initial stages explosive rhyolitic volcanism was followed by subsidence into vacated magma reservoirs (Stage 1, Fig. 23). Perhaps some 20 million years later, extrusion of andesitic magma produced volcanic cones peripheral to and within the area of subsidence (Stage 2, Fig. 23). The subvolcanic Kasalka intrusions and early quartz diorite phase of the Bulkley intrusions represent the plutonic component of this volcanism. The elongate nature of several of these intrusions and their orientation parallel to the inferred boundary of the Tahtsa Lake cauldron subsidence complex implies that they were emplaced along ring fractures that formed during subsidence. Lahar, landslide deposits, and, finally, basalt flows partially filled the subsided area in Late Cretaceous time.

The first major episode of post-subsidence magmatic resurgence and associated hydrothermal activity occurred between 87 and 83 Ma. Rupturing of magma reservoirs resulted in violent escape of highly differentiated volatile-rich magma that formed small plugs, dykes, and breccia pipes of quartz porphyry and dacite porphyry. This was followed by upwelling and possible extrusion of magma to form stocks and dykes of porphyritic granodiorite to quartz monzonite. Extensive hydrothermal systems, which involved circulation and mixing of both meteoric and magmatic fluids, developed about these intrusions. Both epithermal lead-zinc-silver veins and disseminations and zoned porphyry copper deposits formed. Most of the mineralized zones and associated intrusions lie in an arcuate belt about the area of subsidence; their localization may have been controlled by radial and concentric faults formed during volcanic collapse. An episode of extension and emplacement of northwest-trending porphyritic dyke swarms occurred around 78 to 76 Ma (Stage 3, Fig. 23).

The Tahtsa Lake cauldron subsidence complex was again the site of magmatic activity in Late Paleocene and Early Eocene time (Stage 4, Fig. 23). The initial event was emplacement of the Mount Bolom stock accompanied by doming of volcanic strata within the cauldron subsidence complex. Magmatic activity continued well into the Eocene with intrusion of northwest-trending dyke swarms of various compositions, and emplacement of the Berg intrusions; this was accompanied by formation of the Berg porphyry copper deposit. Extrusive activity may have accompanied these plutonic episodes.

SUMMARY

In the Tahtsa Lake district of west-central British Columbia porphyry copper-molybdenum deposits are associated with periods of magmatic resurgence that post dated cauldron subsidence. The inferred sequence of events and apparent time-space relationships of volcanic and plutonic activity are similar to those derived by Lipman, *et al.* (1976) and Steven and Lipman (1974) for the San Juan volcanic field of Colorado, by Sillitoe (1977) for the Andean volcanic arc, and by Robinson, *et al.* (1968) for the Boulder batholith area. In all these areas major episodes of hydrothermal activity postdate the main period of volcanism and are genetically related to short-lived periods of magmatic resurgence that had a relatively minor extrusive component. Structures established during the initial episodes of volcanic activity and caldera collapse, such as radial and ring fractures, appear to have been extremely important in localizing these post-volcanic or post-caldera plutonic centres and their attendant hydrothermal systems.

Although the temporal and spatial relationships of volcanism and plutonism are well established in many areas, reasons for periodic episodes of magmatic resurgence in the evolution of volcanic terranes are not clearly understood. Perhaps fluctuations in the regional stress regime related to changes in the direction and rate of plate subduction are the most important causative factors. Certainly in the Tahtsa Lake area there is evidence that several periods of extension and dyke emplacement postdate the main volcanic event. A similar trend has been documented by Katz (1971) in evolution of the Andean volcanic arc, where the tectonic style at any given point oceanward of the arc became progressively more extensional as the locus of volcanism migrated eastward.

APPENDIX A — FOSSIL IDENTIFICATIONS

REPORT J-6-1978

H. Frebold, Geological Survey of Canada, Ottawa
Field No. 8-78TD-F3, GSC loc. C-80131

Ashman Formation, Bowser Lake Group. On road to Emerald Glacier mine, Mount Sweeney, second lowest west-pointing switch back. 53°43′35″N, 127°15′15″W. Whitesail Lake area. H. W. Tipper coll. July 26, 1978.

Identifications

The ammonites collected at this locality are very poorly preserved. There are some small specimens which cannot be determined safely. Some of them may be inner whorls of a species of the genus *Iniskinites* Imlay, which is represented by a fragment of a larger specimen. The shape of this specimen is globose and the ribs of the preserved parts of the last and penultimate whorls are strong. At a comparable size *I. magniformis* (Imlay) is more globose, has a lower cross-section, and finer ribs. *I. abruptus* (Imlay) is apparently similar in shape to the Whitesail Lake specimen but has much finer ribs at comparable stages of growth. The Whitesail Lake specimen is here listed as *Iniskinites* sp. nov.

Two other genera are present in this collection:

Oppelia (Oxycerites) sp. indet.
Perisphinctid gen. et species indet.
Both ammonites are extremely poorly preserved.

Conclusions

The presence of the genus *Iniskinites* Imlay in this collection indicates a Late Bathonian age.

REPORT Km-4-1979

J.A. Jeletzky, Geological Survey of Canada, Ottawa
Field No. 62C-78RW, GSC loc. 96261

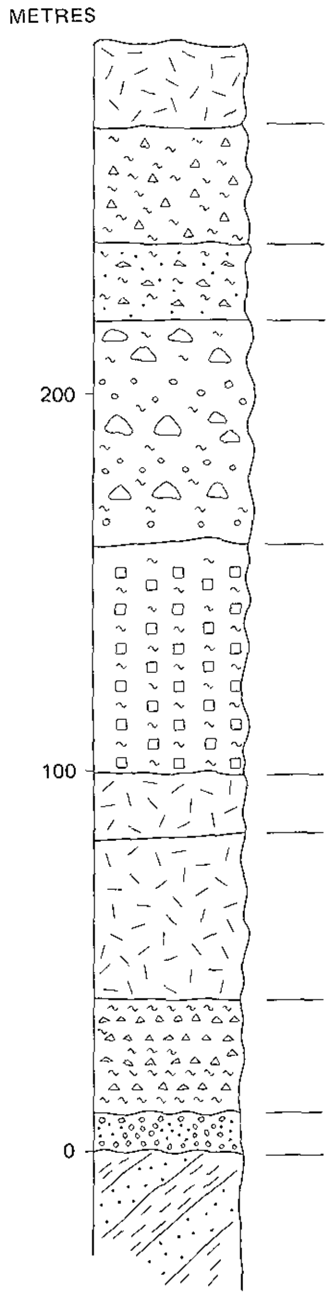
From Skeena Group 609250E, 5963780N. North Sibola Range, northwest of Mount Sweeney, UTM-9U.

Fragments of ammonites resembling *Brewericeras* or *Cleoniceras (Grycia)* but not identifiable generically with any degree of certainty.
Toxaster(?) sp. indet. (an irregular echinoid)
Pecten (Entolium) sp. indet.
Nucula (s. lato) sp. indet.

Age and Correlation

Poor ammonites of the lot 96261 suggest, but do not prove, its early to mid-Albian age. Poorly preserved irregular echinoids, presumably belonging to the genus *Toxaster*, appear to be the same form as that commonly associated with *Cleoniceras (Grycia) perezianum* fauna in the Whitesail Lake area and elsewhere in northwestern British Columbia. It is suggested accordingly that lot 96261 represents this mid-Albian fauna and is correlative with the lots 96252 and 96253. Lot 96261 can only be dated definitively as of a general Cretaceous age on the basis of its poorly preserved fossils alone.

APPENDIX B — KASALKA GROUP TYPE SECTIONS



FELSIC FRAGMENTAL UNIT

MASSIVE FINE–GRAINED MEDIUM TO LIGHT GREY PORPHYRITIC RHYODACITE

MASSIVE POORLY SORTED GREENISH GREY VOLCANIC BRECCIA; MAINLY RHYOLITIC CLASTS

STRATIFIED FINE–GRAINED MEDIUM GREY LITHIC TUFF; NON TO PARTLY WELDED

MASSIVE COARSE–GRAINED MEDIUM GREY VOLCANIC BRECCIA; RHYOLITIC, ANDESITIC, AND SEDIMENTARY CLASTS; MINOR CRYSTAL, LAPILLI, AND ASH TUFF INTERBEDDED WITH THE BRECCIA

FINELY LAMINATED LIGHT TO DARK GREY RHYO–DACITIC CRYSTAL TUFF; MODERATE TO DENSELY WELDED. PROMINENT EUTAXITIC TEXTURES; VERY SILICEOUS IN PLACES

MASSIVE MEDIUM–GRAINED PORPHYRITIC ANDESITE

MASSIVE LIGHT GREY PORPHYRITIC RHYODACITE; FLOW BANDED IN PLACES; GRADES INTO DACITE AND ANDESITE UP SECTION

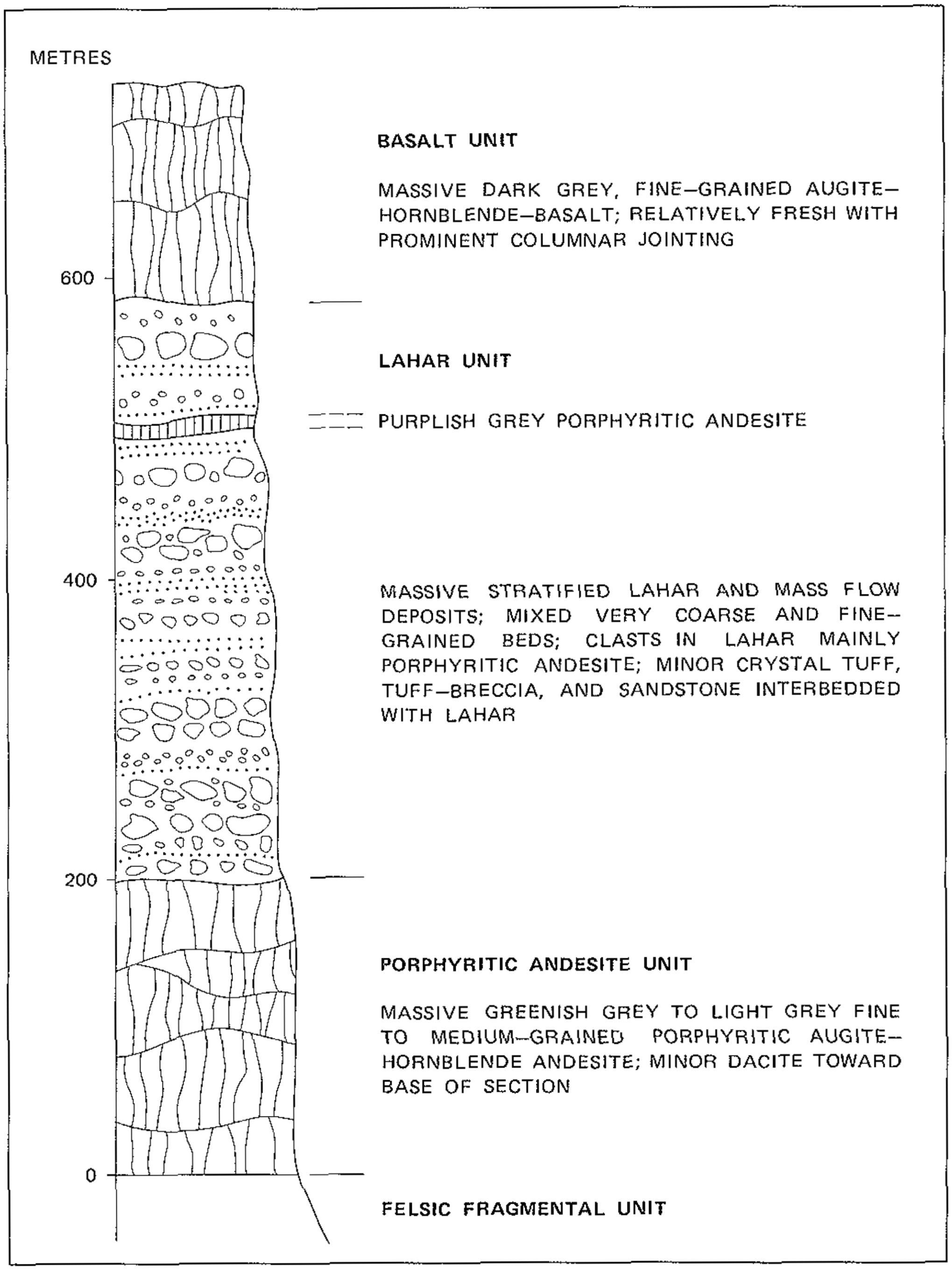
STRATIFIED MEDIUM TO COARSE–GRAINED LIGHT GREY RHYODACITIC LAPILLI TUFF; NON TO PARTLY WELDED

POORLY SORTED RED PEBBLE CONGLOMERATE WITH MINOR SANDSTONE

SKEENA GROUP (ALBIAN)
ARGILLITE, MICACEOUS WACKE

LOCATION: NORTHWEST SPUR OF MT. BAPTISTE

APPENDIX B — KASALKA GROUP TYPE SECTIONS — *Continued*



LOCATION: SOUTH SLOPE OF SWING PEAK RIDGE

APPENDIX C

CHEMICAL ANALYSES (OXIDES, WT %) AND CIPW MOLECULAR NORMS OF TYPICAL SAMPLES OF KASALKA GROUP VOLCANIC ROCKS

MAP UNIT	lukf	ukp						lukf		ukr			ukdr			
No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
SiO_2	57.54	57.60	57.66	60.93	61.40	61.79	63.42	70.89	72.48	73.76	74.79	79.52	57.67	59.10	64.01	56.85
TiO_2	0.79	1.38	1.30	0.73	0.63	0.50	0.59	0.39	0.25	0.25	0.07	0.11	0.80	0.57	0.54	0.60
Al_2O_3	16.81	15.78	16.78	16.81	16.55	16.67	16.25	16.77	14.46	14.22	14.85	12.10	17.65	17.06	16.07	17.86
*Fe_2O_3	6.94	7.30	7.09	4.97	5.30	5.59	4.96	2.00	2.11	1.22	0.87	0.80	6.18	6.58	4.82	7.13
MnO	0.12	0.09	0.12	0.11	0.10	0.15	0.08	0.07	0.09	0.04	0.05	0.08	0.11	0.15	0.10	0.20
MgO	3.52	3.87	2.57	3.77	3.73	3.03	2.85	0.70	0.84	0.53	0.45	0.70	3.53	2.91	2.32	3.59
CaO	5.87	5.71	5.63	4.74	4.88	3.40	3.99	1.52	1.23	0.50	1.06	0.94	6.03	6.97	3.70	5.61
Na_2O	5.13	4.15	4.54	4.26	4.02	5.39	4.53	4.08	4.90	4.66	3.80	3.95	4.16	3.42	4.94	4.62
K_2O	1.56	2.14	2.38	2.14	1.87	1.98	1.96	2.70	2.85	4.15	3.51	1.36	2.28	1.72	2.14	1.90
P_2O_5	0.30	0.57	0.61	0.26	0.25	0.24	0.23	0.16	0.09	0.06	0.02	0.04	0.33	0.31	0.26	0.36
L.O.I.	1.07	1.15	1.50	2.46	1.89	2.18	2.01	2.80	3.24	0.74	1.06	1.34	1.07	2.08	1.79	n.d.
Total	99.65	99.74	100.18	101.18	100.62	100.92	100.87	102.08	102.54	100.13	100.53	100.94	99.71	100.87	100.69	98.57
Q	4.32	8.48	7.41	11.62	13.56	9.34	15.39	30.43	28.48	26.81	33.79	45.39	6.65	12.59	14.68	4.10
or	9.30	12.88	14.31	12.75	11.19	11.75	11.70	16.14	17.40	24.66	20.98	8.18	13.63	10.39	12.76	11.34
ab	46.49	37.97	41.49	38.58	36.55	48.62	41.11	37.07	42.84	42.08	34.52	36.12	37.79	31.39	44.75	41.92
an	18.40	18.46	18.71	20.61	21.87	15.39	18.42	6.59	5.32	2.10	5.19	4.49	23.02	26.71	15.49	22.63
di	7.22	5.32	4.57	1.14	0.81	0.00	0.07	0.00	0.00	0.00	0.00	0.00	4.07	5.28	1.06	2.57
hy	10.02	10.65	7.39	11.37	12.26	11.55	9.78	2.90	2.37	2.01	1.83	2.49	10.58	9.96	7.80	13.63
mt	2.51	3.07	2.98	2.35	2.25	2.10	2.21	0.73	1.32	0.44	0.32	0.29	2.43	2.21	2.15	2.22
il	1.11	1.96	1.84	1.03	0.89	0.70	0.83	0.55	0.35	0.35	0.10	0.16	1.13	0.81	0.76	0.84
ap	0.63	1.21	1.30	0.55	0.53	0.50	0.49	0.34	0.19	0.13	0.04	0.09	0.70	0.66	0.55	0.74
C	0.00	0.00	0.00	0.00	0.00	0.05	0.00	5.25	1.68	1.42	3.23	2.80	0.00	0.00	0.00	0.00
An %	28.36	32.71	31.08	34.81	37.43	24.04	30.94	15.08	11.04	4.76	13.07	11.05	31.05	45.97	25.72	

* Total Fe as Fe_2O_3; L.O.I. = Loss on ignition.

1—Lapilli-tuff, Mt. Baptiste.
2—Porphyritic hornblende andesite, 4.4 km southeast of Laventie Mountain.
3—Porphyritic andesite, Swing Peak.
4—Porphyritic hornblende biotite andesite, south slope Swing Peak ridge.
5—Porphyritic hornblende andesite, 5.8 km southwest of Swing Peak.
6—Porphyritic hornblende andesite, Swing Peak ridge.
7—Porphyritic andesite, 5 km northwest of Mt. Baptiste.
8—*Rhyolitic lapilli-tuff, Mt. Baptiste.*
9—Porphyritic dacite, north slope of Swing Peak.
10—Banded rhyodacite flow, 4.5 km southeast of Laventie Mountain.
11—Tuffaceous rhyodacite flow, 3.1 km east of Berg Peak.
12—Rhyolitic tuff, 8.1 km east of Berg Peak.
13—Medium-grained hornblende-biotite-augite diorite, Ox Lake.
14—Hornblende-augite andesite dyke, north slope, Swing Peak. Sample.
15—Porphyritic hornblende-augite andesite stock (?) northwest of Mt. Baptiste.
16—Porphyritic hornblende-augite andesite dyke, north slope, Swing Peak.

MAP UNIT	ukdr		ukgd				ukpgd	ukgd				ukpgd	ukpqm	ukpgm	ukpqm	ukqp
No.	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
SiO_2	64.35	64.47	60.58	62.96	63.06	64.23	64.23	64.30	67.30	67.82	68.07	66.41	66.91	68.77	70.25	70.62
TiO_2	0.45	0.60	0.76	0.69	0.72	0.66	0.64	0.59	0.47	0.43	0.41	0.49	0.58	0.49	0.42	0.22
Al_2O_3	16.41	16.17	15.94	15.51	16.04	15.31	15.76	15.33	15.13	14.88	15.06	15.29	14.67	14.25	13.81	16.76
*Fe_2O_3	4.81	4.13	5.16	4.97	4.55	4.38	4.29	4.14	3.18	3.17	3.13	3.75	4.02	3.58	3.17	1.50
MnO	0.13	0.07	0.11	0.09	0.08	0.10	0.05	0.08	0.06	0.03	0.03	0.07	0.04	0.08	0.13	0.23
MgO	1.91	2.31	4.18	2.78	2.77	2.83	2.69	2.91	2.15	1.93	1.85	1.84	2.31	1.77	1.84	0.71
CaO	3.71	4.65	5.18	4.52	4.25	4.09	3.92	4.17	3.14	3.36	2.83	4.16	2.85	2.77	2.28	1.08
Na_2O	4.84	4.08	4.37	4.21	4.21	4.07	4.04	4.03	4.28	4.14	4.14	4.05	4.37	3.73	3.75	1.48
K_2O	2.09	2.22	2.09	2.82	2.90	2.95	3.03	3.07	3.11	3.14	3.40	2.81	2.99	3.51	3.32	6.70
P_2O_5	0.26	0.26	0.30	0.32	0.29	0.30	0.26	0.28	0.24	0.20	0.19	0.21	0.27	0.20	0.21	0.06
L.O.I.	2.11	1.01	1.03	0.63	1.02	1.16	2.34	0.83	0.60	0.94	0.84	1.71	0.65	0.51	1.86	2.54
Total	101.07	99.97	99.70	99.50	99.89	100.08	101.25	99.73	99.60	100.04	99.95	100.79	99.66	99.66	101.04	101.90
Q	15.85	18.47	9.87	13.60	13.56	15.65	15.67	15.35	19.28	20.52	20.50	19.56	19.08	23.33	26.12	30.87
or	12.48	13.29	12.45	16.88	17.32	17.64	18.12	18.34	18.55	18.76	20.30	16.83	17.87	21.09	19.94	40.49
ab	43.91	37.13	39.56	38.29	38.22	36.93	36.71	36.59	38.79	37.59	37.57	36.87	39.70	34.06	34.23	13.59
an	16.90	19.52	17.86	15.29	16.49	14.98	16.11	14.84	13.01	12.89	12.61	15.46	11.72	11.98	10.12	5.08
di	0.00	1.73	4.88	4.26	2.35	2.88	1.49	3.40	0.92	2.13	0.28	3.27	0.66	0.55	0.00	0.00
hy	7.55	6.24	11.82	8.23	8.78	8.70	8.89	8.56	7.14	5.93	6.64	5.51	8.13	6.58	6.95	3.10
mt	2.06	2.23	1.87	1.80	1.65	1.59	1.56	1.50	1.15	1.15	1.13	1.37	1.46	1.31	1.16	0.56
il	0.63	0.85	1.07	0.97	1.01	0.93	0.90	0.83	0.66	0.61	0.58	0.69	0.82	0.69	0.59	0.31
ap	0.55	0.55	0.63	0.68	0.61	0.63	0.55	0.83	0.51	0.42	0.40	0.45	0.57	0.43	0.45	0.13
C	0.06	0.00														5.86
An %	27.79	34.45	31.10	28.54	30.14	28.82	30.51	28.85	25.12	25.54	25.12	29.54	22.80	26.01	22.81	27.22

* Total Fe as Fe_2O_3; L.O.I. = Loss on ignition.

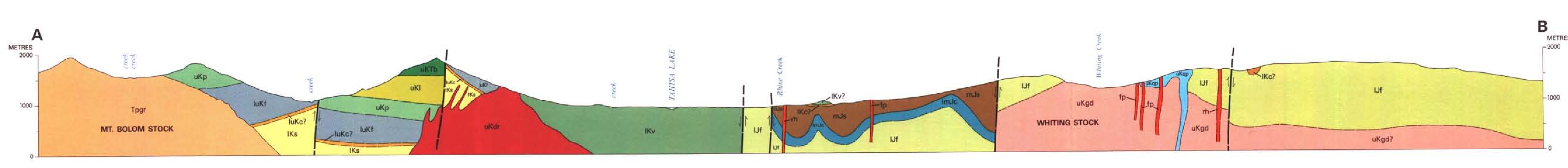
17—Medium-grained hornblende augite diorite plug, south slope, Rhine Ridge.
18—Same as M203.
19—Medium-grained porphyritic biotite quartz diorite, Coles Creek prospect.
20—Medium-grained hornblende-biotite granodiorite, east contact Sibola Stock, 1.9 km northwest of Sibola Peak.
21—Medium-grained biotite quartz diorite, Mt. Baptiste. Sample D-255.
22—Medium-grained hornblende-biotite granodiorite, Sibola Stock, 3.5 km north of Mt. Sweeney.
23—Medium-grained porphyritic hornblende-biotite granodiorite, Coles Creek.
24—Medium-grained hornblende-biotite granodiorite, Sibola Stock, Mt. Sweeney.
25—Medium-grained hornblende-biotite granodiorite, Sibola Stock, 3.2 km northwest of Mt. Sweeney.
26—Medium-grained hornblende-biotite granodiorite, Whiting Stock, Whiting Creek.
27—Medium-grained hornblende-biotite granodiorite, Whiting Stock, Whiting Creek.
28—Medium-grained porphyritic hornblende-biotite granodiorite, Ox Lake.
29—Coarse-grained porphyritic hornblende-biotite quartz monzonite, Bergette Prospect.
30—Medium-grained porphyritic hornblende-biotite quartz monzonite, Bergette Prospect.
31—Medium-grained porphyritic quartz monzonite dyke, 3.2 km northwest of Mt. Sweeney.
32—Quartz porphyry dyke, Whiting Creek.

CHEMICAL ANALYSES (OXIDES, WT %) AND CIPW MOLECULAR NORMS OF TYPICAL SAMPLES OF KASALKA GROUP VOLCANIC ROCKS—*Continued*

MAP UNIT	ukr	ukqp			Tpg — Mt. Bolon						Tqd		Tpqm				
No.	33	34	35	36	37	38	39	40	41	42	43	44	45	46	A	B	C
SiO_2	75.83	80.28	76.41	76.76	64.99	65.27	66.68	71.55	74.06	73.37	59.46	62.86	67.54	62.50	61.50	73.23	65.50
TiO_2	0.10	0.08	0.08	0.07	0.64	0.86	0.79	0.56	0.35	0.40	0.85	0.75	0.51	0.51	0.70	0.24	0.61
Al_2O_3	13.99	13.68	13.40	13.18	15.54	15.79	15.44	14.05	13.16	13.83	16.83	16.21	15.62	15.12	17.00	14.03	15.65
*Fe_2O_3	0.56	0.41	0.66	0.61	4.03	3.83	3.57	2.34	1.48	1.69	5.91	4.96	2.00	2.58	5.40	2.47	4.70
MnO	0.05	0.00	0.04	0.05	0.10	0.10	0.09	0.15	0.04	0.08	0.13	0.10	0.02	0.06	0.09	0.02	0.09
MgO	0.39	0.98	0.39	0.33	3.28	1.71	2.07	1.28	0.69	0.62	3.56	2.79	1.04	1.49	2.30	0.35	1.86
CaO	1.08	0.13	0.45	0.40	2.44	3.32	2.12	1.04	0.87	0.80	5.98	4.57	1.02	2.39	5.30	1.32	4.10
Na_2O	3.69	0.19	4.21	4.15	4.26	4.94	4.68	4.55	3.99	4.38	3.85	4.07	2.76	3.13	3.90	3.94	3.84
K_2O	3.78	3.89	3.83	3.95	3.27	2.86	3.23	3.57	4.71	4.14	1.82	2.29	5.06	4.55	1.90	4.08	3.01
P_2O_5	0.02	0.02	0.04	0.03	0.31	0.31	0.34	0.16	0.06	0.06	0.33	0.28	0.30	0.18	0.23	0.05	0.23
L.O.I.	2.13	1.62	1.04	0.68	2.04	1.52	1.18	0.91	0.92	0.61	0.79	1.21	n.d.	n.d.	1.30	—	0.69
Total	101.62	101.28	100.55	100.21	100.90	100.51	100.19	100.16	100.33	99.98	99.51	100.09			99.42	—	100.28
Q	34.61	60.27	33.30	33.71	16.22	15.29	18.33	25.41	27.90	27.30	11.48	15.29	30.50	24.70	—	—	—
or	22.62	23.92	22.84	23.57	19.48	17.03	19.24	21.29	28.15	24.70	10.92	13.72	31.20	29.10	—	—	—
ab	33.56	1.78	38.16	37.64	38.56	44.72	42.37	41.24	36.24	39.71	35.12	37.07	25.90	30.40	—	—	—
an	5.30	0.54	1.99	1.81	10.18	12.57	8.39	4.16	3.97	3.62	23.64	19.48	3.20	7.70	—	—	—
di	0.00	0.00	0.00	0.00	0.00	1.61	0.00	0.00	0.00	0.00	3.47	1.35	3.00[1]	4.80[1]	—	—	—
hy	1.41	2.99	1.49	1.32	11.13	5.53	7.23	4.61	2.52	2.45	11.31	9.64			—	—	—
mt	0.20	0.15	0.24	0.22	1.45	1.38	1.29	0.84	0.54	0.61	2.16	1.80	1.40	2.00	—	—	—
il	0.14	0.12	0.11	0.10	0.90	1.21	1.11	0.79	0.49	0.56	1.20	10.60	0.30	0.10	—	—	—
ap	0.04	0.04	0.08	0.06	0.65	0.56	0.72	0.34	0.13	0.13	0.70	0.59			—	—	—
C	2.11	10.19	1.77	1.57	1.42	0.00	1.32	1.31	0.07	0.92	0.00	0.00			—	—	—
An %	13.63	23.21	4.96	4.58	20.89	21.94	16.51	9.17	9.88	8.35	40.23	34.45			—	—	—

* Total Fe as Fe_2O_3; L.O.I. = Loss on ignition [1] total pyroxene

33—Aphanitic rhyolite, Whiting Creek.
34—Quartz porphyry dyke, Whiting Creek.
35—Fine-grained quartz porphyry dyke, north shore, Troitsa Lake.
36—Quartz porphyry, north shore, Troitsa Lake.
37—Medium-grained porphyritic hornblende-biotite granophyre, Mt. Bolom Stock, north tip of Blanket Lakes.
38—Medium-grained porphyritic hornblende-biotite granophyre, Mt. Bolom Stock, 7.8 km north-northeast of Mt. Bolom.
39—Medium-grained porphyritic hornblende-biotite granophyre, Mt. Bolom Stock 5 km north of Mt. Bolom.
40—Medium-grained porphyritic hornblende-biotite granophyre, Mt. Bolom Stock 5 km north of Mt. Bolom.
41—Fine-grained porphyritic hornblende-biotite granophyre, Mt. Bolom Stock, 2.5 km east of Mt. Bolom.
42—Fine-grained porphyritic biotite granophyre dyke, 1.5 km south of Swing Peak.
43—Medium-grained hornblende-biotite quartz diorite, 0.5 km east of Berg prospect.
44—Medium-grained hornblende-biotite quartz diorite, 2 km south of Berg prospect.
45—Porphyritic quartz monzonite, Berg Stock. Carter, 1981.
46—Plagioclase biotite quartz porphyry, Berg Stock. Carter, 1981.
A—Quartz bearing latite-andesite, north volcano Tumisa, Chile. Seigers *et al.*, 1969.
B—Average rhyolite, Cascade Volcanos. Carmichael *et al.*, 1974.
C—Average hornblende-biotite granodiorite. Nockolds, 1954.



Province of British Columbia
Ministry of Energy, Mines and Petroleum Resources

FIGURE 2

GEOLOGY OF THE TAHTSA LAKE MINERAL DISTRICT

N.T.S. 93E/11, 14

GEOLOGY COMPILED BY D. G. MACINTYRE
CARTOGRAPHY BY J. ARMITAGE AND P. CHICORELLI

SCALE 1:50 000

kilometres 1 0 1 2 3 4 kilometres

LEGEND

QUATERNARY
PLEISTOCENE AND RECENT

Qal — GLACIAL TILL, ALLUVIUM, COLLUVIUM

TERTIARY
EOCENE AND YOUNGER (MAY INCLUDE CRETACEOUS) DYKES, SILLS, AND PLUGS

LAMPROPHYRE (lm), BASALT OR ANDESITE (mf), MAFIC-RICH TO MAFIC-POOR FELDSPAR PORPHYRY (fp), PINK APLITE PORPHYRY (ap), WHITE RHYOLITE PORPHYRY (rh) AND BRECCIA PIPES (bx)

EOCENE
NANIKA INTRUSIONS

Tpqm — PORPHYRITIC BIOTITE-QUARTZ MONZONITE

COAST INTRUSIONS

Tqd — BIOTITE-HORNBLENDE QUARTZ DIORITE

PALEOCENE
MOUNT BOLOM INTRUSION

Tpgr — PORPHYRITIC HORNBLENDE-BIOTITE GRANOPHYRE

UPPER CRETACEOUS
BULKLEY INTRUSIONS

uKpqm — PORPHYRITIC HORNBLENDE-BIOTITE QUARTZ MONZONITE

uKpgd — PORPHYRITIC HORNBLENDE-BIOTITE GRANODIORITE

uKgd — BIOTITE-HORNBLENDE GRANODIORITE

uKqd — BIOTITE-HORNBLENDE QUARTZ DIORITE AND DIORITE

RHYOLITIC INTRUSIONS

uKqp — SERICITIC QUARTZ 'EYE' PORPHYRY, BIOTITE-FELDSPAR-QUARTZ PORPHYRY (DACITE PORPHYRY); LOCALLY BRECCIATED (uK_{bx})

LOWER TO UPPER CRETACEOUS
KASALKA INTRUSIONS

uKdr — PORPHYRITIC AUGITE-HORNBLENDE MICRODIORITE AND ANDESITE AS LACCOLITHS, DYKES, SILLS, AND SMALL STOCKS

KASALKA GROUP (IN PART TERTIARY ?)

uKTb — *BASALT UNIT:* COLUMNAR-JOINTED BASALT FLOWS

uKr — *RHYOLITE UNIT:* WHITE SERICITIC FLOW-BANDED RHYOLITE

uKl — *LAHAR UNIT:* STRATIFIED BOULDER AND PEBBLE CONGLOMERATE, CHAOTIC BRECCIA, MINOR VOLCANIC SANDSTONE AND MUDSTONE, MINOR PORPHYRITIC ANDESITE FLOWS

uKp — *PORPHYRITIC ANDESITE UNIT:* COLUMNAR-JOINTED GREENISH GREY, FINE TO COARSE-GRAINED PORPHYRITIC AUGITE-HORNBLENDE ANDESITE FLOWS (MAY INCLUDE SUBVOLCANIC SILLS AND LACCOLITHS OF SIMILAR LITHOLOGY)

luKf — *FELSIC FRAGMENTAL UNIT:* INTERBEDDED RHYOLITIC TO ANDESITIC LAPILLI TUFF, ASH FLOW TUFF, CRYSTAL TUFF, BRECCIA, PEBBLE CONGLOMERATE, PORPHYRITIC ANDESITE AND DACITE FLOWS (MAY INCLUDE LACCOLITHS OF SIMILAR LITHOLOGY)

LOWER TO UPPER CRETACEOUS *(CONTINUED)*
KASALKA GROUP *(CONTINUED)*

luKc — *BASAL PEBBLE CONGLOMERATE UNIT:* RED POLYMICTIC PEBBLE CONGLOMERATE, MINOR RED SANDSTONE (LOCALLY UNIT IS GREENISH GREY)

LOWER CRETACEOUS (MAINLY ALBIAN)
SKEENA GROUP

lKs — *MARINE SEDIMENTARY UNIT:* INTERBEDDED ARGILLITE AND MICACEOUS LITHIC WACKE, MINOR GRANULE CONGLOMERATE (SUCCESSOR BASIN TURBIDITES)

lKv — *AMYGDALOIDAL BASALT UNIT:* COLUMNAR-JOINTED, SPILITIZED, AMYGDALOIDAL BASALT FLOWS, MINOR FLOW TOP BRECCIAS

lKc — BASAL BOULDER CONGLOMERATE?

MIDDLE JURASSIC (UPPER BATHONIAN TO LOWER CALLOVIAN)
BOWSER LAKE GROUP

mJs — *MARINE SEDIMENTARY UNIT (ASHMAN FORMATION):* LITHIC AND FELDSPATHIC WACKE, PEBBLE AND GRANULE CONGLOMERATE, CHERTY BLACK ARGILLITE, ASH TUFF, SHALE (MAY INCLUDE SMITHERS FORMATION OF HAZELTON GROUP)

LOWER TO MIDDLE JURASSIC (SINEMURIAN TO MIDDLE BAJOCIAN)
HAZELTON GROUP

lmJc — *FELSIC VOLCANIC AND CHERT UNIT (SMITHERS OR WHITESAIL FORMATION ?):* INTERBEDDED LIGHT GREY, MOTTLED, BANDED CHERT (EXHALITE ?), WHITE TO CREAM FLOW-BANDED RHYOLITE AND ASH FLOW TUFF, DACITIC TO RHYOLITIC WELDED AND NON-WELDED LAPILLI TUFF; MINOR ARGILLITE, FELDSPATHIC WACKE, AND RED TO GREEN ANDESITIC TUFF

lJf — *ANDESITIC FRAGMENTAL UNIT (TELKWA FORMATION):* THIN TO THICK-BEDDED, RED TO GREEN LAPILLI, LITHIC, CRYSTAL, AND ASH TUFF, TUFF BRECCIA, AGGLOMERATE, ACCRETIONARY CHERTY TUFF, PORPHYRITIC ANDESITE FLOWS

SYMBOLS

BEDDING: INCLINED, VERTICAL
SYNCLINE, ANTICLINE
FAULT: BALL ON DOWNTHROWN SIDE, LINEAR
GEOLOGICAL CONTACT: DEFINED, ASSUMED
AREA OF ABUNDANT OUTCROP
MINERAL OCCURRENCE AND TYPE .... 5•Cu
FOSSIL LOCALITY .... (F)
PERVASIVELY ALTERED PYRITIC ZONE
ROAD
TOPOGRAPHIC CONTOUR (100-METRE INTERVAL) 900

INDEX TO MAJOR MINERAL OCCURRENCES

MAP NO.	NAME	MOST RECENT OPERATOR	COMMODITY	RESERVES	DESCRIPTION	REFERENCE
1	BERG (93E–46)	Placer Development Ltd., 1980	Cu, Mo	400 m.t. 0.4% Cu 0.05% MoS_2	Annular zone about Eocene porphyritic quartz monzonite stock, supergene enriched.	Panteleyev, 1981
2	BERGETTE (93E–52)	Granges Exploration, 1973	Cu, Mo	non-defined	Quartz porphyry breccia pipe contains molybdenite, pyrite, and chalcopyrite. Pyritic veinlets occur in hornfels adjacent to the main stock.	Church, 1971
3	SYLVIA (93E–89)	Hudson's Bay Oil and Gas, 1976	Cu	non-defined	Pyrite and chalcopyrite occur in Upper Cretaceous (uK) quartz diorite and Jurassic volcanic rocks.	GEM 1974, p. 246
4	WHITING CREEK (WHIT) (93E–49, 50)	Saskatchewan Mining and Development Corp., 1981	Mo, Cu	123.5 m.t. 0.043% MoS_2 0.062% Cu (Ridge Zone)	Quartz-molybdenite veinlets occur in altered uK quartz porphyry; chalcopyrite and molybdenite veinlets occur in potassic-altered uK granodiorite and porphyritic quartz monzonite.	Cann, 1980
5	WEE (93E–86)	Hudson's Bay Oil and Gas, 1979	Cu	non-defined	Pyrite and chalcopyrite occur in breccia intruded by small uK quartz diorite stocks.	GEM 1974, pp. 243-244
6	HUCKLEBERRY (LEN) (93E–37, 38, 39)	Granby Mining Corp., 1974	Cu, Mo	87 m.t. 0.408% Cu 0.025% MoS_2	Annular zone of disseminated and veinlet sulphides in hornfels adjacent to uK porphyritic granodiorite stock.	James, 1976
7	OX LAKE (OX) (93E–4)	ASARCO Exploration Co. of Canada, 1982	Cu, Mo	23.6 m.t. 0.35% Cu equiv.	Zone of disseminated and veinlet sulphides in hornfels and breccia adjacent to small uK porphyritic granodiorite stock.	Richards, 1976
8	REA, TL, LEAN-TO (93E–40)	Lansdowne Oil and Minerals Ltd., 1983	Cu, Mo, Ag	non-defined	Pyrite, chalcopyrite, arsenopyrite, pyrrhotite, marcasite, sphalerite, and tetrahedrite occur in quartz porphyry breccia pipe.	GEM 1972, p. 340; Ager and Holland, 1983
9	COLES CREEK (FAB) (93E–41, 42, 43, 44)	Amax Potash Corp., 1972	Cu, Mo, Pb, Zn, Ag	non-defined	Quartz vein stockwork with chalcopyrite and minor molybdenite occurs in potassic altered uK porphyritic granodiorite stock; galena and sphalerite occur in argillic altered uK volcaniclastic rocks and dacite porphyry; chalcopyrite, molybdenite, galena, sphalerite and magnetite occur in quartz porphyry breccia pipe.	MacIntyre, 1974
10	TROITSA (OVP) (93E–3, 5, 9)	Cerro Mining Co. of Canada Ltd., 1971	Cu	non-defined	Chalcopyrite occurs in altered feldspar porphyry dykes cutting uK granodiorite.	Cawthorn, 1973
11	EMERALD GLACIER (93E–1) also GLACIER, STANLEY (93E–47, 48)	Emerald Glacier Mines Ltd., 1982	Pb, Zn, Ag	non-defined producer 1951–1953 4 200 tonnes averaging 12.1% Pb 11.5% Zn 408 g/tonne Ag 0.27 g/tonne Au	North-trending, steep-dipping shear zone with quartz, calcite, galena, sphalerite, and minor chalocpyrite and pyrite.	Sutherland Brown, 1967
12	SWANNELL, CAPTAIN (SWING, SAM) (93E–35)	Tahtsa Mines Ltd., 1981	Pb, Zn, Ag	non-defined	Galena, sphalerite, pyrite, and minor tetrahedrite occur in steep northwest-trending shear zones.	Goldsmith and Kallock, 1981
13	LEAD EMPIRE (SET, LOST, ICE) (93E–8)	Sierra Empire Mines Ltd., 1971	Pb, Zn, Ag	non-defined	Pyrite and quartz with variable galena and sphalerite occur in shear zones near Eocene quartz diorite.	Duffell, 1959
14	WEST VIEW (93E–74)	?	Zn, Pb, Ag, Au	non-defined	Quartz, sphalerite, minor galena, and pyrite in veins.	MMAR 1916, p. K163
15	ORIENTAL (93E–51)	?	Ag, Au	non-defined	Minor pyrite in quartz veins.	May be Gold Crown, Bellecini, Golden Chest, Jolimont claims described in MMAR 1916
16	RIVERSIDE (93E–36)	?	Au, Ag, Cu, Zn	non-defined	Pyrite and arsenopyrite occur in quartz veins with minor chalcopyrite and sphalerite.	Duffell, 1959
17	GLORY (93E–7)	?	Ag, Pb, Cu, Au	non-defined	Pyrite, chalcopyrite, galena, and specular hematite occur in quartz stringers.	Duffell, 1959

MMAR = British Columbia Minister of Mines Annual Report.
GEM = Geology, Exploration and Mining in British Columbia.
m.t. = million tonnes.

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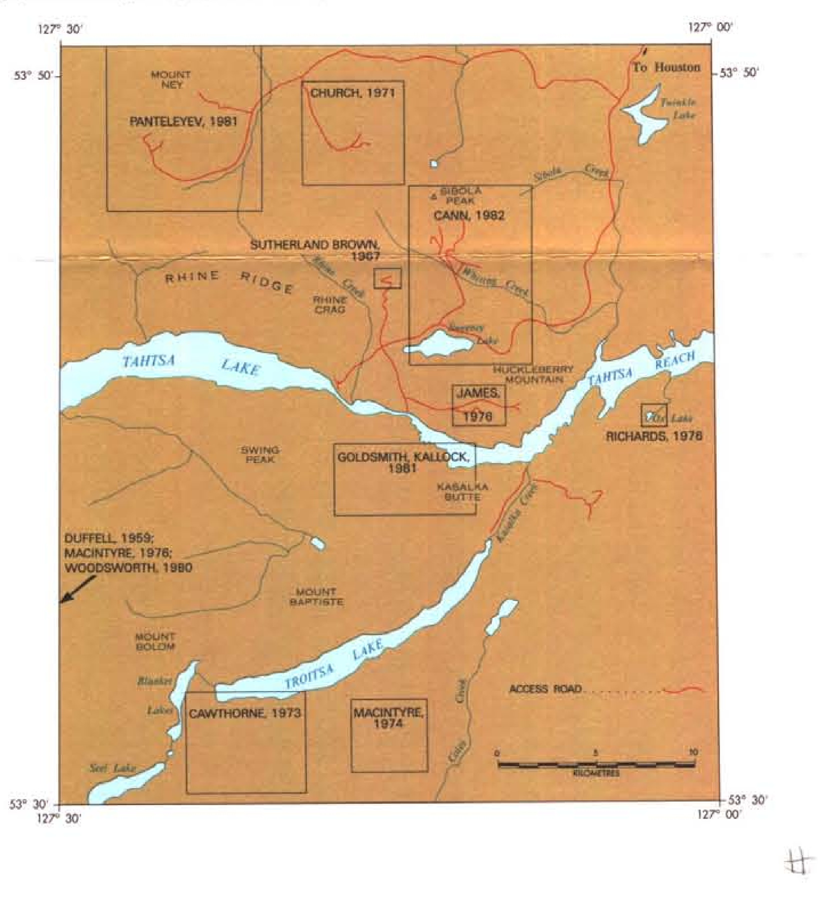

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